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To the Roots

This special issue is published under the patronage of Roman Hrmo and Lucia Kristofiakova. Its goal is an exchange of relevant trends, research results and hands-on experience within engineering pedagogy.

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Engineering Pedagogy

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Editorial

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This special issue, “To the Roots: Engineering Pedagogy”, is published under the editorial guidance of Roman Hrmo and Lucia Krištofiaková, both of whom are affiliated with DTI University. This edition of R&E-SOURCE seeks to disseminate contemporary trends, research findings, and practical insights in the field of engineering pedagogy.

To effectively fulfil their professional responsibilities – which include education, training, and the holistic development of learners – teachers must possess a comprehensive understanding of their subject matter, robust pedagogical training, and a broad general knowledge base. Within this context, the Internationale Gesellschaft für Ingenieurpädagogik (International Society for Engineering Education, IGIP) plays a pivotal role in advancing the discipline.

IGIP was established in 1972 at the University of Klagenfurt by Professor Adolf Melezinek. The formalisation of engineering pedagogy as an academic discipline marked a significant advancement, as it represented the first scientific integration of engineering and pedagogy. As early as the 1970s, European integration and the development of standardised educator profiles were identified as key priorities for education, training, and learning. Engineering pedagogy is an interdisciplinary scientific domain that incorporates principles of pedagogy and psychology into technical education to enhance instructional effectiveness.

The core focus of engineering pedagogy is the body of knowledge essential for preparing educators to teach future engineers in technical disciplines. IGIP actively promotes scientific research while coordinating and supporting international initiatives in engineering education.

The key themes explored in this volume include teacher education, engineering education, emerging trends in field didactics, accreditation, curriculum development, quality assurance in education, technical teacher training, key competencies, the integration of social sciences in engineering education, information and communication technologies in education, talent development, lifelong learning, and challenges in educational practice.

We sincerely appreciate the meticulous language proofreading of this special issue conducted by Mgr. Andrea Fedorová.

Roman Hrmo and Lucia Krištofiaková

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To the Roots: Engineering Pedagogy

The Use of Software for Teaching Economic Subjects at Secondary Vocational Schools

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Abstract

Using a wide range of specialized software is one of the most effective ways to bridge theoretical knowledge with practical application. In educational practice, the use of software is an integral component of teaching professional subjects with content that is directly applicable in real-world contexts. The aim of this paper is to present the results of a survey focused on how and to what extent specific software is used for teaching accounting at secondary schools in the Czech Republic. The research tool employed was a self-constructed questionnaire. The sample group consisted of secondary schools offering fields of study within the 'Economics and Administration' group. The respondents were teachers of economic subjects. The survey was conducted in the spring of 2024, with a total of 75 teachers participating.

Keywords: Teaching Software, Economic Subjects, Secondary Vocational Schools

1 Introduction

Accounting is a field (surely like many others) that requires an impeccable understanding of basic principles and guidelines, knowledge, diligence, integrity and, last but not least, adherence to a code of ethics. All of these are formed in the pupils during each teaching unit and the content and form of the pupils' education needs to guide them in the right direction. At the same time, it is necessary that teaching is in line with the current requirements for graduates of secondary schools with an economic focus. Pupils should be as well prepared as possible for their future careers. The more the content of teaching incorporates practical skills and gives pupils the opportunity to encounter with practice, the easier the transition to professional life will be for them. The literature states that "accounting is an activity in which

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the state of and changes in assets, liabilities and equity, costs and revenues are recorded in monetary terms in order to prepare a profit and loss account at the end of the accounting period" (Munzar & Čuhlová, 2006, p. 57).

In order to set up an appropriate approach to teaching the subject of accounting, it is important to set teaching objectives within the framework of didactic principles in order to make the educational activity effective. The current requirements of the accounting profession should be reflected in the teaching of accounting in secondary schools (Fišerová, 2022, p. 47). One of the requirements for the job position of 'accountant' is at least a basic ability to operate an accounting software (Berková, 2015, p. 9). Secondary schools specializing in economics usually have accounting software and incorporate it in teaching. This approach ensures the development of practical skills (Berková, 2015, p. 10; Fialová, 2013, p. 60).

2 Use of accounting software

The use of accounting software is the most appropriate way to transfer theoretical knowledge, ideally without unnecessary delay, into practical activities. In practice, accounting software is an integral part of accounting work. The visual aspect of the theoretical training on the so-called 'T-Accounts' is essential and also the only one possible. However, after the transition to professional life, this form of representation is only supplementary and is no longer used for accounting itself. It therefore serves only to teach and understand accounting guidelines and principles. In contrast, accounting software is a compulsory working tool in which the T-Accounts have a different visual representation. In the context of teaching the subject of accounting, teachers should relate topics to real-life situations when teaching. This is facilitated by the inclusion of thematically interesting practical examples in the classroom, which allow pupils to apply their knowledge but also to relate it to their own personal or mediated knowledge. Practical exercises and simulations of real situations provide pupils with the opportunity to develop the skills needed in practice. Solving real-life problem situations is also a beneficial form of learning. For example, demonstrating an error in an accounting entry is also one effective way of linking theory to practical application. Pupils learn to analyse why the error occurred, what the consequence is and look for solutions.

As Berková (2015, p. 9) states, "For ensuring consistency between the requirements of economic practice and the content of university curricula, it is increasingly desirable to orient teaching practically." Despite Berková (2015) specially refers colleges, it is important to note that many secondary school graduates enter the workforce directly and transition immediately into their professional lives. Orienting teaching also in a practical direction is therefore desirable and beneficial for the future employment of secondary school graduates. The above facts indicate that practical training in the subject of accounting is very important. Given the fact that the professional responsibilities of the job title 'accountant' are often financially very risky, more consistent and extensive practice with the use of accounting software would be very beneficial here as well. Practice in the accounting subject should be incorporated into the subject without undue delay, ideally within 1 week of the theory being covered. In particular, practice should be an integral part of the accounting subject to such an extent as to ensure that graduates are well equipped for their future careers.

3 Secondary school subjects focusing on accounting

For teaching the subject of accounting, the most foundational document is the Framework Educational Programme for the field of Business Academy (MEYS, 2024). The FEPs provide a generally binding framework for developing school educational programmes across all educational fields in pre-school, primary, primary art, language, and secondary education. These programmes were introduced into education in the Czech Republic by Act No. 561/2004 Coll., on pre-school, primary, secondary, higher vocational and other education (Education Act). Based on the FEPs and the rules they establish, individual schools create their own school curricula (School Educational Programmes — SEPs), which must align with the FEP requirements. In these curricula, schools have to define the specific educational objectives of a given subject, its form, length, content, etc.

The subject of accounting is primarily taught at economically oriented secondary schools, particularly in business academies. It is also offered as an elective subject at other vocational secondary schools. Accounting serves as a subject that fosters students' fundamental economic thinking. Its key objective is to teach students to think effectively and behave rationally in both professional and personal contexts (SEP Business Academy, Blatná, 2010).

Students are encouraged to independently seek economic information and apply it alongside their theoretical knowledge. A critical component of the subject includes a basic understanding of legal norms that establish clear rules for the accounting field, along with an awareness of the consequences of non-compliance. Together with the subject Economics (or Fundamentals of Economics), Accounting is considered a core subject for majors dealing with economics, business or entrepreneurship. Throughout the study of the subject Accounting, coherent examples on the topic are worked out. The assignment of the examples is based on accounting practice so that the topics are as close as possible to the students and their experience.

4 Possibilities of implementing practical exercises in accounting subjects

There are three main forms of theoretical knowledge practice in secondary schools. The first form is the inclusion of practical exercises directly within the teaching of the accounting subject. Schools usually include the use of accounting software in their School Curriculum. The use of accounting software may be included directly in the accounting subject. It depends on the content of the school's curriculum and the school's ability to teach some accounting classes directly in computer labs. The technical equipment of the school and the setting of the timetable so that pupils can work independently or in pairs to complete assignments are also important.

The second option could be a separate subject dedicated to user skills using accounting software. This is a complementary subject to the accounting subject or other economic subjects. The parameters of these complementary subjects are defined in the school curricula, which set out their general objectives and didactic approach. At the same time, they define the pupils' key and professional competences. A supplementary subject is usually intended to supplement learning activities for which there is insufficient time during regular subjects. In relation to the accounting subject, these subjects deal mainly with practical exercises where theory is combined with practice. They are therefore used to practice examples using various didactic means. One of the best-known complementary subjects is the so-called 'mock company'. It is a teaching method that develops the entrepreneurial competences of pupils and students of primary, secondary, higher vocational and higher education institutions through the simulation of the activities of a real business entity (Hula, 2022, p. 3).

Teaching is most often conducted in computer labs so that students can work either independently or in small groups. Schools also opt for a form of special classrooms that have a corporate reception area, a meeting room and a computer room. Pupils have the freedom to choose their business plan, the staffing of departments and managers, etc. The teacher is involved when necessary to consult the best solutions to given situations or to communicate with the authorities. However, the responsibility for individual decisions lies with the pupils.

One of the building blocks of the subject is the mutual cooperation of pupils and the deepening of communication skills. An integral part of this is the cyclical movement of pupils within all departments so that they learn about all spheres of business activity. Another important fact is that the subject is not primarily focused on taking time to practice all accounting cases in accounting software. As Fialová (2013, p. 62) states, the form of teaching in the Mock Company subject has all the elements of practical application of theoretical knowledge not only from the accounting subject but also from other related subjects. Its basic task is to teach students to think efficiently and economically, which will help them in their professional and personal life. Pupils take an active interest in political, economic and social events during the subject. They develop critical thinking skills, investigate the credibility of information and learn to process all administrative and working documents.

The third form is a work experience placement, which usually takes place over two to four continuous weeks. According to the Education Act, pupils' practical training takes place in schools and educational establishments or at the workplaces of natural persons or legal entities who are authorised to carry out activities related to the field of education and have made an agreement with the school on the content and scope of practical training and the conditions for its conduct (Education Act No. 561/2004 Coll., paragraph 2). Practical training with employers (companies or other organisations) must always be regulated by a written contract that specifies the content, scope and conditions of cooperation. The provisions of the Labour Code governing working hours, occupational safety and health, care of employees and working conditions for women and adolescents and other regulations on occupational safety and health apply to pupils during their internship.

In specific cases of practice in organisations (companies) that provide client accounting services, several questions arise. Can students be allowed to handle all accounting documents or only certain types of documents? Can it be ensured that accounting documents are not damaged? Can it be relied upon that the accounting data accessed will not be misused or disclosed to a third party? Therefore, there may be a concern on the part of the provider that it is not in their power to ensure total compliance with the needs of the learners and the working rules. This can mean considerable complications which, in an extreme case, may end up in court proceedings. As Fialová (2013, p. 63) argues, sensitive data is likely to be one of the reasons for the difficulty in linking school and practice. The current attitude of companies is that they must not treat pupils as employees and follow the recommendation that the pupil should not be involved in the business activities of the practice provider (Vejsada & Škubal, 2019, unpaginated).

Indeed, as the authors further state in their article - the primary object of the internship should be the acquisition of knowledge and experience on the part of the intern, not the acquisition of unpaid labour on the part of the employer.

From all the forms above it can be concluded that the content of these subjects, nor the practice itself, is not sufficient to acquire and master the acquired theoretical knowledge that would be applied in accounting software. A similar conclusion was reached by Fialová (2013, p. 59), who states that "a frequently criticized shortcoming of education in the Czech Republic, not only in secondary schools but also in tertiary education, is the high level of theoretical knowledge imparted and the provision of a small percentage of practical skills".

5 A survey of the use of accounting software in secondary school accounting education

The aim of the following text is to present the results of a survey aimed at finding out how and to what extent the use of accounting software is included in the teaching of accounting in secondary schools in the Czech Republic. The aim was to answer the following survey questions:

The main research question was stated as follows:

- *Does the school use accounting software as part of the accounting subject?*

The sub-questions of the survey were set as follows:

- *In which economic subjects is accounting software used?*
- *How is the practice of accounting theory ensured?*

- *To what extent do pupils practice accounting theory in professional practice?*

The research instrument was a self-constructed questionnaire. The questionnaire was constructed using a form on the Google platform. The questionnaire, as already mentioned, contained a total of 16 research questions, of which 14 were dedicated to the objectives of the research and 2 were identification questions. The following is an evaluation of selected questions, not all of them, so as to fulfil the purpose of the paper. The questionnaire was designed in such a way that the questions gradually revealed the use of accounting software in teaching and the extent of their use. The questionnaire was divided into four main sections of questions:
Section 1: *Respondent Identification*.
Section 2: *The use of accounting software in teaching the accounting subject.*
Section 3: *Using accounting software in teaching a complementary subject.*
Section 4: *Opportunities and content of pupils' work experience.*

The sample consisted of secondary schools that teach economics or offer subjects related to economics and business. The selection was made through the official register of schools on the website of the Ministry of Education, Youth and Sports of the Czech Republic. The register allows to filter secondary schools by a given criterion, which was the group of fields of study '63 - Economics and administration'. There were 87 business academies and 167 other secondary schools, i.e. 254 schools in total. The questionnaire was sent to the official contact emails of the selected schools between 5 February 2024 and 19 March 2024, and the data collection was closed on 16 April 2024. The specific respondents were the teachers at the contacted schools who teach economics subjects and were therefore best equipped to answer the questionnaire. A total of 75 respondents responded, of which 15 were eliminated due to invalid or duplicate responses. Of the 60 schools included in the treatment, 27 were secondary vocational schools and 33 were business academies.

6 Results of the survey

When asked: "Is practicing accounting with the use of accounting software on a computer included directly in the accounting subject?" 25 of them answered 'Yes', i.e. 41.6% and 35 of them answered 'No', i.e. 58.4%. More than half of the respondents have not included practicing theory with the use of accounting software directly in the accounting subject.

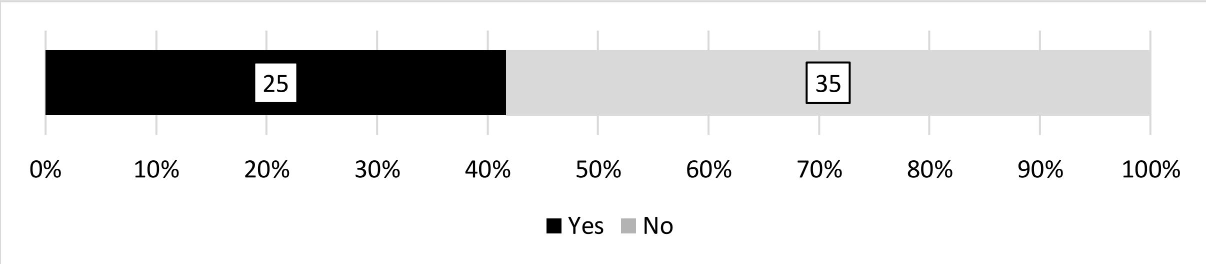

Chart 1: Is practicing accounting using accounting software on a computer included directly in the accounting subject?

Of the 25 respondents who have practicing accounting directly in their accounting subject using accounting software (question 3), 18 (72%) respondents stated that they use the accounting software *Pohoda*, 2 (8%) respondents use the accounting software *ABRA*, 2 respondents (8%) use the accounting software *Money*, 2 respondents use the accounting software *Stereo* i.e. 8% and 1 respondent (4%) uses the accounting software *Premier*. Hence, it is clear from the above that the most used accounting software is *Pohoda*. The accounting software *Pohoda* was also prevalent in the researche of Fialová (2013) and Berková (2015).

Software name	Absolute frequency	Relative frequency
Pohoda	18	72%
ABRA	2	8%
Money	2	8%
Stereo	2	8%
Premier	1	4%
Total	**25**	**100%**

Table 1: Please provide the name of the accounting software(s) your school uses?

Out of the 25 respondents who have accounting practice directly included in their accounting subject using accounting software, 18 respondents (72%) indicated that they do not practice within one week, while the remaining 7 respondents (28%) practice accounting software within one week of going through the theory. Hence, from the above, it is evident that out of the total 60 respondents, 25 respondents i.e. 41.6% of them include practicing accounting with the use of accounting software on computer directly in the accounting subject but only 7 of them practice on accounting software within one week of going through the accounting theory on the subject. This amounts to only 11.6% of the total respondents who use practicing on accounting software within the accounting subject within an appropriate time interval.

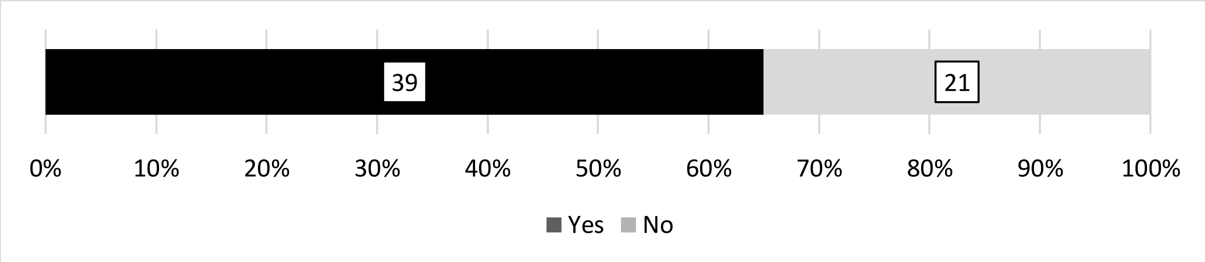

Chart 2: Is there a complementary subject at your school in which accounting in accounting software is practiced?

Thirty-nine respondents (65%) reported that an additional subject is taught at their school. The remaining 21 respondents, representing 35%, reported that the complementary subject is not taught at their school.

Name of complementary subject	Absolute frequency	Relative frequency
Accounting in practice	6	15.4%
PC-Accounting	11	28.2%
Practice	6	15.4%
Integrated economic subject	4	10.3%
Mock company	1	2.5%
Economics exercises	6	15.4%
Exercises in accounting	5	12.8%
Total	**39**	**100%**

Table 2: Names of additional subjects in which accounting is practiced in accounting software

Within the group of 39 respondents who had set up supplementary subjects in their schools to practice using accounting software, 7 specific supplementary subjects were listed, with the largest representation being the PC accounting subject with 11 respondents, or 28.2%. The second most frequent subjects were Accounting in Practice, Practice and Economics Exercises, all with 6 respondents or 15.4%. 5 respondents (12.8%) mentioned the subject Accounting Exercises, 4 respondents (10.3%) mentioned the Integrated Economics subject and one respondent mentioned the subject Mock company representing the remaining 2.5%.
39 respondents answered the question "What accounting software does your school use in the supplementary subject?". The accounting software Pohoda was again mentioned by the highest number of respondents, i.e. 22 representing 56.4%. Money was mentioned by 9 respondents (23.1%), Stereo was mentioned by 6 respondents (15.4%) and the remaining 2 respondents mentioned Premier accounting software (5.1%). As was the case for practicing in the accounting subject, Pohoda is also the most used accounting software in the complementary subject. Thus, this again confirms the research results of Fialová (2013) and Berková (2015).

In response to the question "Does the supplementary subject include practice in accounting software on the computer immediately (within one week) after the accounting theory on the topic is covered?" out of a total of 39 respondents, only 8 of them (20.5%) answered that they practice the theory within one week of learning it. The remaining 31 respondents representing 79.5% responded that they did not. Thus, it can be seen from the above that out of the 39 respondents who practice accounting using accounting software on computer as a supplementary subject, only 8 of them do so within one week of learning accounting theory on the subject. This represents only 20.5% of this group of respondents.

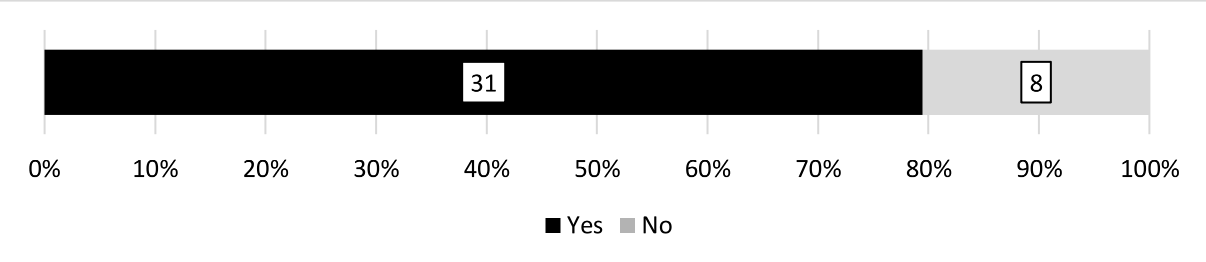

Chart 3: Does the additional subject include practice in accounting software on the computer immediately (within one week) after the accounting theory of the topic?

Of the 60 respondents, 25 (41.7%) reported that students do practice in accounting departments of companies or other organizations. On the other hand, 35 respondents, i.e. 58.3%, reported that this is not the case. It is therefore clear from the above that pupils are not placed in accounting departments as part of their internships with contractual partners and more than half of the respondents do not gain accounting experience. It should be noted that in most cases the pupils arrange their own practice and are not given a shadow position by the educational establishment in which to practice.

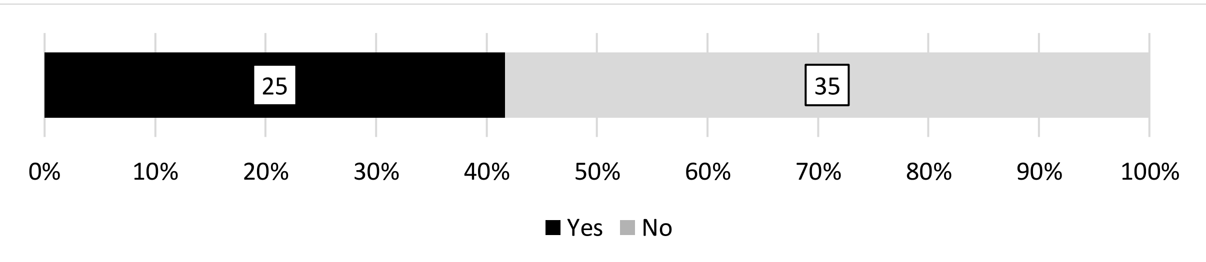

Chart 4: Do students practice directly in the accounting departments of contractual partners?

All 60 respondents also answered the last question. The option 'Yes' was chosen by 16 of them, i.e. 26.7%, and the same number said, 'They don't know'. The second highest number of responses was recorded for the 'No' option from 12 respondents (20%), 9 respondents (15%) said that direct accounting depends on the decision of the practice provider and the remaining 7 i.e. 11.6% said that it only happens 'Sometimes'.

Option to do accounting within the practice	Absolute frequency	Relative frequency
Yes	16	26.7%
No	12	20%
Depends on the provider's decision	9	15%
Sometimes	7	11.6%
I don't know	16	26.7%
Total	**39**	**100%**

Table 3: Can students do case accounting as part of their practice with contractors?

It follows that educational establishments do not actually have sufficient insight into the scope of their pupils' work experience, which is often not directly related to the field of study.

7 Summary and Discussion

The questionnaire survey revealed several important issues that schools could consider and address more effectively in the future. The results suggest that schools vary significantly in their use of accounting software and have differing approaches to its integration into the teaching of accounting. Almost ¼ of the secondary schools (23.3%) in our survey used accounting software only when teaching the accounting subject and did not extend its use in teaching of additional subjects. Less than 1/5 of the respondents (18.3%) used accounting software not only in the accounting subject but also in the teaching of additional subjects. More than 10% of respondents (11.7%) reported that they used accounting software in neither the primary accounting subject nor in supplementary subjects. Almost half of the respondents (46.7%) used accounting software at least in the supplementary subject but not in the main accounting subject. Of those respondents who used accounting software either in the main subject or in supplementary subjects, about 30-40% practiced material currently covered in class within 1 week of teaching it.

It is important to note that the gradual digitalization of accounting practices (Fišerová, 2022, p. 48) and the increased reliance on various economic systems require secondary education—particularly in economic fields—to adapt by implementing innovative approaches and allocating more time to the use of accounting software.

The Pohoda software remains one of the most commonly used accounting tools. This conclusion aligns with previous research by Fialová (2012) and Berková (2015). However, it is worth noting that our study and the referenced research were conducted 12 and 9 years ago, respectively. Despite this time gap, it is reasonable to assume that Pohoda software continues to be a practical and cost-effective solution for schools, even though financial constraints were mentioned only once in the survey. The results of our investigation pointed to another alarming result concerning the mandatory performance of internships with contractual partners (companies) while studying. More than half of the respondents indicated that students do not work in accounting departments during their practice and only 26.7% of all respondents indicated that students could practice accounting. The rest of the respondents cannot influence this, accounting does not occur at all and have no prior knowledge of the scope of practice.

We consider the findings from 60 secondary schools that offer education in economics and prepare future accountants and economists for the profession to be beneficial. Information and facts have been identified from which suggestions can be drawn and their implementation in the content framework of accounting education can subsequently be thought about. At the same time, the results of our investigation offer suggestions for reflection on how to link theory and practice in the field more intensively. With the help of the right educational objectives, competences and the use of appropriate didactic tools (such as accounting software), students can be better prepared for their future careers.

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Disciplinary literacy in CLIL

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Abstract

This paper reviews the current state of disciplinary literacy within CLIL (Content and Language Integrated Learning), by synthesizing findings from various studies and reports conducted across different European countries. CLIL has been positively embraced by educators at various educational levels and settings, fostering a dynamic and active research community. The aim of this article is to determine the status and progress of CLIL from linguistic to content research and to observe developments in different countries. The objective is to highlight the relevance and significance of disciplinary literacy in CLIL contexts. The first part of the article describes the general shift in CLIL from a focus on language towards content, based on relevant sources. The second part focuses on the characteristics of disciplinary literacy, while the third part summarizes the state of CLIL in various countries. The contribution of this article lies in understanding the current state of CLIL in our region and identifying what needs to be done to make progress, which we consider a necessity for further research.

Keywords: Disciplinary Literacy, CLIL, Bilingual Education

1 Introduction

Although CLIL was initially intended to emphasize integration, early studies predominantly treated it as a language teaching approach, focusing on outcomes in foreign language proficiency. Research consistently shows that CLIL students generally achieve higher levels of foreign language proficiency compared to their peers in traditional language programs (Pérez-Vidal & Roquet, 2015; Heras & Lasagabaster, 2015). However, this research has faced criticism for comparing (self-)selected CLIL students with mainstream students (Paran, 2013). A meta-analysis of CLIL research indicated that English language learning through CLIL saw only slight improvements in countries with already high levels of English proficiency, like the

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Netherlands, while countries with lower English proficiency, such as Spain, experienced significant gains (Goris et al., 2019).
More recent studies by Nikula et al. (2016) and Coyle (2018) have emphasized the necessity of clearly conceptualizing CLIL as an approach that integrates both language and content learning. This perspective places a clear focus on the use of language at the content and subject interface, emphasizing the learning of subject-specific elements of the foreign language (Llinares et al., 2012).
Within the expanding research on disciplinary literacies in CLIL, students consistently exhibit greater lexical improvements compared to their non-CLIL peers. Several studies piloted by Gablasova (2014) and Rieder-Bünemann et al. (2019) have shown that CLIL students use subject-specific vocabulary and phraseological expressions with more confidence. Research has also explored the development and utilization of typical discourse patterns in specific subjects such as history and science (Bieri, 2018; Evnitskaya & Morton, 2011; Lorenzo, 2017). These findings emphasize that different school subjects have unique bi/multilingual disciplinary literacies and would benefit from additional input from subject matter experts. Language learning research also points to the significant impact of out-of-school learning, particularly through digital media (Sundqvist & Sylvén, 2016), but this has been largely overlooked in the context of disciplinary literacies. Consequently, there has been no investigation into potential connections between CLIL teaching and Europe-wide initiatives aimed at enhancing digital competence, such as the EU DigComp Framework.
Additionally, leading Austrian CLIL researcher Christiane Dalton-Puffer has developed conceptual tools to investigate discourse patterns across various subjects and educational levels. One significant tool is the construct of Cognitive Discourse Functions, which describe the common linguistic patterns used in classrooms to articulate cognitive processes involved in learning subject content, such as defining or evaluating (Dalton-Puffer, 2013). Other researchers have created models to illustrate the developmental trajectory of subject-specific discourse patterns, clarifying the relationship between content learning and language learning. These include specific discursive patterns (Hüttner & Smit, 2018; Whittaker et al., 2011) and the Pluriliteracies Model, which provides a comprehensive framework (Coyle & Meyer, 2021). Overall, these findings suggest that CLIL enhances very specific aspects of integrated language and content learning, particularly the ability to use a foreign language to produce texts (both oral and written) suitable for specific subjects. This capability is referred to as bi/multilingual disciplinary literacies, highlighting their complementarity to existing or developing disciplinary literacies in the first language (L1) or the primary language of education.
Despite robust research and intriguing models, the study of bi/multilingual disciplinary literacies in CLIL remains fragmented, often focusing on isolated aspects. Additionally, CLIL research activity is unevenly distributed across Europe, with only a few geographical and educational contexts studied. As a result, there is limited empirical evidence validating existing models of bi/multilingual disciplinary literacies across diverse contexts. Therefore, current CLIL research on bi/multilingual disciplinary literacies requires more systematic data on: a) the patterns of use and learning trajectories in specific subjects in relation to learning disciplinary literacies in the first language (L1), and b) the application and critical evaluation of proposed models. Achieving this would enable the development of a framework for transforming these models into clear pedagogical guidance. This endeavor necessitates the integrated expertise of subject and language education specialists, as well as applied linguists.

2 CLIL in European countries

2.1 European context and policy support

The European Union has consistently promoted multilingualism and the use of CLIL to enhance language competencies across member states. The COST Action CLIL Network for Languages in Education (CLILNetLE) has been instrumental in this regard, aiming to develop a shared research agenda to optimize CLIL for bilingual and multilingual disciplinary literacies. This initiative seeks to coordinate research efforts and disseminate best practices across Europe (COST, 2022).

2.2 Research in various European countries

In Italy, research on CLIL has focused on its implementation in secondary education. Minardi (2020) explored the effectiveness of CLIL in promoting disciplinary literacy in physics classes. The study found that students in CLIL programs demonstrated better critical thinking skills, and a more profound understanding of physical concepts compared to those in non-CLIL programs. This research underscores the potential of CLIL to foster higher-order thinking skills and disciplinary understanding.

Belgium, being a multilingual country, has naturally integrated CLIL into its education system. Research by Goris et al. (2019) examined the impact of CLIL on students' language and content learning in both Flemish and French-speaking regions. The study found that CLIL students exhibited higher levels of motivation and engagement, as well as improved proficiency in both the target language and the subject matter.

The Netherlands has implemented CLIL primarily in secondary education. A study by De Graaff et al. (2007) explored the outcomes of CLIL in Dutch schools, revealing significant improvements in students' English language skills and academic achievement. The research highlighted the effectiveness of CLIL in promoting language acquisition alongside content learning.

In Spain, CLIL has been widely implemented in various educational contexts. Research by Llinares, Morton, and Whittaker (2012) has shown that CLIL programs significantly improve students' academic language proficiency and subject-specific knowledge. Their study indicates that students in CLIL settings develop a deeper understanding of subject content and are better equipped to use academic language effectively.

Finland has a long history of bilingual education and has integrated CLIL into its education system extensively. Nikula et al. (2016) conducted a study examining the impact of CLIL on students' disciplinary literacy in science education. The findings suggest that Finnish students in CLIL programs outperform their peers in traditional programs in both content knowledge and language skills. The study highlights the importance of integrating language and content learning to enhance overall academic performance.

3 Research in Slovakia

In Slovakia, the CLIL approach has been increasingly integrated into the educational system, reflecting both local and European trends towards bilingual education. According to Kopecká (2024), CLIL is utilized primarily to enhance foreign language proficiency while simultaneously delivering subject content, thereby promoting disciplinary literacy among students. This method is particularly evident in primary and secondary education, with a growing interest in its application at higher educational levels.

Several studies have focused on the implementation and outcomes of CLIL in Slovak schools. Hurajová et al. (2020) emphasize that the primary goal of CLIL is not the language itself, but the use of a foreign language as a tool for learning subject content. This approach aligns with the broader educational goals outlined by the European Commission, which supports multilingualism and the development of language competencies across member states (European Commission, 2012) as mentioned above.

A significant national study by Menzlová et al. (2020) involved an experimental CLIL program in 14 primary schools, focusing on English and German language. This research aimed to compare the language proficiency and motivation of students in CLIL and non-CLIL settings. The findings indicated that CLIL students achieved higher scores in vocabulary, listening, reading comprehension, and writing. Additionally, these students demonstrated increased motivation to learn foreign languages. It was a national project, although not focused on content. Nonetheless, it was likely the first of its kind to utilize a broad sample and achieve statistical significance in Slovakia. As Kováčiková (2020) describes, there are no specific surveys or studies available on implementing CLIL in tertiary education yet.

Despite positive outcomes, the empirical evidence validating CLIL models in Slovakia remains limited. Kopecká (2024) argues that more systematic data collection is needed to understand the patterns of use and learning trajectories in specific subjects. Additionally, there is a need to critically evaluate existing models of bilingual and multilingual disciplinary literacies to develop effective pedagogical guidance. A recent publication Overview of CLIL provision in Europe and country-specific insights by Gülle & Nikula (2024) uncovers difficulties while implementing and so researching CLIL context in various countries. For Slovakia, securing backing from national organizations and policymakers, along with offering effective incentives for CLIL teachers and obtaining essential funding, were regarded as highly challenging. Likewise, the challenges of sourcing and developing suitable materials, effectively assessing students' learning, and addressing the diverse needs of CLIL students are also seen as very challenging, indicating substantial pedagogical difficulties.

Current research on disciplinary literacies in CLIL lessons in higher education remains notably underdeveloped in Slovakia. While other European countries have well-established studies and frameworks exploring the integration of language and content instruction, Slovakia has yet to develop a significant body of research in this area. This represents a critical gap and an opportunity for Slovak scholars to pioneer research efforts that could enhance the integration of language and content instruction, ultimately contributing to the broader academic discourse and improving educational outcomes in higher education.

Above mentioned European network – COST, and its sub-project CLILNetLE aims to do so. The CLILNetLE COST Action (CLIL Network for Languages in Education: Towards bi- and multilingual disciplinary literacies) aims to connect researchers across Europe to create a significant, shared research agenda and strategy focused on developing bi- and multilingual disciplinary literacies in CLIL. Since its inception, this collaborative network has brought together over 180 researchers from 37 countries, encompassing language education, non-language subject methodologies, and experts from digital media and multilingual schools. Authors of this paper, Elena Kováčiková is an official Management Committee member for Slovakia and a member of Working Group 1: "Conceptualising bi/multilingual disciplinary literacies," and Dorothea Bagalová is a Working Group 2: "Learning and using bi-and multilingual disciplinary literacies in specific subjects" member, specifically active in the subgroup for Science. Through five dedicated Working Groups, the network is developing a unified conceptual framework and research roadmap to explore bilingual and multilingual disciplinary literacies within CLIL contexts (COST, 2024).

Progress towards further research in Slovakia can also be seen in the approval of project VEGA from the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences. as an internal grant system of the Ministry of Education and the Slovak Academy of Sciences awarded the grant to the project titled "Disciplinary Literacy and Critical Thinking in Bilingual Education" with Associate Professor Mgr. Elena Kováčiková, PhD. being the principal coordinator. This project aligns with the CLILnetLE directions and follows European trends in implementing CLIL in upper secondary education. It examines bilingual education not from a language competence perspective but by assessing its impact on acquiring disciplinary literacy in Mathematics, Biology, and History within the new Slovak educational curriculum reform. The project focuses on developing general-domain mental processes, especially critical thinking constructs. The research team aims to clarify these relationships, expecting the findings to significantly influence national didactic guidelines.

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Training of future doctors in computer modeling

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Abstract

Rapid changes in modern medicine and the requirements for training specialists in medicine require the active use of computer modeling in medical education. The aim of this study is to study effective methods of introducing computer modeling into the educational process of medical educational institutions. To achieve this goal, the methods of analysis, synthesis, generalization and systematization were used. The results of the study revealed the key stages of computer modeling training in medical education, which include theoretical lectures, practical classes, laboratory work, specialized internships, projects and research, as well as multidisciplinary training. Theoretical lectures provide basic knowledge of the principles of computer modeling, including anatomy, physiology and mathematical principles. Practical classes and laboratory work allow students to master the skills of working with software and creating virtual models of organs. Specialized internships provide an opportunity to apply the acquired skills in a real clinical environment. Participation in projects and research is focused on the application of computer modeling in solving clinical problems, and multidisciplinary training creates a comprehensive understanding of methods in medical science.

The results point to the need for a systematic and fundamental approach to teaching computer modeling in medical education and its inclusion in the curricula of medical schools on a systematic basis.

Keywords: Medical Education, Virtual Reality, Interdisciplinary Approach

1 Introduction

In modern medical education and practice, there is a rapid introduction of modern computer modeling technologies that provide unique opportunities to improve the diagnosis, treatment

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and training of medical specialists. In light of this context, it is necessary to conduct in-depth research in the field of computer modeling training in medical education in order to understand the current challenges, achievements and potential of this approach.

Despite some research in this area, the issues of developing effective teaching methods to improve the computer competence of students in medical education, as well as the use of interdisciplinary possibilities of anatomy and informatics, have not been considered. Computer modeling training should be conducted in the context of an elective course. An elective course in computer modeling offered to students of the Faculty of Medicine can provide an important overview of key anatomical concepts.

The elective computer modeling course offered to students of the Faculty of Medicine can provide an important overview of key anatomical concepts and include aspects related to the integration of artificial intelligence into computer modeling in medicine.

The research problem lies in the need to develop effective teaching methods that will ensure the steady assimilation of theoretical aspects by students, the systematization of practical skills and a deep understanding of computer modeling methods in the context of the anatomy course.

Based on this, the aim of the study is to identify effective methods of integrating computer modeling into the educational process of medical schools when teaching the elective course "Computer modeling of the human genitourinary system" in order to improve the quality of training of future medical specialists.

D. Li and co-authors (Li, D., Hu, W., Zhou, X., Li, L., Wang, J., Zou, M., & Zhou, D. (2023)) investigated the development of virtual reality technologies in medical education and treatment in China. They created integrated models, including the structure of the stomach, pathologies, pharmacological processes and clinical scenarios.

The study highlights the improvement in the quality of medical education, the updating of approaches and the potential of three-dimensional models for future medicine.

D. Edwards and co-authors (Swede, M. I., Geryak, S. M., Martynyuk, L. P., Susla, O. B., Martynyuk, L. P., & Yastremskaya, I. A. (2023) in their work consider the technology of three-dimensional printing (3D) to create individual structures based on digital models of patients. They highlight its wide application in engineering, architecture and medicine, especially in dentistry and regenerative medicine, where it is used to create custom-made small implants and organ bioprinting.

A study by L. Lyu et al. (Lyu, L., Cui, H., Shao, M., Fu, Y., Zhao, R., & Chen, Q. (2021) analyzes the development of computational medicine, highlighting it as an area that uses computer models to simulate diseases and treatment. The authors emphasize the importance of algorithms and GPU that expand the use of computing technologies in medicine, and discuss the potential of computer vision in clinical research. The research includes an analysis of the history of development, presentation of global progress in computational medicine, discussion of clinical applications, identification of problems and limitations, as well as forecasts, including computational Chinese medicine.

In addition to virtual reality, in-game radiological education and team competitions in virtual worlds have been recognized as exciting and innovative teaching methods with numerous benefits, including student engagement, social interaction and a personalized learning environment (Rudolphi-Solero, T., Jimenez-Zayas, A., Lorenzo-Alvarez, R., Domínguez-Pinos, D., Ruiz-Gómez, M., & Portero, F. (2021). In addition, the use of virtual clinical modeling has been recognized as an attractive learning strategy for developing disciplinary and flexible skills in medical students through structured educational activities with assessment and feedback (Segura-Azuara, N. & Lopez, M. (2021).

Moreover, the use of virtual simulation, including high-precision simulation of real clinical scenarios based on adult mannequins in virtual reality, has been evaluated for its effectiveness in teaching clinical pharmacology to medical students. Virtual modeling is defined as interactive computer simulation of real clinical scenarios of medical training, teaching or assessment, meeting various training requirements in medical education (Gudadappanavar, A., Hombal, P., Benni, J., Patel, S., & Tubaki, B. (2023).

The existing methods of teaching computer modeling in Kazakhstan medical universities are crucial to ensure that medical students receive high-quality education and training. Simulation learning is promoted as a way to provide medical education that is very similar to a real clinical environment, conforms to medical ethics, and uses simulated scenarios to train and evaluate various skills.

In the context of medical education, it has been shown that simulation training is effective in teaching basic skills in various specialties, including otolaryngology (Keilin, C. A., Farlow, J. L., Malloy, K. M., & Bohm, L. A. (2021). In addition, the use of simulation-based advanced training programs for teaching doctors new medical procedures was evaluated, which demonstrated their potential effectiveness in medical education (Issa, N., Liddy, W., Samant, S., Conley, D. B., Kern, R. C., Hungness, E. S. & Cohen, E. (2021).

Simulation-based medical education is a widely recognized approach that can be carried out both in the form of low- and high-precision training, using dummies and special technologies for on-site training. The use of high-precision simulators for teaching the principles of cardiovascular physiology to medical students was studied, which demonstrated the potential of modeling as an effective learning tool (Suvarna, P. & Basti, A. R. S. (2022).

2 Methodology

The introduction of computer modeling in medical education is associated with various problems and difficulties that need to be solved. In the context of computer modeling training, evaluating the effectiveness of teaching medical students emphasizes the importance of having a good teaching staff, intensive training, timely feedback, curriculum development, integration of real cases and the use of realistic computer models. The needs of future doctors in computer modeling-related competencies are necessary to prepare medical students to meet the demands of the evolving healthcare environment.

The use of deep learning models for automated assessment of students during high-precision modeling makes it possible to improve the accuracy and effectiveness of assessment in medical education, especially in the context of computer modeling and simulation.
Table 1 provides an overview of the key methods of computer modeling in medicine.

Computer modeling method	Description
Modeling of organs and tissues	Creation of highly detailed computer models of human organs and tissues.
The development of augmented reality	The use of augmented reality to simulate created computer models.

Table 1: Computer modeling methods

The main stages of training are presented in Table 2.

Stages	Description
Theoretical lectures	Providing fundamental knowledge about the principles of computer modeling, including basic aspects of anatomy.
Practical exercises	Mastering students' skills of working with modern software tools used to create computer models. The formation of practical skills necessary for the successful application of modeling in medical practice.
Projects and research	Active participation of students in projects and research aimed at computer modeling of anatomical orgones in medicine.

Table 2: Stages of computer modelling training in medicine

The authors of the article have developed an elective course "Computer modeling of the human genitourinary system", which has the following content:

INTRODUCTION
I. MODELING THEORY
1.1. The history of modeling as a method of cognition
1.2. The concept of modeling
1.3. Types of modeling
1.4. Classification of models
1.5. Stages of computer model development
II Computer modeling of human internal organs.
2.1. Setting the task
2.2. Building an information model of human internal organs
2.2. Building 3D models on 3D MAX or (Blender)
2.3. Checking the adequacy of the model
III. CREATING AUGMENTED REALITY ELEMENTS

3.1. QR code
3.2. Creating a QR code for each internal organ of a person

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Learning as a Motivation Factor in Learning Organizations

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Abstract

In this paper, the authors focus on learning organisations, with special emphasis on learning as a motivational factor within the context of leadership in such organisations. Following a literature review, the paper presents a research study on the topic. A qualitative research design was employed, and data were collected using a questionnaire containing open-ended questions. The research sample included 100 employees from micro, small, medium-sized, and large enterprises located in the Slovak Republic and the Czech Republic. Recognising the importance of integrating learning into an organisation's philosophy, the authors sought to identify the motivational factors applied by respondents' employers in the workplace, with particular attention to the role of providing learning opportunities for employees.
The research findings indicate that employees value the availability of opportunities for personal and professional growth, highlighting the need for further research on this topic.

Keywords: Learning Organisations, Learning, Motivation

1 Introduction

Considering that continuous learning (Doppelt, 2003), improvement, and the development of competencies positively influence the functioning of various types of organisations (Iqbal & Ahmad, 2021), three interrelated phenomena emerge as crucial in the context of

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organisational behaviour: knowledge management, organisational learning, and the transformation process from a traditional organisation to a learning organisation.

Integrating formal, non-formal, and informal learning opportunities—both on-the-job and off-the-job—into organisational policies can significantly impact other aspects of organisational behaviour in a positive way. For this reason, it is essential to focus on the defining characteristics of learning organisations.

2 Learning Organisations

Although the rapid development of digital technologies and the trend of a broader application of AI can be observed in all spheres of life, these still cannot fully replace the human labour force, and so, knowledge remains the key determinant of organisations' sustainable success. Therefore, it is necessary to realise the significance of investments in human capital (Matúšová, 2015) and subsequently employ measures to fulfil the concept of a learning organisation, which is a challenge for leaders.

The notions of 'knowledge management' and 'learning organisation' are interconnected as each organisation should promote their employees' personal and professional growth and thus, learning should become an integral part of their philosophy. Jamali (2006) points out that organisations should have learning characteristics, such as learning culture, team building, and shared purpose. It is evident that from the aspect of cost minimisation and profit generation maximisation, alongside increasing the quality of the provided services, satisfying their customers' needs, or quick handling of customer requests, it is important to distribute the profit to meet the needs, requirements, and expectations of all parties, including the employees. This requires changing organisations' approach and investing in employees' systematic on-the-job and off-the-job training (Barna, 2018). As Krásna (2016) claims, available research results show that opportunities for personal and professional growth, including learning opportunities, significantly contribute to employees' job satisfaction.

Learning organisations can be characterised as those that promote innovations and experimenting, are ready to learn from the past and, thanks to constant learning and development, are able to adapt to changing circumstances without delay (Marsick & Watkins, 2003). Following the above, an organisation can be considered a learning ones if it is aware that knowledge forms the basis for an increasing number of fields of human functioning and realises that if it wants to make progress, it needs to introduce changes and innovations, which is impossible without systematic education and training (Barnová & Barna, 2019). Undoubtedly, promoting learning in organisations contributes to increasing performance (Ju et al., 2021), as well as to other parties' satisfaction, including customers, citizens, suppliers, owners, the environment, etc. Leaders have a crucial role in the transformation process of organisations on their pathway towards becoming learning organisations (Hargitai & Bencsik, 2023).

Although leaders do not have full responsibility for the organisation's culture, they have the power to shape it and introduce measures to incorporate learning into their organisation's philosophy.

There are several key features of learning organisations:

1. Clear vision – goals and their understandable wording on the organisational level, as well as the level of individuals.
2. Concept based on the quality of the human capital – creating favourable work conditions, opportunities for learning, and high-quality HR management.
3. Promoting a positive approach to changes, accommodating way of thinking, promoting changes in the employees' mindsets.
4. Promoting teamwork and open communication in the workplace.
5. Strict rules regarding working with data (produced, collected, or used within the organisation).
6. A clear definition of the learning process, the notion of learning, and its forms and principles (Pokorná & Ivanová, 2010).

According to Truneček (2004), learning organisations can be characterised as follows:

1. A particular climate promoting skill development and increasing productivity is typical for them.
2. By their culture, they try to influence their suppliers, customers, and other partners.
3. They have a specific strategy for HR development – the individuals' and the organization's learning are a priority.
4. They change under the influence of the results of individuals' and the organization's learning.

Pokorná and Ivanová (2010) identified five fields that need to be developed in the process of transforming traditional organisations into learning ones with the aim to achieve changes in individual's approach to work and their mindsets.

1. Promoting system thinking – the ability to see the associations between individual tasks and events, search causes rather than focusing on consequences, and predict.
2. Promoting the development of personal mastery – developing specific skills and characteristics in individuals, especially in the context of lifelong learning, which contribute to proactivity, systematicity, and the application of an innovative, non-traditional approach in a variety of situations.
3. Changing mental models – eliminating deeply rooted ideas and prejudices, and developing positive attitudes (towards the employer, the job, customers, products, etc.) and desired mental models.
4. Creating a shared vision – a shared (organisational) vision should be superior to those of individuals. It sets the direction of the organisation, as well as groups and individuals within it. It gives a sense to individual steps and procedures, provides a picture of the

future, and allows evaluation of the organisation's current situation. As pointed out by Choi (2007), employees' participation in decision-making and creating the organization's vision contributes to their feeling of empowerment and subsequently increases their job satisfaction.

5. Promoting team learning – creating teams, departments, sections, divisions, etc., that should learn together and contribute to meeting the organisation's goals and vision. Employees can achieve better learning results when confronted with different modes of thinking and the ideas of others (Osagie et al., 2020).

All the five fields identified by Pokorná and Ivanová (2010) should be developed simultaneously as a whole since they build on each other and condition each other.

In learning organisations, mentoring as a form of workplace learning has an important role to play. A mentor is an experienced colleague trusted by the employer and the mentee, who takes over the role of a counsellor, consultant, and guide. A mentor can be helpful in a broad range of fields:

1. Identifies the mentee's skills, interests, and aspirations.
2. Guides the mentee in identifying key knowledge and skills from the aspect of performing a particular job.
3. Helps understand the unwritten rules and explains what should not be said or done in the organisation.
4. Helps to find answers to questions and shares insights.
5. Provides emotional support.
6. Serves as a role model.

This helps create a positive environment in which the mentee is not afraid to make mistakes and maintains self-confidence (Luthans, Luthans, & Luthans, 2021).

3 Methods

The main objective of a research project under realisation is to find out about organisational behaviour as perceived by employees and to analyse the obtained results according to the variables of the size of the organisation, its location, the respondents' gender and years of experience. In the present part of the research study, we attempted to answer the research question of whether the organisations, the employees of which participated in the study, can be considered learning organisations, and the extent to which they use learning opportunities as a motivational factor was examined.

For the research study, a qualitative research design was employed. While acknowledging the limitations of the chosen method, a questionnaire was used as the research instrument, as it is less time-consuming and more convenient compared to conducting interviews. Questionnaire surveys allow for faster data collection, and, due to the anonymity of respondents, they are likely to yield more honest responses.

3.1 Research Instrument

In the study, a self-constructed questionnaire containing four open-ended questions was administered online, allowing us to collect qualitative data.

1. What do you consider the specific features of your organisation's culture?
2. What forms of motivation are applied inside your organisation?
3. What are the strengths of your organisation?
4. What are the weaknesses of your organisation?

The questionnaire was administered online because, compared with traditional methods, it has several advantages: 1. it is a faster way of collecting data; 2. the potential respondents are more likely to take part in a research study if they can fill in a questionnaire when it is convenient to them, and 3. the processes of sorting, processing, and storing data are less demanding. One part of the collected qualitative data was quantified to get a more detailed picture of the situation in organisations. The gathered data were processed by using the statistical software ATLAS.ti 23.

3.2 Research Sample

	N	*%*
Size of Enterprises		
Micro Enterprises	10	12.50
Small Enterprises	12	15.00
Medium-Sized Enter.	37	46.25
Large Enterprises	21	26.25
Location of the Organization		
Slovakia	74	92.50
Czechia	6	7.50
Years of Experience		
0-1	9	11.25
2-10	43	53.75
11-20	24	30.00
21 or more	4	5.00
Gender		
Male	38	47.50
Female	42	52.50
Total	80	100

Table 1: Composition of the research sample according to variables

3.3 Research Procedures

Following on from the theoretical part of the study, where special attention was paid to the characteristics of learning organisations and the importance of learning in the context of achieving success, in the empirical part of the study, the focus was on finding the answer to the question whether the respondents spontaneously, i.e. without being asked, reported promoting education being a part of the philosophy of their organisation and if they perceive it as a specific feature of their organisation's culture and identify. Another observed phenomenon was learning as a motivation factor and whether organisations use it with their employees.

Although aware that it does not allow for creating a holistic picture of the emphasis placed on on-the-job and off-the-job learning opportunities in organisations, the collected data were categorised and quantified in the first phase of data analysis. The ratio behind doing so is that we wanted to know what share of respondents mentioned education without being particularly asked about. On the other hand, it is possible that some respondents did not mention education since they consider it a natural part of their organisation's functioning; they do not assign it such importance or simply forgot to mention it. In the following phase of the research, a thorough data analysis of data divided in categories was carried out.

4 Results

4.1 Education as a Component of the Organisational Culture

Education as a specific feature of an organisation's culture was reported by 26 participants (32.5 %). The collected data indicate that organisations focus on a variety of areas of education following their peculiarities and needs. Some participants responded only in phrases but did not specify the educational activities within the organisation. Their answers were as follows: „... continuous education and training, the training programmes are often updated, and new ones are introduced because there is always something new to learn … “; “education”; “educational opportunities”; “professional training”; “regular education and training activities based on the organisation's needs”; “regular employee training”; “permanent learning and improvement”; and “training”.

Other participants provided a more detailed picture: “… excellent adaptation programmes and training as a part of professional growth and in the case of advancement …”; “... organising health days and seminars on prevention and employees' health protection”; “self-education”; “occupational health and safety training”; “credit system of education”; “education or training for every field of expertise”.

4.2 Learning as a Motivation Factor in Organisations

Learning and training opportunities provided by the organisation (on-the-job training) or allowing participation in such activities outside the organisation (off-the-job training) are considered a motivation factor by 35 among the 80 participants (43.75 %), including 19 (54.29 %) females and 16 (45.71 %) males. This is a surprisingly high share of employees and a very good signal from the perspective of organisations' work since it indicates that at least these employees are interested in educational activities and developing and improving their competencies necessary for performing a particular job. In the most interesting responses, the participants specified, which learning or training opportunities are attractive for them: "For me personally, participation in various workshops where I had an opportunity to see how art supplies can be used in practice, or opportunities to attend public events organised by "Kultúra Snina" were motivating."; "... Constant provision of training opportunities either within their area of expertise or languages."; "We subsidise our employees' and directors' learning activities, including online courses and webinars."; „The organisation offers its employees a variety of courses and training opportunities for gaining qualifications and acquiring new information for performing their jobs."; "Employee development is supported by employee training focused on updating knowledge in the form of supervision, individual learning opportunities, and practical training."; "The organisation promotes lifelong learning in the form of training opportunities and courses."; "... providing systematic lifelong learning opportunities for all employees." Other participants provided shorter responses, for example: "accessible learning opportunities"; "promoting development"; "promoting learning"; "employee training"; "professional and non-professional training"; "professional lifelong learning and development"; "courses"; "foreign language courses for employees"; "courses focused on professional and personal skill development"; "professional training"; "requalification"; "training based on the employer's needs"; "training new employees by experienced and well-trained colleagues"; "a possibility to earn a bachelor's or master's degree alongside employment"; "own system of education and training".

The findings revealed the existence of a positive trend in organisations and their willingness to invest in their employees' training. Many organisations also support learning activities that are not directly connected with improving skills or knowledge related to performing a particular job, which could suggest, that leaders recognise the importance of their employees' job satisfaction, but also their life satisfaction which can be positively influenced by opportunities for their personal growth.

5 Conclusions

Learning is the fundamental prerequisite for an organisation's successful functioning. It is important to recognize that only knowledge, combined with human effort and performance, can drive progress in achieving the organisation's goals, mission, and strategies. While this is indisputable, it is also clear that in the digital era, material resources—such as digital technologies, financial resources, raw materials, and access to information — are key determinants of success.

In the present qualitative study focused on organisational behaviour as perceived by the employees of micro, small, medium-sized, and large enterprises in the Slovak Republic and the Czech Republic, we aimed to determine whether the organisations where our respondents were employed at the time of the study meet the standards of learning organisations. Although being aware of the limits of the research study given by the composition and size of the research sample, based on the obtained results, it can be assumed that a surprisingly high share of organisations promotes their employees' learning activities and as subjectively evaluated by the participants, recognize the importance of education and training from the aspect of their organisation's success. Such positive results were not expected since the respondents were not directly asked about the role of learning in their organisation. On the other hand, there is a high probability that in the case of asking them questions targeted on the accessibility of on-the-job or off-the-job learning activities, the number of respondents mentioning education as a part of organisational culture would be even higher.

Although the obtained results could suggest that the transformation process of traditional organisations to learning ones is among the priorities of all types of organisations, these findings cannot be generalised, and a high degree of cautiousness is needed in interpreting the obtained data. Therefore, it is important to conduct extensive research studies in the field.

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To the Roots: Engineering Pedagogy

Collaboration between CPU and ASC in the Preparation of Future Teachers

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Abstract

This paper presents the collaboration between the Faculty of Education at Constantine the Philosopher University (CPU) in Nitra and Applied Software Consultants (ASC), the developers of the school information system ascEdupage. It focuses on the implementation of the system and its importance in preparing future teachers, highlighting examples of educational materials (such as thematic plans, lesson preparations, tests, etc.) that students are introduced to and find relevant for their future professional practice. Additionally, the paper outlines the benefits and necessity of incorporating this platform into the undergraduate training of future teachers. The collaboration serves as an example of successfully integrating modern technologies into the educational system, significantly contributing to the professional development of future teachers and fostering innovation in education.

Keywords: School Information System, AscAgenda, AscEdupage, CPU, Preparation of Future Teachers

1 Introduction

In the digital era, where technology rapidly transforms everyday life, the way we learn and teach is also evolving. In this educational revolution, ascAgenda plays a significant role. It is not just an application but a platform that transforms the dynamics of classrooms, schools, and educational institutions worldwide. This comprehensive school information system offers a wide range of tools for teachers, students, and parents in over 170 countries and across 150,000 schools. The platform enables easy management of school agendas, facilitates communication between teachers, students, and parents, and provides space for interactive learning.

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Currently, ascAgenda is used in preschools, elementary and secondary schools, as well as in basic art schools and some sports clubs, including school clubs for children and various extracurricular activities.

A component of ascAgenda is ascEduPage, a fully integrated school system featuring a world-renowned scheduling system (EduPage Help, 2024; Karchynskaya et al., 2024), which simplifies the creation and management of school websites. EduPage is a cloud-based school management system that facilitates communication between the school/teachers/administrative staff and students/parents. Thousands of schools use ascEduPage (hereinafter referred to as EduPage) as both a website and an internal school portal, where students, parents, and teachers can work with electronic grade books, view schedules, and manage substitutions without the need for programming. Perhaps the greatest advantage of the EduPage portal is the comprehensiveness of its services and features in one place and under one access password.

2 Key Features of Edupage

The features of EduPage are diverse, ranging from basic school agenda management to electronic grade books and e-learning with the ability to assign tasks and evaluate students through tests, etc. Students and parents have easy access to this information through an online interface. It allows teachers to quickly input grades and assessments, which are immediately available to students and their parents, simplifying and streamlining the evaluation process.

The platform also provides various tools for effective communication between teachers, students, and parents. This includes chat, emails, and announcements that help keep all parties informed. EduPage offers space for online courses, testing, and exercises, enabling students to learn and practice material outside of traditional classroom hours. Teachers, students, and parents have access to educational progress tracking through various statistics and reports provided by EduPage.

The advantages of EduPage can be summarized as follows:

- Streamlining Processes: EduPage facilitates the management and organization of school agendas for both teachers and students.
- Improved Communication: The platform provides tools for effective communication among all involved parties, increasing engagement and involvement.
- Flexibility in Education: EduPage allows access to educational materials anytime and from anywhere, supporting flexibility in learning.
- Transparency: With the electronic grade book and assessment system, the evaluation process is more transparent and accessible to students and their parents (Pisoňová et al., 2021).

EduPage offers numerous features, making it clear that targeted preparation of future teacher students is necessary for its full utilization.

2.1 Preparing Future Teachers to Work with EduPage

In connection with preparing teachers to work with EduPage, ASC s.r.o. organizes numerous training sessions and webinars. Despite sufficient support, there have been requests from practicing teachers to our Faculty of Education at CPU in Nitra to include a course in teacher training that focuses specifically on preparing teachers to work with EduPage. Teachers in schools do not have the opportunity to test specific features without actually sending the activity to students or publishing content that they only want to send as a test. This lack of access to training tools can hinder their ability to fully utilize the potential of EduPage in the teaching process. Furthermore, even though training sessions exist, many teachers still desire systematic and deeper preparation as part of their formal pedagogical education. Integrating a course focused on working with EduPage into the teacher training curriculum would effectively meet these needs, allowing them to better understand and utilize technological tools in their educational practice.

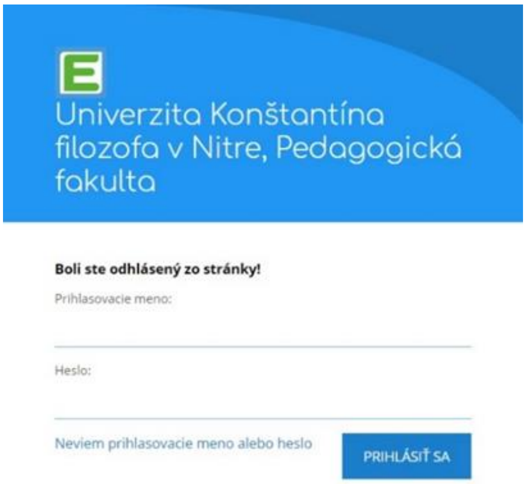

Figure 1: Login to the CPU Training School

Given this demand, during the latest comprehensive institutional accreditation of Constantine the Philosopher University in Nitra, the Department of Technology and Information Technologies at the Faculty of Education introduced the course "School Information Systems." Starting from the 2022/23 academic year, all students preparing for the teaching profession must complete this course as part of the pedagogical-psychological and social-science foundation of teacher education. Part of the course content is dedicated to working in the EduPage environment, where students have their own access accounts and act in the role of a teacher. The accounts, access, and initial contact sessions with the EduPage web interface are facilitated by a representative from ASC s.r.o., who also conducts the initial workshops

(Figure 2). During these workshops, students are introduced to the basic modules of ascAgenda and the EduPage features focused on educational activities and basic pedagogical documentation.

Figure 2: Student Workshop with ASC s.r.o.

Students become familiar with the basic activities and functions of EduPage, ranging from creating lessons and recording them in the class register to tracking attendance, creating thematic plans, and developing tests. They learn how to assign online tests, use different types of questions, and explore various student assessment options, including the development of comprehensive e-learning lesson plans. (Figure 3). They also verify specific functions from a student's perspective using the EduPage mobile application.

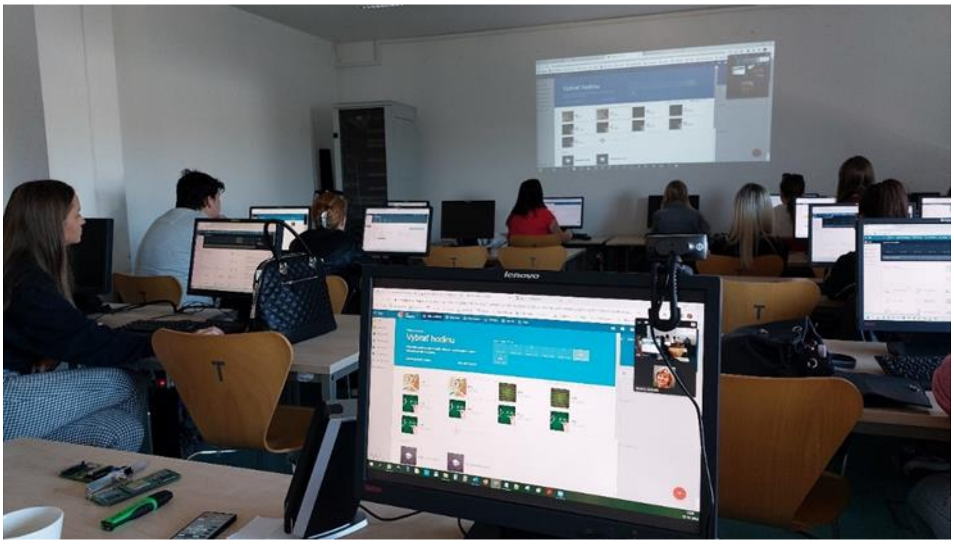

Figure 3: Students Familiarizing Themselves with the EduPage Environment

2.2 Preparation of Educational Materials

After completing the initial workshops, students focus on creating their own time-thematic plans and preparations within their subject areas (Figure 4). They also concentrate on developing content for selected topics, aiming to utilize the full potential of the platform. They focus on effectively using various multimedia, a wide range of tasks, and leveraging pre-existing content available in the EduPage library under the Standards.

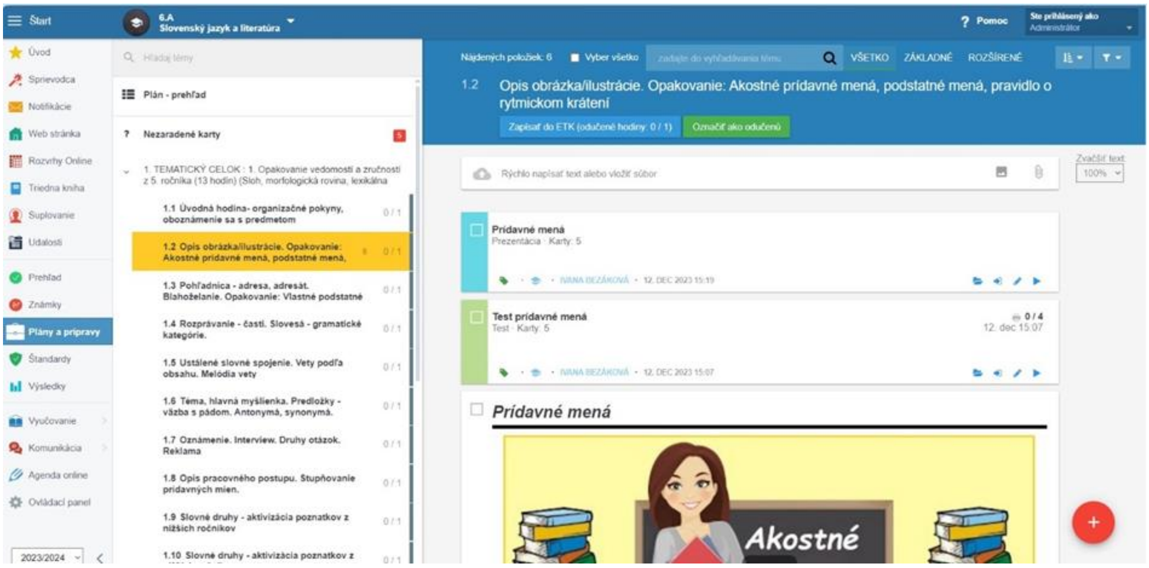

Figure 4: Example of Creating Time-Thematic Plans and Preparations

The materials include:

- Presentation: This involves creating a presentation within the EduPage environment, where widget elements can be used to prepare a very simple presentation, similar to Microsoft PowerPoint. Widgets allow for the insertion of images, tables, etc. This presentation can be displayed on an interactive whiteboard or assigned to students for viewing.
- Test: This involves creating tests, where each card contains one test question. The types of test questions available in EduPage include:
  - ABCD,
  - Fill-in-the-blank,
  - Ordering – descending or ascending,
  - Blind map,
  - Categories, groups – categorizing individual terms into groups,
  - Matching – matching image to image, image to text, or text to text,
  - Open question.

The advantage of creating tests in EduPage is the possibility of automatic grading. After evaluating the test, it is possible to record the grade. The only exception to automatic grading is the open question, which must be manually corrected and scored by the teacher.

When creating tests, it is recommended to first prepare individual questions. Later, these prepared questions can be easily compiled into a test. The advantage of this approach is that the questions can also be used in other materials and easily modified as needed. Teachers can prepare a test in advance and assign it to students later. Tests can be assigned for online completion, allowing students to work on them using a computer, tablet, or mobile phone. EduPage materials have a responsive design, meaning they adjust to the screen size. As mentioned earlier, a significant advantage of online tests is that the system automatically grades closed questions. Teachers can also print the prepared test, distribute it to students, and correct the tests manually. EduPage can also assist teachers with grading printed tests. The results are stored in EduPage, allowing students to see where they made mistakes. The system processes the results by calculating the student's success rate based on the ratio of points obtained to the maximum possible points or by individual questions, making it easy to identify both easy and difficult questions. If performance standards from the State Education Program (ŠVP) are linked to the questions, teachers can also see which topics (standards) students have mastered and which they are struggling with. (Figure 5). EduPage allows for easy creation of question modifications, meaning the same type of question but with different numbers, for example. Such similar tasks can be grouped into a question pool. Using question pools, teachers can create tests with different variants to minimize student copying. Test variants can be created for both online and printed tests.

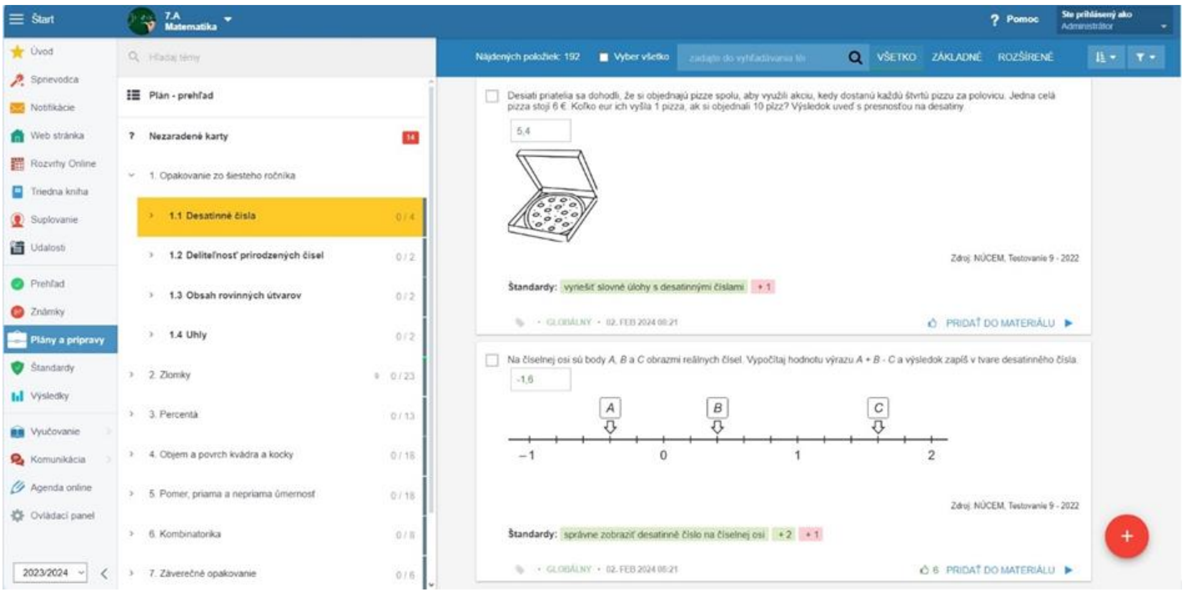

Figure 5: Example of Test Task Creation by Students

- Homework and Projects: The advantage of assigning homework and projects in EduPage is that students can see the submission deadline. Settings allow for an automatic note to be added if homework is not completed. If the homework or project does not meet the teacher's requirements, it can be returned to the student for revision. Another benefit of this module is that students can upload their work in various file formats, such as images, photos, PDF files, or HTML files.

Besides the functions related to preparing materials and tests, EduPage also includes many other modules that we, unfortunately, do not have time to cover in our students' training. The system can track the attendance of both students and teachers, automatically calculate absences and tardiness, and regularly inform parents. For teachers and schools, this solution is also advantageous for substitute teaching. Once the information about a change in the teacher is entered into the system, it appears everywhere it is needed. The system can also integrate a canteen module, which not only offers the menu but also allows for meal sign-ups and cancellations, payment tracking, meal record-keeping, and order management.
EduPage also handles various payments that need to be made throughout the school year. Besides enabling online payments, the system allows for payment tracking and correct assignment to the student by importing payment data directly from the bank. The system also supports electronic submission of excuse notes, applications, registrations for seminars, clubs, olympiads, and other events. For school administrators, the aScOrbit module is available. This tool provides administrators with data on the schools under their jurisdiction without requiring any imports, thus reducing administrative burden. Particularly interesting for administrators is the attendance information, whether for "free lunch" programs, truancy, or declaring flu breaks. Based on attendance data, aScOrbit calculates the number and amount needed to pay for lunches and the amount to collect from parents. Administrators do not need to regularly request data from schools or check which schools have yet to provide data. They have access to all necessary information for their schools at any time (aScOrbit pre zriaďovateľov, 2024).

3 Conclusion

As the significance of technology in education continues to grow, EduPage is likely to play an even more substantial role in the future. Ongoing development and innovations in this area will allow the platform to offer a broader spectrum of features and tools that better support modern educational needs. EduPage already provides an innovative and efficient approach to education with the potential to fundamentally transform the future of learning worldwide. With the increasing use of digital technologies in schools, EduPage is becoming an essential tool for teachers, students, and parents. The platform enables efficient management of educational processes, communication among all stakeholders, and customization of teaching to meet individual students’ needs. This capability allows teachers to more easily monitor their students' progress, identify areas where they need assistance, and offer personalized learning plans. Furthermore, EduPage continually adds new features that reflect current trends and needs in education. For example, integration with various online tools and applications that support interactive and practical learning can significantly enrich the educational process.

Virtual classrooms, automated task assessment, digital portfolios, and various analytical tools are just some of the features that teachers and students can use to improve the efficiency of teaching and learning.

EduPage also supports the concept of lifelong learning, as it allows students to access learning materials and resources anytime, anywhere. This approach is crucial today, as education is no longer confined to classrooms but occurs continuously throughout life. Last but not least, the EduPage platform has the potential to overcome geographical and cultural barriers, contributing to equal educational opportunities for all students regardless of where they live. International collaboration and knowledge exchange can enrich educational systems worldwide and create a global community of teachers and students who learn and grow together.

For these reasons, it is essential that students—future teachers—are thoroughly prepared to work with EduPage. Preparing future teachers for EduPage is crucial not only for their personal professional growth but also for the overall improvement of the quality of the educational process. Teachers who are technically proficient and capable of using modern tools will be better prepared to motivate and inspire their students, thereby contributing to their success and development. Integrating EduPage training into teacher programs can also boost future teachers' confidence when entering the workforce, reducing the stress associated with adapting to new technological demands. Moreover, this preparation fosters a culture of continuous professional development, which is essential in today's dynamic educational landscape.

Thorough preparation of future teachers to work with EduPage is key to effectively managing their future profession, positively influencing the quality of teaching, administrative processes, and the overall operation of educational institutions.

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The relationship between M-learning and Self-regulated-learning in the context of vocational education

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Abstract

This article focuses on the link between mobile learning (M-learning) and self-management in the context of vocational education. It first discusses the importance of innovative technologies in vocational education that can improve the quality of higher education in the 21st century. The paper presents the results of a systematic mapping exercise carried out in the context of M-learning and the subsequent categorisation of innovative technologies. M-learning offers many benefits, but it is important to pay attention to potential risks such as overuse of technology and distraction. The paper emphasizes self-regulated learning and recommends the promotion of students' self-regulatory skills in M-learning environments. Recent research in the area of self-regulated learning of university students and blended learning versus traditional teaching offers interesting results and suggests that M-learning can be an effective tool both in terms of professional learning and for promoting self-regulation, but it requires communication, a systematic approach and collaboration between teachers and students.

Keywords: M-learning, Self-Regulated-Learning, Vocational Education, Innovative Educational Technologies

1 Introduction

Generation Z students who are growing up in the digital age are showing an increased level of autonomy in managing their own learning process. Almost unlimited access to online tools

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motivates them to take a more active and independent approach. The rapid development of digital technologies places demanding requirements on educators as they have to constantly adapt their teaching methods. Research shows that Generation Z learners make heavy use of digital technologies for academic purposes, favouring interactive and personalised forms of learning, which is what M-learning is. They are used to instant access to information and collaborative digital tools, online platforms and AI. Given these realities, it is essential to try to understand how Generation Z learners use digital technologies to support their development and how these technologies influence their learning strategies. (Firas Khairi, 2024)

The systematic use of innovative educational technologies by teachers to enhance professional learning is a current requirement and trend not only in higher education institutions. The more teaching methods and learning strategies a teacher has, the better he/she motivates students' cognitive activity, the more varied, interesting and effective he/she conducts lessons, promotes the solution of non-standard tasks and situations, encourages the continuous adoption of innovative technologies, practical activities and deep learning. A competitive professional constantly improves his/her didactic skills, develops innovative strategies, chooses new innovative technologies and teaching methods (Vinnyk, 2021).

Nowadays, hybrid forms of teaching, which combine traditional face-to-face teaching with e-learning and the use of modern digital technologies, are increasingly used in higher education. The implementation of technology in vocational education requires students to have an awareness of independent learning, such as exploring learning materials, participating in discussion forums, solving creative online tasks or tests. This blended learning is one of the innovative approaches to integrate digital technologies into vocational education to promote the development of higher cognitive functions, digital creativity and at the same time independent and self-directed learning of students. A prerequisite for success is sufficient preparation on the part of the teacher and sufficient learning materials that are made available to students.

The use of technology to support learning is flexible and stimulating for students as they learn skills such as spatial visualisation, innovative thinking, problem solving, analytical and critical thinking. (Criollo-C, S. et al., 2024)

2 Innovative Educational Technologies

Innovative educational technologies ensure the competitiveness of universities and lifelong learning institutions in the market of educational services and create all the conditions for improving the quality of education. Innovative educational technologies as a means of improving the quality of higher education are understood as modern technologies created on the basis of innovations and current trends.

According to Desiatov (Knysh, 2023), innovative educational technologies, especially distance learning technologies, require greater self-organization, allow to choose the rhythm of learning, provide students with the opportunity to carry out high-quality continuous independent work, provide opportunities for self-expression, and shape the information culture among students. Such technology improves the content of performing and completing practical tasks, systematizes materials, provides the opportunity to acquire knowledge in a professional field at any convenient time, and improves professional skills throughout life. Innovative technology contributes to students' mobilization of forces for interest during education; individual's professional orientation, the formation of education seekers' creativity; increases their motivation to work; orients students to form their own methods of activity.

Knysh (2023) identified the characteristics and needs of innovative educational technologies to improve higher education:

- optimality: the ability to achieve educational goals with the least expenditure of time, effort, and resources;
- modernity: continuous improvement of the content of the professional discipline, striving for innovation, reducing the gap between the latest achievements of production and science;
- scientificity: the implementation of a fully comprehensive analysis of the results of education on the basis of the latest professional achievements in the scientific field of knowledge;
- integrity: synthesis of interdisciplinary knowledge;
- optimality of the material and technical base of education;
- reproduction of the educational process and the results of the monitoring of the education sector;
- programme activities for university candidates and teachers;
- comprehensive use of didactic teaching aids and modern technical conveniences that enable the activation of professional activity in the academic environment;
- qualitative and quantitative monitoring of education and evaluation of learning outcomes.

In order to gain insights into the use of educational technology in education, a systematic mapping exercise was carried out between 2018 and 2022, which can increase knowledge about the state of research in this area. The search identified a number of related works, but only the most relevant ones were included in the mapping. The selection of papers included journal and conference articles, research reports, theses and book chapters. A keyword search string of three scientific databases (Scopus, Web of Science and IEEE Xplore) was used during the five-year systematic mapping (Criollo-C, S. et al., 2024).

Based on the results and within the five categories, a new classification of educational technologies was proposed to cover the largest number of digital technologies used in education. Table 1 shows the categories (A-E) defined for each type of educational technology. These technologies have been used in higher education and lifelong learning. Table 2, on the other hand, lists each educational technology and its categorization. (Criollo-C, S. et al., 2024)

Code	Category
A	Technologies that support adaptive learning
B	Technologies that support collaborative learning
C	Technologies in the service of pervasive learning
D	Technologies that support learning through games
E	Technologies for understanding and creating with devices and hardware

Table 1: Categories of educational technologies in education. (Criollo-C, S. et al., 2024)

Type of new technology	A	B	C	D	E
1 Artificial intelligence	X				
2 Augmented reality	X			X	X
3 Big data	X				
4 Blockchain	X				
5 Cloud computing	X	X	X		
6 Collaboration tools		X			
7 Gamification	X		X	X	
8 Hardware					X
9 Internet of Things					X
10 Learning management systems	X	X	X		
11 Machine learning	X	X			
12 M-LEARNING	**X**	**X**	**X**	**X**	**X**
13 Mooc's			X		
14 Podcasts, Vodcast, Screencast		X	X		
15 Social Networks		X	X		
16 Virtual Reality	X			X	X
17 Wikipedia		X	X		
18 World-Wide Web		X	X		

Table 2: Classification of new technologies in higher education. (Criollo-C, S. et al., 2024)

The results of the systematic mapping showed that M-learning was the most used educational technology, which was found in all five categories (A-E). Learning supported by mobile devices is a trend that is strongly applied in academic settings. Gamification, cloud computing, LMS, AR and VR share the second place. These technologies are being used to support learning at all levels of education, from primary through higher education to lifelong learning. As technologies are constantly and rapidly changing, the findings and trends identified in this period (2018-2022) may have evolved or changed, and the information gathered may not be entirely relevant to the current state of ET in education (Criollo-C, S. et al., 2024).

The university of the future is a hybrid, flexible learning environment that should harmoniously combine tradition and innovation, effectively and rapidly adapting to trends and innovative changes. Video-learning, e-learning, artificial intelligence, gamification, social networks or virtual and augmented reality are relevant trends in innovative educational technologies for higher education. The introduction of innovative educational technologies, such as M-learning, into the educational process creates the necessary conditions for the attractiveness or flexibility of higher education (Vinnyk, 2021).

3 M-learning in vocational education

In the context of blended learning, the mobile form of M-learning, which is the process of learning through mobile devices such as tablets, laptops, smartphones or tablets, is increasingly being applied in universities. This form of learning takes place in an online environment and offers many advantages, including convenience, flexibility, efficiency, interactivity and portability.

When integrating M-learning into hybrid courses and professional learning, it is important to ensure:

- Coherence with face-to-face teaching. Mobile apps and platforms should support and complement the content of face-to-face classes.
- Interactive elements. Students should be able to actively engage in the learning process, e.g. through quizzes, discussions or simulations.
- Professional content. Mobile apps should provide high quality and up-to-date content that is relevant to the needs of the learners.
- Teacher support. Teachers should be prepared to support students in the use of mobile technologies.

The implementation of mobile technologies in the educational process brings fundamental changes in the way students learn. This form offers students a flexible and interactive way of learning that goes beyond the traditional classroom. M-learning offers a wide range of opportunities for the development of different competencies of students (Koldeova, 2023). The author lists the goals of M-learning in terms of the development of these competencies according to Wiepcke (2006, Koldeová 2023):

Development of professional competences. Mobile devices enable students to engage more actively in the learning process. Thanks to them, learners have a wealth of information at their disposal, which they can adapt to their individual needs and pace of learning. M-learning thus promotes the development of independence, flexibility and the ability to use available resources effectively.

Development of personal competences. The use of mobile devices in education contributes to the development of students' personal competences. Students become responsible for their own learning, develop initiative and the ability to work independently. M-learning also supports the development of digital competences and critical thinking skills.

Development of methodological competences. Mobile technologies offer new opportunities for personalised and flexible learning. Students can create their own learning plans and pacing, allowing them to better understand the material and achieve better results. M-learning also supports the development of collaborative skills and the ability to work in teams.

Developing media competencies. M-learning contributes to the development of students' media literacy. Students learn to critically evaluate the information they receive from different sources and to use it responsibly. The implementation of mobile technologies also brings new opportunities for personalisation and streamlining of the educational process in language teaching. Mobile apps and platforms allow learners to practice language skills anytime, anywhere, use authentic materials, get instant feedback and interact with other learners.

The integration of M-learning in professional learning represents a promising avenue, especially due to its advantages, as described by Kolde (2015).

Advantage	Description
Flexibility	Students can learn anytime, anywhere, allowing them to tailor their learning to their lifestyle and individual needs.
Personalisation	Learning content and pace can be tailored to each student's individual needs, increasing the effectiveness of learning.
Interactivity	M-learning offers a wide range of interactive tools such as games, quizzes, simulations and more to increase student engagement and motivation.
Authenticity	Students have access to authentic materials such as videos, articles, allowing them to immerse themselves in the target language and culture.
Collaborative	M-learning encourages collaboration between students through online forums, chats and collaborative projects, which develops their communication and social skills.
Immediate feedback	Mobile apps provide instant feedback, allowing students to quickly identify and correct their mistakes.
Accessibility	M-learning makes learning materials and tools accessible to a wide range of learners, regardless of their geographic location or economic means.
Motivation	The interactive nature of m-learning and the ability to track one's own progress increase student motivation.

Table 3: Advantages of M-learning in professional learning.

However, despite all these advantages, we now see that M-Learning can present challenges. Excessive use of mobile devices can lead to an addiction known as Fear of Missing Out (FOMO), which can cause sleep problems, dizziness and distractibility, and difficulty concentrating. Educators should promote a balanced approach that helps students achieve work-life balance, Joy of Missing Out (JOMO), and improves students' overall well-being. Collaboration and communication are key. It helps students using mobile devices access a variety of online resources and the ability to connect with others, fostering a sense of community and knowledge sharing.

The implementation of M-learning in professional learning can make a significant contribution to the development of key 21st century competencies such as digital competence, critical thinking, creativity and collaboration. Equally, its flexibility, personalisation and interactivity make it destined to become an integral part of innovative vocational education.

4 Self-Regulated Learning (SRL)

Since M-learning contributes mainly to increasing motivation and interest in learning, which are essential aspects of self-regulation and meta-learning, it is important to address this topic from the perspective of self-regulated learning. Self-Regulated Learning - SRL is understood as learner-centred learning in which the learner is aware of and manages his/her own learning, controls his/her thought processes and incoming stimuli, also distinguishes incoming information, understands the meaning and purpose of learning and becomes responsible for it. (Zelina, 2021)

The distance between the student and the teacher allows the student autonomy in self-learning and the chance to significantly improve the organization and mastery of independent work, giving him the space for his time management and regulation of priorities, obtaining and evaluating information, controlling his own results, taking responsibility for his own learning, realizing the meaning and reason for learning itself, and above all, the interest in achieving predetermined results.

In terms of building self-management (self-regulation) of learning, Zelina (2018) lists the following six areas of control and skills. Each of these areas focuses on a different aspect of the learning process and allows learners to actively manage their learning:

- Attentional control: the ability to focus on the learning and resist external distractions.
- Decoding control: The ability to evaluate information, filter out what is essential and resist manipulation.

- Emotional Control: The ability to manage one's emotions while learning, maintain a positive attitude, and communicate effectively.
- Motivational Control: The ability to set goals, maintain motivation and cope with obstacles.
- Environmental Control: The ability to create an appropriate learning environment and eliminate distractions.
- Cognitive control: The ability to manage one's thought processes, become aware of one's learning strategies and reflect on them.

In the context of the use of digital technologies and the Internet, we consider attention control to be a particularly important area, which is literally "bombarded" by a barrage of constantly, easily and quickly available information, and requires constant control of our attention, where, when and to what extent we give our attention. Another important area of control in relation to the use of the Internet is decoding control, which we believe relates to the ability to think critically and independently, to judge, to evaluate what is essential and relevant to us. In the context of environmental control, which focuses on distracting elements, the related impairment of concentration, the tendency to procrastinate, etc., we see the use of technology as a means of regulating learning and leisure activities, so-called time-management, i.e. regulating or managing one's own time, planning and scheduling time effectively and positively (apps for planning, calendars, quick and effective communication, reminders for regular and irregular learning tasks, getting and handing in one's results and work quickly, etc.). It is important to what extent and for what purposes the technologies will be used because, if used incorrectly, they can, on the contrary, become a distraction to learning.

We consider the research carried out in university settings in Chile in the areas of Self-Regulated Learning (SRL), Blended Learning (BL) and Traditional Teaching (TL) to be fundamental for the academic development of students, as well as for the development of current educational methods. This research focused on conceptualizing self-regulated learning with a blended learning modality using direct perceptions of students completing an undergraduate degree. Students defined the SRL-BL relationship with respect to the same three phases of SRL: planning, implementation, and evaluation.

Students' emphasis on planning and autonomy, along with a limited focus on implementation and evaluation, indicated that they perceived SRL-BL as primarily a preparatory and organizational process. The authors recommend that educators focus more on improving students' reflective techniques and self-assessment skills to promote a more comprehensive understanding of SRL-BL that includes all phases of the self-regulation cycle (Lobos et al., 2024).

The emphasis on the integration of personal and academic life suggests that students perceive self-regulation as a holistic process. It is not just about achieving academic goals, but about building a lifestyle that supports their overall development. This perspective, according to the authors, indicates a mature understanding of self-regulation, where learning is part of a broader context of personal growth. This analysis shows that students perceive self-regulation in the context of BL as a multifaceted process that requires skills in emotions, digital technologies, and distraction management. Furthermore, they emphasize the importance of aligning personal and academic lives as an integral part of their learning experience.

The study conceptualized the relationship between self-regulated learning and blended learning (SRL-BL) as a process in which students systematize, monitor, and evaluate their learning through self-reflection and digital technologies, with a particular emphasis on planning. Significant differences were identified between SRL-BL and traditional SRL; in face-to-face learning, teacher supervision is greater, while in SRL-BL, students take on more responsibility and autonomy, thus developing self-management skills. In face-to-face learning, the responsibility for learning lies with the teacher, while in the BL context, the responsibility shifts to the student, making self-regulation skills more critical. Although SRL-BL promotes autonomy and responsibility, students face obstacles such as distractions from social media and leisure technologies that affect their concentration and study planning. (Lobos et al., 2024)

In M-learning, according to the authors, it is important to emphasize a structured and distraction-free learning environment for successful self-regulation. The presence of multiple sources of distraction in a virtual environment challenges students to develop effective strategies to maintain concentration and adhere to study plans. The need for additional effort to manage distractions suggests that students need to be more conscious and purposeful in applying self-regulation strategies in the context of BL. This includes setting clear boundaries for the use of leisure technology and social networks, as well as creating an organized study environment that minimizes distractions. We agree with the authors that distractions pose a significant threat to self-regulated learning, requiring students to make conscious efforts to focus and adhere to their study plans. Promoting self-regulation skills that specifically address these distractions can increase learning effectiveness and help students face the unique challenges of today's digital world. (Lobos et al., 2024)

5 Conclusion

M-learning appears to be a promising tool on the path to modernizing higher education. Its flexibility, personalization, portability, and interactivity predispose it to become an integral part of hybrid courses and blended learning. However, the implementation of M-learning requires thorough and systematic preparation and support from teachers and institutions, as well as a discussion of the challenges it brings.

Higher education teachers should not only offer students opportunities to discover the usefulness of digital technologies and support their integration into the learning process itself, but also support students' self-regulation in learning. One of the tasks of the teacher is to strive to create a learning environment that supports independent and self-regulated learning, in which students have the opportunity to seek challenges, reflect on their progress, and take responsibility for their learning. In the context of M-learning, the student takes a large part of the control over learning and the learning environment. We consider it all the more important to explore and discuss how to guide students to acquire self-regulation techniques and the above-mentioned skills within the six areas of self-regulation control. Current research on the impact of technology on students' concentration and focus also suggests the need to update and systematize the concept of self-regulated learning (SRL) in the current educational context influenced by technological progress.

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To self-reflect or not to self-reflect: That is the question

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Abstract

Self-reflection should play a pivotal role in the professional development of all teaching professionals as it helps to enhance their effectiveness, personal and professional growth, and the quality of their student outcomes. However, the results of our qualitative research of five experienced English language teachers reveal that regular and formative teacher self-reflection is not quite frequently, if at all, used at selected primary or secondary schools in Slovakia. This paper uncovers the current status quo of the problem as well as the reasons causing the participating teachers not to self-reflect. It also provides an overview of some of their opinions on the researcher-led self-reflection they have recently experienced.

Keywords: Professional Development, Effectiveness of Teaching, Talk Self-reflection

1 Introduction

Teacher self-reflection has been widely researched and assessed by many renowned authors in Slovakia and abroad, both qualitatively and quantitatively. This paper summarizes the major preliminary findings of our qualitative research carried out during the global COVID-19 pandemic of years 2020 and 2021. It aims at contributing to the existing scientific knowledge in the field by examining self-reflection of classroom teacher talk in the context of online English language teaching. Specifically, it focusses on the ability of five qualified and experienced English language teachers to recognise the strengths and weaknesses of their own online classroom teacher talk as well as their preparedness to identify its more effective alternatives.

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2 Research Framework

2.1 Research Aims

The aim of our research is to contribute to the wider discussion on the importance of self-reflection in the work of foreign language teachers. Through teacher self-reflection we analysed and described the positive and negative aspects of classroom teacher talk in online English classes. We focussed on the views of five research participants, their ability to detect and describe the strengths and weaknesses of their online classroom teacher talk as well as their openness to modification and/or more effective solutions.

2.2 Research Questions

In our research we formulated five research questions. They were meant to help us uncover the nature of the research problem from the perspective of our research participants:

1. How did research participants perceive the role of self-reflection in the work of a foreign language teacher *before* their active participation in our research?
2. What examples of satisfactory and problematic classroom teacher talk can be identified in online classes of the observed teachers?
3. Which problematic areas of their online classroom teacher talk can the research participants identify themselves, i.e. without the help of the researcher?
4. What modifications of the problematic areas of their online classroom teacher talk can the observed teachers suggest?
5. How do research participants perceive the role of self-reflection in the work of a foreign language teacher *after* their active participation in our research?

2.3 Research Participants

Our research sample consisted of a group of five qualified Slovak non-native English language teachers with a minimum teaching experience of five years, teaching at primary and secondary schools in western and central Slovakia (Bratislava, Nitra, Zlaté Moravce, Žiar and Hronom). To guarantee confidentiality and anonymity in the research reporting, we use their pseudonyms:

1. Ms. Karolína, from a 5-year bilingual grammar school, teaching B2 English classes to 14–15-year-olds
2. Ms. Daniela, from a 4-year grammar school, teaching B2 English classes to 18-19-year-olds
3. Ms. Radka, from a secondary vocational school of trade and services, teaching B1 English classes to 18-19-year-olds
4. Ms. Zora, from an elementary school, teaching A2 English classes to 14–15-year-olds

5. Mr. Jakub, an elementary school, teaching B1 English classes to 14–15-year-olds

2.4 Research Methodology and Design

In terms of methodological approach, we chose qualitative, empirical, basic research. From a wide range of available research designs, we opted for a collective (multiple) case study, which is descriptive and evaluative in its focus and outputs (Cohen, Manion, Morrison, 2018).

2.5 Research Time Frame and Phases

Our research was carried out in seven phases between September 2020 and December 2021.

In Phase 1 (September – December 2020) we formed our research sample, described in chapter 3.3, and informed each research participant about the details of our research. In this phase the teachers were asked to audio record three of their online classes taught to the same group of students and submit the recordings to the researcher.

In Phase 2 (January 2021) we designed a Self-reflection Sheet No. 1 with general questions about online classroom management, interaction and student-centeredness. In this phase we also prepared selected readings covering the topic of classroom teacher talk, which the participants were provided with in a later stage of our research.

In Phase 3 (February - March 2021) the teachers were asked to listen to the three recordings of their online classes and self-reflect on each one of them by answering the questions in the Self-reflection Sheet No. 1. In this phase we listened to all fifteen audio-recordings and started taking researcher notes on each.

In Phase 4 (April – June 2021) we facilitated the first round of semi-structured in-depth self-reflective interviews with all participating teachers about each of their three recorded online classes. In this phase we also designed a Self-reflection Sheet No. 2 with specific questions targeting the area of classroom teacher talk.

In Phase 5 (July – August 2021) we provided the teachers with the selected readings as well as the Self-reflection Sheet No. 2. Their task was to self-study the reading materials, listen to the audio recordings again and self-reflect on all the three, while focussing on their classroom teacher talk. In this phase we listened to all fifteen recorded in-depth interviews and supplemented the researcher notes with our findings.

In Phase 6 (September – November 2021) we facilitated the second round of semi-structured in-depth self-reflective interviews with all teachers, each about the three recorded online classes. We wanted to find out whether, and to what extent, the teachers can identify and describe positive and negative examples of their online classroom teacher talk. At the same time, we were interested in learning about what more effective alternatives to the problematic areas they can suggest.

In Phase 7 (December 2021) we listened to the five recorded in-depth interviews and added our findings to the researcher notes.

2.6 Research Data

The main sources of information in our research, which Skalková et al. (1985) refer to as primary documents, were data collected from audio-recordings of online classes, Self-evaluation sheets and individual in-depth interviews. They are all listed in Table 1:

Recordings and Documents	**Length of one** (in minutes)	**Length of one** (A4 pages)
15 audio-recordings of on-line English classes	35 to 45	-
15 full transcripts of on-line English classes	-	16 to 22
15 Self-evaluation sheets No. 1	-	2 to 3
15 audio-recordings of in-depth interviews from Round 1	90 to 120	-
15 full transcripts of in-depth interviews from Round 1	-	10 to 43
5 Self-evaluation sheets No. 2	-	3 to 5
5 audio-recordings of in-depth interviews from Round 2	90 to 120	-
5 full transcripts of in-depth interviews from Round 2	-	15 to 40

Table 1: Research data overview: Recordings and Documents.

2.7 Data Analysis

Our qualitative research neither confirms nor disproves any existing theories. After collecting enough research data, we analysed it for regularities, formulated preliminary conclusions and then looked back again for more support in the available data. Although the findings of this type of research are not representative and cannot be generalised, they uncover interesting and statistically invisible details and nuances, which, we believe, can impact educational processes.

3 Research Results

As each teacher participating in our research was unique and his or her case was specific, we present the preliminary results in this chapter case by case. They were collected from the transcribed audio-recorded online classes and the teacher self-reflection sheets No. 1 and No. 2. The data from the in-depth self-reflective interviews are still being processed.

3.1 Research Question 1

How did research participants perceive the role of self-reflection in the work of a foreign language teacher *before* their active participation in our research?

Ms. Karolína:

- did not experience systematic self-reflection before our research
- she sees no reasons why to self-reflect
- sometimes informally thinks about her classes, especially whether they are interesting for her students

Ms. Daniela:

- did not experience systematic self-reflection before our research
- occasionally informally self-reflects on the classes that do not go smooth or according to the plan

Ms. Radka:

- did not experience systematic self-reflection before our research
- does not use self-reflection in her work at all mainly because of heavy workload

Ms. Zora:

- did not experience systematic self-reflection before our research
- in the past she recorded some of her classed, listened and analysed them with the aim of improving her teaching

Mr. Jakub:

- did not experience systematic self-reflection before our research
- there is no self-reflection culture in the school where he works
- occasionally briefly and spontaneously self-reflects about his classes, especially if covering difficult topics

3.2 Research Question 2

What examples of satisfactory (+) and problematic (-) classroom teacher talk can be identified in online classes of the observed teachers?

Ms. Karolína:

+ asking a lot of questions of all types (mainly open) during the whole class
+ using a wide variety of oral elicitation techniques
+ occasionally supporting student self-correction
+ sometimes allowing students to finish their answers – not interrupting them
- overuse of fillers (ah, uhm, err, ehm, ok, yes, etc.)
- extensive input – frequent lengthy teacher monologues

- complex and complicated instructions
- echoing, i.e. repeating own questions right after asking them
- immediate explaining of new vocabulary without involving students
- absence of think time and/or wait time for students to prepare their contribution

Ms. Daniela:

+ clarity of some instructions
+ supporting students and motivating all of them to active participation
+ regular praising and encouragement
+ involving all students equally into tasks and activities
+ asking a variety of questions during the class
- overuse of fillers (“So, this is it.”, “So, tell me.”, etc.)
- overhelping: starting or finishing answers for students, repeating or paraphrasing own questions, etc.
- immediate explaining or translating of new vocabulary without involving students
- complexity of some instructions leading to long teacher monologues
- absence of think time and/or wait time for students to prepare their contribution

Ms. Radka:

+ asking a lot of questions of all types (mainly open) during the whole class
+ using a wide variety of oral elicitation techniques
+ distinguishing between fluency and accuracy tasks, i.e. not interrupting during fluency tasks
+ occasionally allowing student peer-correction
+ sometimes providing think time and/or wait time for students to prepare their answers
- overhelping: starting or finishing answers for students, repeating or paraphrasing own questions, etc.
- using mainly teacher correction
- immediate explaining or translating of new vocabulary without involving students
- interaction limited to teacher asking questions and individual students answering these questions

Ms. Zora:

+ asking a lot of questions of all types (mainly open) during the whole class
+ using a wide variety of oral elicitation techniques
+ supporting students and motivating them to active participation
+ involving all students equally into tasks and activities
+ listening without interrupting students who talk
- immediate explaining or translating of new vocabulary without involving students
- using too much Slovak even when unnecessary
- interaction limited to teacher asking questions and individual students answering these questions
- expecting impromptu answers – not providing think time/wait time

- overhelping: starting or finishing answers for students, repeating or paraphrasing own questions, etc.

Mr. Jakub:

+ enthusiasm and very supportive way of communicating with students
+ using humour regularly during the class
+ asking a lot of questions of all types (mainly open) during the whole class
+ using a wide variety of oral elicitation techniques
+ ability to discuss the depth and width of the topic
+ distinguishing between fluency and accuracy tasks, i.e. not interrupting during fluency tasks
+ supporting students in asking questions, not just answering
+ regular praising and encouragement
- overhelping: starting or finishing answers for students, repeating or paraphrasing own questions, etc.
- tendency to "running commentary"
- echoing, i.e. repeating own questions immediately after asking them
- expecting impromptu answers – not providing think time/wait time

3.3 Research Question 3

Which problematic areas of their online classroom teacher talk can the research participants identify themselves, i.e. without the help of the researcher?

Ms. Karolína:

- overhelping students
- not providing enough think time/wait time to students
- not allowing students to correct themselves
- interrupting student answers
- too much teacher talking time
- reading instructions and examples from the book instead of asking students to do so
- answering questions instead of students

Ms. Daniela:

- asking too many questions
- echoing, i.e. repeating own questions immediately after asking them
- finishing student answers
- paraphrasing own questions
- overhelping
- too much teacher talking time
- quick pacing

Ms. Radka:

- repeating student answers
- repeating own questions
- using only Teacher – Student interaction

Ms. Zora:

- not allowing students to ask questions
- not providing enough think time/wait time to students to prepare their answers
- echoing, i.e. repeating own questions immediately after asking them

Mr. Jakub:

- not providing enough class time to students
- too much teacher talking time
- absence of peer teaching and peer correction

3.4 Research Question 4

What modifications of the problematic areas of their online classroom teacher talk can the observed teachers suggest?

Ms. Karolína:

- students need to be given more time to think as well as speak
- students should be involved into reading instructions and examples
- I should slow down and step back during classes
- more peer correction and self-correction is necessary
- students can explain vocabulary before the teacher does

Ms. Daniela:

- my role of a teacher – leader or teacher – speaker should be modified to a teacher – facilitator
- I must reduce the number of questions
- it´s important to allow students to prepare their answers without my interruptions
- slower pace is necessary

Ms. Radka:

- I need to be more patient and wait for the students to prepare their answers
- I should include other forms of interaction not only Teacher – (one) Student
- student should be involved in repeating answers or questions instead of myself

Ms. Zora:

- provide enough think time instead of repeating or paraphrasing questions
- use pair work or group work so the students experience talking to each other not just answering the teacher´s questions
- reduce the use of Slovak
- slow down when talking about more complex topics

Mr. Jakub:

- students need more think time which I need to plan in

- students need to cooperate with each other and learn from each other which I need to plan in
- I will try to shift roles from a teacher – leader to a teacher – facilitator

3.5 Research Question 5

How do research participants perceive the role of self-reflection in the work of a foreign language teacher *after* their active participation in our research?

Ms. Karolína:
- self-reflecting on my own work was an eye-opening experience
- self-reflecting can be very useful for teachers

Ms. Daniela:
- I realised a few problems of my teacher talk only thank to listening to the recording and analysing the class; I was not aware of those before

Ms. Radka:
- if there is time to self-reflect, it is useful and can help teacher to improve but it is difficult to find time for self-reflection in the busy teaching schedule

Ms. Zora:
- self-reflecting was very useful as this was the only time, I had a chance to self-reflect on the quality of my online class teaching
- I appreciate being guided though the self-reflection from general to very specific points of English methodology

Mr. Jakub:
- interesting experience which made me re-consider certain practical details of my everyday work on the one hand and on the other hand made me think about my mindset and some different techniques worth trying with my students

4 Conclusion

The conclusive results of our qualitative research will be available after we have finalised processing the data from all the in-depth interviews. We strongly believe our scientific endeavour will confirm what the preliminary results mentioned above already indicate. Self-reflection is an essential tool for all teaching professionals. It fosters continuous improvement, promotes a growth mindset, and can significantly enhance both teacher and student performance. Teachers who engage in regular self-reflection are better equipped to tackle the problems and master the challenges of everyday classroom and ensure high-quality education to their students and the institutions they work for. Systematic self-reflection supports both personal and professional growth and is essential for improving the effectiveness of foreign language teaching. Therefore, whether to self-reflect or not to self-reflect should not be a question but should rather be a fundamental part of a teacher's daily practice.

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The use of microcontrollers to improve the quality perception of the education environment

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Abstract

Many domestic and international studies confirm that a high-quality environment enhances human performance, including performance influenced by the quality of the educational setting. The educational process involves activities that require critical thinking, creativity, and sustained concentration.

To effectively improve the learning process, targeted measures can be implemented to create optimal conditions for student performance. Our proposed methods aim to enhance the perception of the educational environment, thereby improving well-being during education.

Optimizing the well-being of teachers and students requires assessing and evaluating key indicators that influence well-being, followed by the development of strategies for their optimization. We designed and constructed microcontroller-based instruments to measure these indicators. The measured values (objective indicators) were then compared with students' perceptions of comfortable learning conditions (subjective indicators) to assess the overall quality of the educational environment.

Keywords: Microcontrollers, Calibration, Information and Communication Technologies

1 Introduction

The article describes the research carried out on optimizing the quality of the educational environment and its impact on the performance of participants in the educational process. The importance of the quality of the environment in which the educational process takes place is undeniable. Current research, both domestically and internationally, clearly demonstrates that environmental quality directly influences individual performance. This applies not only to

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workplaces but also to schools, universities, and other educational institutions. Since the educational process involves activities that enhance cognitive engagement, creativity, concentration, and motivation, it is essential that the learning environment meets specific qualitative criteria.

This article focuses on evaluating the quality of the educational environment in terms of its impact on the well-being of education participants—teachers and students—and on optimizing these conditions through targeted measures. Additionally, it presents methods for measuring and evaluating factors that influence environmental quality, with an emphasis on both objective and subjective indicators.

2 Environmental Quality and Its Impact on Performance in the Educational Process

The educational process is complex and dynamic, including various activities that require the active involvement of thinking, cognitive abilities, creativity and concentration. The ability of pupils and students to learn and achieve optimal results depends not only on their individual abilities, but also on the factors that affect their well-being and comfort during class. These factors include the quality of the physical and psychological environment into which education and learning are integrated. A quality environment can promote learning efficiency, creativity, and productivity, while a low-quality environment can inhibit these processes.

Recent studies show that an optimal environment contributes to better focus, reduced stress, and improved overall well-being. The importance of these factors is particularly important in educational settings, as students are subjected to long-term mental and emotional strain that affects their ability to absorb new information, solve problems, and engage in creative activities.

Given that the well-being of participants in the educational process is key to achieving performance, it is necessary to carry out a systematic assessment of the factors that influence this well-being. These factors include, in addition to physical aspects (such as temperature, humidity, lighting, acoustics), psychological factors such as teacher-pupil interactions, the organisational structure of teaching, as well as the subjective perception of the environment by pupils and teachers (Marchand, J.-M. 2007, p. 756), (Wargocki, P. et al. 2007, p. 63).

2.1 Measurement of objective and subjective indicators of environmental quality

Measuring the quality of the educational environment can be carried out using various tools that provide both objective and subjective indicators. In our research, we focused on combining these two approaches to get a comprehensive picture of the impact of the environment on student performance.

Objective indicators: These indicators are based on the measurement of physical and technical parameters of the environment, such as:

- Temperature and humidity: Air quality and temperature can directly affect students' concentration and comfort. Temperatures that are too high or low can cause discomfort that leads to a decrease in productivity.
- Lighting: High-quality lighting is essential for proper visual perception, reducing eye fatigue and promoting concentration.
- Acoustic conditions: Disturbing sounds and high noise levels can significantly.

As part of the research, we used measuring instruments based on microcontrollers, which enabled continuous monitoring of these parameters in real time. These instruments provided accurate and reliable data on temperature, humidity, lighting and noise in classrooms, giving us an objective basis for comparison with students' subjective assessments.

Subjective indicators: The subjective assessment of the comfort of the environment by students and teachers is equally important, as it reflects their personal perception of the conditions during the lesson. To find out the monitored indicators, we used the Marchand questionnaire, which focuses on the evaluation of various aspects of the school environment from the point of view of comfort and satisfaction of participants in the process. This questionnaire allows you to identify the factors that have the greatest impact on subjective feelings of well-being, such as stress levels, emotional experiences during class, or perception of relationships with teachers (Depešová, 2019, p. 92).

2.2 Optimization of the conditions of the educational environment

The aim of our research was not only to obtain objective and subjective data on the quality of the environment, but also to propose measures for its optimization. Based on the analysis of the results of measurements and questionnaires, we have identified key areas in which the conditions for effective learning and teaching can be improved.

- *Temperature and humidity:* Maintaining an optimal temperature in classrooms (around 21°C) and adequate humidity can improve concentration and reduce fatigue. In this case, it is recommended to invest in a high-quality ventilation and air conditioning system.

- *Lighting:* Using natural daylight, along with artificial lighting that mimics natural conditions, can reduce eye strain and improve overall well-being. It is also important to place the light sources correctly to avoid glare or uneven lighting.

- *Acoustics:* Ensuring low noise levels and optimizing the acoustic properties of the classroom through appropriate materials and equipment (e.g. acoustic panels) can significantly increase comfort during lessons.

- *Electromagnetic smog:* Electrical and electromagnetic impulses cause various health problems – nervousness, depression, headache and eye pain, buzzing and whistling in the ears, sleep disorders, leukaemia, Alzheimer's, behavioural disorders. The most effective protective factor is the harmonization of the environment in which we live, work, or teaching is in progress. The basic means of protection against the effects of electromagnetic smog is sufficient shielding of the radiation source.

- *Psychological factors:* To improve the psychological conditions of the environment, it is essential to promote positive interaction between teachers and students, develop active learning methods and strengthen student engagement. Creating an environment that encourages creativity, open communication, and flexibility leads to improved well-being of participants in the educational process (Tureková et al. 2018, p. 86), (Tureková & Depešová, 2020, p. 250).

A student working indoors is primarily affected by the heat-humidity microclimate, which influences heat and moisture flows within the building. These flows can enter the interior through the building's envelopes. Additionally, the interior can be impacted by the odor microclimate, which generates gaseous components in the space. While these odors do not directly threaten human health, at higher concentrations they can reduce concentration, impair performance, and cause nausea (Heschong, L., 2002, p. 159).
Environmental well-being can be understood as the sum of chemical, biological and physical factors in the environment that affect building occupants as a whole. The well-being of the environment is influenced by air temperature, air flow velocity, air humidity, heat-insulating properties of clothing and physical activity of a person.

The well-being of the environment can be divided into several areas, such as:

- energy – heat, cold, noise, radiation,
- cloth – water vapour, gases and aerosols,
- thermal, thermal humidity,
- acoustic, light and others.

Factors influencing personal well-being include gender, age, and the ability to acclimatize. An optimal microclimate refers to a condition in which the body does not need to engage thermoregulatory mechanisms (Kachaňáková, 2007, p. 32).

3 Conducting a research survey

Monitoring of the quality of the environment was carried out in a selected classroom in such a way that the monitoring device was connected to a computer via the Fy Eaton PLC module, or it is also possible to connect to a mobile phone.
As a model space suitable for monitoring, we chose a lecture room designed for about 50 people, where it is a prerequisite to create suitable conditions for monitoring selected factors. The connection of the measuring instrument via the PLC device creates a connection that allows the measured factors to be recorded in short periods of time. The device for measuring parameters characterizing air quality is currently connected to the EATON PLC system, which sends the measured data in 30-second intervals directly to an Excel document within Google Apps with the currently measured values through a communication protocol implemented by us.
This creates a database of data suitable for subsequent analysis and evaluation. These output values are followed by a software tool designed by us to compare the measured values with the required parameters set by the valid documents pertaining to the given measured factor, evaluate these results with an emphasis on human health and propose effective measures to improve the workplace in accordance with legal regulations. The implementation of measurements and the subsequent proposal for optimization of working conditions is expected to achieve an improvement in the quality of the working climate and thus an increase in working comfort and performance.

3.1 Tools for verifying the quality of measured factors

To assess the quality of the educational environment, activities were carried out that led to the design and implementation, creation of a software tool for evaluating the results of the obtained measured values. The design of the method of evaluating the mutual relationships of the measured factors can be verified with the required values using a simple software tool designed by us.
Based on the assessment of the factors that have the greatest impact on the quality of the results of the educational process in the educational process, we have selected the factors for which the software tool was created.

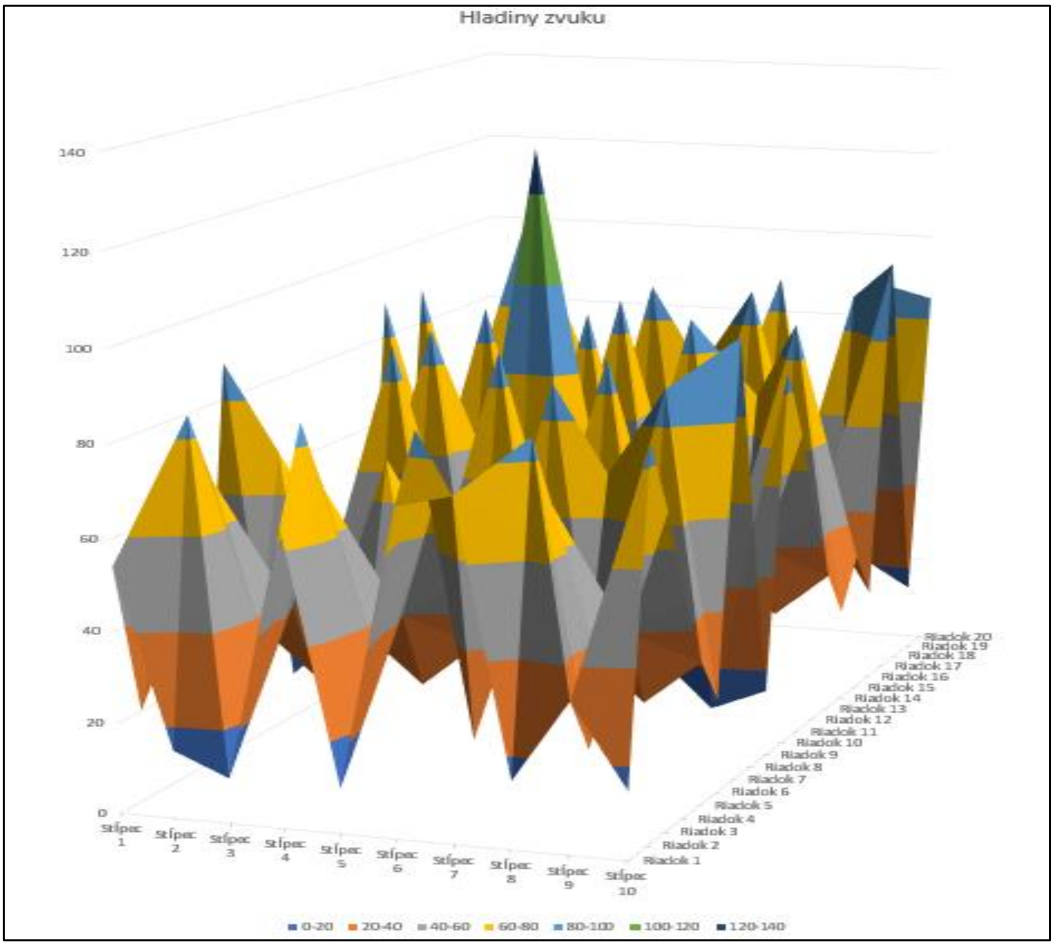
When creating it, we relied on valid documents:
Decree 99/2016 (temperature and humidity)
Decree 541/2007 (lighting)

Government Regulation 355/2006 (CO2)
Government Regulation 115/2006 (noise).

As an example of the created software tool, we present a table for recording measured noise values and the corresponding graph of measured values. With the help of a software tool, the measured value is compared in a graph with the permissible values specified in the relevant decree. Just as the measured values are recorded in a table, a specific level is recorded and evaluated in the corresponding graph.
Other selected factors of the educational environment are processed in a similar way and the measured parameters are evaluated.

Tabuľka	Stĺpec 1	Stĺpec 2	Stĺpec 3	Stĺpec 4	Stĺpec 5	Stĺpec 6	Stĺpec 7	Stĺpec 8	Stĺpec 9	Stĺpec 10
Riadok 1	54	15	10	65	10	71	74	15	33	15
Riadok 2	20	85	20	85	20	85	20	85	20	85
Riadok 3	30	69	30	69	30	69	30	69	30	69
Riadok 4	40	48	40	48	40	48	40	48	40	48
Riadok 5	22	32	22	32	22	32	22	32	22	32
Riadok 6	88	69	30	69	30	21	88	69	88	21
Riadok 7	36	48	40	48	40	48	40	48	36	98
Riadok 8	48	32	22	32	22	32	22	32	48	55
Riadok 9	10	21	88	21	88	21	88	21	10	15
Riadok 10	20	32	22	32	22	32	22	32	20	85
Riadok 11	30	21	88	21	130	69	30	69	30	69
Riadok 12	40	48	40	48	40	48	40	48	40	48
Riadok 13	22	32	22	32	22	32	22	32	22	32
Riadok 14	88	21	88	21	88	21	88	21	88	21
Riadok 15	22	32	22	32	22	32	30	69	30	32
Riadok 16	88	21	88	21	88	21	40	48	40	21
Riadok 17	36	32	22	32	22	32	22	32	22	98
Riadok 18	48	21	88	21	88	69	88	21	88	55
Riadok 19	10	98	36	48	40	48	22	32	22	15
Riadok 20	20	85	20	32	22	32	88	21	88	85

Table 1: Normalized Sound Level Action Values.



Graph 1: Sound level measurements.

4 Conclusion

The quality of the educational environment plays a crucial role in optimizing the effectiveness of the educational process. Measuring objective indicators such as temperature, humidity, lighting, and acoustics, alongside subjective assessments of comfort from students and teachers, provides valuable data for identifying and optimizing conditions that enhance well-being and learning efficiency.

Implementing appropriate measures to improve these conditions can significantly contribute to better overall educational outcomes while mitigating negative factors that affect student performance.

All activities conducted during the research aimed at optimizing the well-being of both teachers and students. The monitoring of research results focused on improving selected environmental factors, such as thermal comfort, lighting, noise levels, and the presence of pollutants, particularly carbon dioxide concentration in classrooms. The emphasis on objective factors facilitates the implementation of effective measures. Ultimately, improving these factors enhances students' health and increases their productivity.

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To the Roots: Engineering Pedagogy

Research-oriented model of cognitive learning in the subject of Technique

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Abstract

This article focuses on the research-oriented model of student education in the subject of Technique in lower secondary education in the Slovak Republic. The proposed model reflects the long-term educational needs in the subject of Technique, which, despite updates to the curriculum in the Educational Standard of the subject, have yet to be fully addressed. The learning model includes worksheets for students that feature experiments, along with a methodology for carrying out each experiment. Students discover new knowledge through research activities during the experiment, which they then evaluate at the end of the worksheet. The worksheet also includes a self-assessment sheet, where students record their responses to the experiment, reflect on their understanding of the content, and assess their satisfaction with their performance.

The article also presents the results of empirical research aimed at verifying the proposed research-oriented model. This research is part of the KEGA project No. 006UMB-4/2022, conducted in 2022.

Keywords: Primary School, Subject Technique, Model of Education

1 Introduction

The school reform of primary schools in Slovakia, implemented in 2008 and modified in 2013, has not met expectations, as the set objectives have not been achieved in various subjects, including Technique in lower secondary education. This is one of the reasons why a new curriculum reform, set to be implemented from the first year in all primary schools starting in 2026, is being tested in selected schools beginning in the 2023-2024 school year.

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The main objective of the reform is to educate students in the key competencies of the 21st century (creativity and innovation, creative and critical thinking, problem-solving, etc.). This requires teachers to adapt their teaching approach, shifting towards a research-oriented model of learning, as well as adjusting how they assess students' performance.

2 Starting points of the problem addressed

The subject of Technique has a specific place in the system of teaching subjects in lower secondary education in Slovakia and it is not replaceable by any other subject. It is focused on forming, acquiring and developing students' key competences. The traditional and most widely used approach to assessing student performance, focused on classification and marking (summative assessment), prevails in the subject even today. Since one of the objectives of the current curriculum reform is to transform the traditional school into a modern school, the application of formative assessment and student self-assessment is coming to the fore. In this type of assessment, the student is more active, receives feedback on the correctness of his/her learning, and his/her performance is not classified but verbally evaluated by the teacher.

From a didactic perspective, self-assessment can be viewed as a competence that promotes self-reliance and independence from the teacher. Both self-assessment and self-checking are important motivational tools for students. As stated by several authors (Ďuriš & Stadtrucker, 2016; Ďuriš et.al, 2017; Ďuriš et.al, 2018; Ďuriš, Stadtrucker & Pandurović (2019); Koedinger, McLaughlin & Hefferman, 2010; Ďuriš & Kvasnová, 2022; Ďuriš et.al, 2023; Ďuriš, Očkajová & Kvasnová (2023); Ďuriš, Tomková & Kvasnová, 2024), formative assessment of students should be used more extensively, as it improves the quality of students' knowledge and skills. More information about formative assessment of students can be found in the publication of the authors (Ďuriš, Stadtrucker & Pandurović, 2019).

A part of the research-oriented model of education in the subject of Technique is our workbook, which includes exemplification tasks. The worksheets in the workbook contain tasks designed to encourage students' exploratory activities. The tasks, which focus on the properties of technical materials (wood, metals, plastics), align with the content of the thematic unit "Technical Materials and Methods of Their Processing," taught in the 6th year of primary school. The properties of these materials can be observed directly or explored through simple experiments. Based on experiments carried out by the students themselves, they can more easily understand the phenomena observed and explain and justify the changes that occurred during the experiment. At the end of each experiment, students carry out a self-assessment and self-check as part of the formative assessment. They answer the prepared questions in their own words and express in writing their opinion about the experiment, how they understood the given topic and how they managed to work out the task in the experiment (Ďuriš et.al, 2023, p. 9).

Each worksheet is designed with the same structure but features different content. It includes the name and aim of the experiment, the task, tools, and the procedure for carrying out the experiment. The worksheet also contains a table in which the student records data while solving the problem, which is then analysed and evaluated in the following steps. In the final part of the worksheet, there are questions formulated within the self-assessment record sheet for the student to answer. The record sheet also includes a suggested table, where the student marks one of the emoticons (x) in each row based on how well they understood the task and how much they enjoyed the experiment. The student expresses their level of satisfaction with their performance using one of the three offered options: ☺ very well, 😐 good and ☹ I need to improve.

In individual experiments, the content of text in the self- assessment record sheet varies according to the type of experiment. However, they all have a uniform introductory wording, so that the student is able to express a level of agreement with following statements:

- I know the reason why ....,
- I can name the feature ....,
- I understood how ....,
- I understood the given task, the experiment was illustrative, and I found it interesting.

The workbook contains 17 worksheets. In empirical research carried out in fully organised primary schools in Slovakia, students in the 6th year of primary school solved ten worksheets focused on a specific property of a given material. We present the worksheets completed by students in the research.

Worksheet nr. 2 (elasticity of wood); Worksheet nr. 3 (hardness of wood); Worksheets nr. 4 and 5 (water absorption capacity of wood); Worksheet nr. 7 (density of wood); Worksheet nr. 8 (electrical conductivity of metals); Worksheet nr. 11 (magnetic properties of metals); Worksheet nr. 12 (elasticity of metals); Worksheet nr. 13 (corrosion of metals); Worksheet nr. 17 (weldability of plastics). To give the reader a better idea, we present an excerpt of the full version of Worksheet nr. 4 (Ďuriš et.al, 2023, pg. 26-28).

The worksheet nr. 4

The water absorption capacity of wood is the ability of wood to absorb water, when it is in contact with water, not water vapour. A practical use of this property is when we need the wood to increase its volume (e.g. immersing a hoe, rake or axe handle in the water), so that the wooden handle absorbs the water and increases its volume.

To protect the wood from unwanted water absorption, we paint the wood located outdoor in the

Experiment nr. 4 Water absorption capacity of wood

The aim is to determine the water absorption of soft wood and hard wood and to compare them with each other.

Task:

On selected soft wood and hard wood samples determine the degree, to which the wood is saturated with water, provided that both soft wood and hard wood samples are immersed with their entire volume in water for the same time.

Tools:

- soft wood sample (spruce, pine or fir), hard wood sample (beech or oak) of dimensions 40x40x100 mm,
- digital or laboratory scales, set of weights,
- tub - water container, water thermometer,
- stopwatch for time measurement,
- water at 25°C – 30°C, textile (paper) cloth.

Work procedure

1. Using digital scales, determine the weight of soft wood and hard wood samples and enter the values in the table.
2. Immerse a soft wood and hard wood sample in a tub of water at the same time and use a weight for each sample (set of weights) so that they are completely immersed in the water and do not float.
3. Leave the wood samples immersed in water for 20 minutes.
4. After a given time, remove both samples from the water, dry them with a cloth, find the weight of the soft wood and hard wood samples and enter the values in the table.

Complete the collected data in the table.

Sample of wood	Weight of the sample *[g]*		Difference in weights *[g]*
	Beginning of the experiment	End of the experiment	
spruce (soft)			
beech (hard)			
altern. oak (hard)			

Explain in your own words, what caused each sample to change in weight at the end of the experiment compared to the weight at the beginning of the experiment.

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………

………

Explain in your own words, why the weight of the soft wood sample is different compared to the hard wood sample after the experiment.

………

………

Your comments on the experiment (briefly justify the difficulty and clarity of the learning task):

………

………

In each row of the table mark one of the emoticons with an (**x**) based on your understanding of the task and how you liked the experiment.

How did I understand the lesson? How was it to work out the task?	☺ very well	😐 good	☹ I need to improve
1. I know the reason why soft wood is lighter (weights less) than hard wood.	( )	( )	( )
2. I understood that soft wood and hard wood have different water absorption capacity.	( )	( )	( )
3. I can name the property of wood that causes soft or hard wood to gain weight when immersed in water.	( )	( )	( )
4. I understood the task, the experiment was illustrative, and I found it interesting.	( )	( )	( )

3 Research strategy

3.1 Definition of the research problem

In the subject of Technique in lower secondary education, teaching in the cognitive domain with use of the traditional teaching concept continues to prevail. The teacher presents existing knowledge and information to the student, justifies, reasons and emphasises, what is most relevant in the curriculum and tries to use appropriate tools if available.

Students listens and observe the teacher, write down notes from the blackboard and/or the textbook (if available), imitate the teacher and apply the method of observation. Students try to perceive, understand, remember and consolidate the learning content by problem solving. Many teachers focus only on the lower levels of learning, especially memorising of information, when assessing student's performance. There is a predominance of memory learning and mechanical reproduction of mostly retained knowledge, which often leads to a one-sided overloading of students with unreasonable demands on memory performance by the teacher. Students' personality development is suppressed. In general, it can be said that learning is passive and repetitive.

The subject of Technique has a practical focus, where students acquire and develop knowledge, practical skills, and habits in various areas of technique. The curriculum content enables students to tackle different problem-solving, technically oriented tasks, in which they apply knowledge gained from other subjects, particularly natural sciences. The content of the curriculum allows teachers, if the teaching process is properly organised, to implement a research-oriented way of learning and to develop students' technical creativity and critical thinking.

In specialized articles, research-oriented learning is defined as a fundamental teaching activity that enables learning about the world. The aim of research-oriented education is to make the content of the curriculum more attractive and to activate students in the acquiring of knowledge and skills. Research-based learning appears to be an effective approach to learning (Misbah, M., Hamidah, I., Sriyati, S., & Samsudin, A., 2024; Kireš M. et al., 2016).

The introduction of innovative activating methods in the teaching of students should also be reflected in the way students are assessed during lessons. Traditional assessment, which favours summative assessment, results in distancing the knowledge needed for real life from school knowledge, as students do not apply it in real situations. Knowledge serves only to get a grade for students (Semb, G. B., & Ellis, J. A.,1994).

On the contrary, formative assessment and self-assessment of students' performance in the cognitive domain should be at the forefront. Students should be systematically guided to evaluate their own performance in order to receive immediate feedback on the learning process already during the lesson. This leads to students' understanding of where they are still deficient and in which area they need to improve.

This highlights a learning approach that is primarily based on a thoughtful, systematic, and creative method by the teacher, who is able to fully implement the research-oriented model of education. The teacher should be able to design experimental learning tasks that are problem-based and actively involve the students and their classmates in the process of performance assessment. Thus, the teacher also assesses the students' learning process in the context of the development of their personality and key competences.

The above approach of the teacher is not common in today's primary school, rather it is a rare phenomenon. It is our endeavour to try to propose such a research-oriented model of education, which will include the application of formative assessment of student performance through a self-assessment record sheet.

In context of the problem, we will look for answers to the questions:

1. Are the proposed experiments suitable for supporting the research-oriented model of learning in the selected content of the curriculum in teaching the subject of Technique with the application of formative assessment of students?
2. Is a self-assessment record sheet suitably designed in order for students to be able to express their views through self-assessment of acquired knowledge and understanding of the learning content?

3.2 Objectives, tasks and hypotheses of the research

The main objectives of the research include:

a) to find out the viewpoints of qualified teachers teaching the subject of Technique in primary schools on a designed workbook, in which worksheets with experiments on the properties of technical materials are proposed,
b) solution of selected worksheets (implementation of experiments) by teachers in the teaching process in the subject of Technique in the 6th grade of primary school,
c) to find out, based on the completed self-assessment record sheets, the feedback from students to what extent they understood and mastered the learning content in cognitive domain by means of the implemented experiments.

The main objectives of the research resulted in the following tasks:

1. Study and analysis of domestic and foreign literature focused on the issue of knowledge testing and assessment of students (summative and formative assessment).
2. Study and analysis of domestic and foreign literature with a focus on research-oriented teaching in primary school and implementation of experiments in school practice.
3. Analysis of the Educational Standard of the subject of Technique and selected content of the curriculum of the thematic unit Technical materials and working procedures of their processing included in the 6th grade of primary school, with a main focus on the performance standard.
4. To design and produce a set of worksheets with experiments as a tool for formative assessment of students.
5. To design and produce a self-assessment record sheet for the student, in which he/she records opinions and views on the experiment and thus provides feedback to himself/herself and to the teacher on how well he/she has understood and mastered the learning content.
6. To develop methodological tool for teachers.
7. To design a questionnaire for teachers, in order to find out their opinions on the workbook for the subject of Technique with exemplification tasks for students in the 6th year of lower secondary education.

8. Implementation of research in selected fully organised primary schools in selected regions of Slovakia.
9. Evaluation and interpretation of research results based on quantitative and qualitative analysis.

The research objectives and resulting research tasks were decisive in forming the hypotheses of the pedagogical research, which were tested in the implementation of the research. As the project activity focuses on the possibilities of effective application of the research-oriented model of education in the subject of Technique, we set the main hypothesis as follows:
H: Solving the designed experiments in the workbook will statistically significantly support the research-oriented model of education in the subject of Technique.

In order to clearly verify the main hypothesis quantitatively and qualitatively, we have formulated the following working hypotheses:
H1: Solving the designed experiments will statistically significantly affect the level of students' understanding of the curriculum.
H2: Solving the designed experiments will statistically significantly affect the level of students' mastering of the curriculum.

3.3 Methods used in the research

The choice of research methods used during the research was influenced by the main research objective. To test the validity of the main hypothesis *H* and to test the working hypotheses *H1* and *H2*, we chose the following research methodology. The basic method in the preparatory part of the scientific research was the literature method. Its essence was the study of relevant literature, sorting and processing of information.
Another research method was the questionnaire method. We designed a non-standardized questionnaire, which was addressed to teachers of the subject of Technique in lower secondary education. The aim of the questionnaire was to find out opinions of qualified teachers of the subject of Technique on the proposed Workbook with exemplification tasks. The questionnaire with 13 questions includes closed questions, semi-closed questions and open questions, where the respondents formed their answers.
We also used mathematical statistic methods to evaluate the research results. For statistical verification of main hypothesis *H* and working hypotheses *H1* and *H2* we used χ^2- goodness-of-fit test, suitable for statistical detection of significance of differences and testing the hypothesis of dispersion of normal distribution (Markechová, Tirpáková, Stehlíková, 2011).
In χ^2 – goodness-of fit test it is necessary to formulate the null and alternative hypotheses. The null hypothesis (denoted by H_0) is assumption that there is no relationship (association, difference, etc.) between observed phenomena. Alternative hypothesis (denoted by H_A) on the contrary is assumption that there is a relationship between the observed phenomena.
To process the research results, we used the online website of statistical software VassarStats.

3.4 Research sample

The subjects of the research were students of 6th grade of fully organized primary schools. The following representative characteristics were required to include a school in the research:

1. Fully organised state primary school with teaching language Slovak, where the subject of Technique was taught in accordance with the current Educational Standard.
2. The subject of Technique was taught by a qualified teacher (apprenticeship in technical education, basics of technique, or basics of industrial production, extended study of the subject of Technique) with the required teaching experience.
3. The management of the primary school consented to conduct the research at the school.
4. Teachers teaching the subject of Technique conducted the lessons in a specialized technical classroom.
5. The primary school was equipped with one or two specialized technical classrooms for teaching the subject of Technique.

The research involved 18 primary schools from different regions of Slovakia. These were primary schools in the Prešov, Banská Bystrica, Trenčín, Trnava, Nitra and Bratislava regions.
25 teachers (13 women and 12 men) and 573 students of the 6th grade of primary schools took part in the research. The primary school teachers could decide which of the 17 experiments to carry out with their students. The research in primary schools was carried out in March-May 2024 after covering the curriculum in the given thematic unit during the school year 2023/2024. The formative assessment tool for students was self-assessment record sheets, which were included in the worksheets.

4 Analysis and interpretation of research results

4.1 Analysis of selected questionnaire items

The purpose of the proposed questionnaire was to find out the opinions of the respondents on the proposed Workbook with exemplification tasks. Since the scope of this article is limited, attention is paid to the analysis of only selected items from the questionnaire. One of the items was to find out the respondents' opinion on the contribution/non-contribution of the workbook for the support of teaching in the subject of Technique. On the basis of the answers, we note that all 25 respondents (13 women and 12 men) answered unanimously that the presented workbook will support teaching of the subject of Technique and contains a number of compact, research-oriented topics and tasks with direct focus on the curriculum contained in the thematic unit Technical materials and working methods of their processing (6th grade of primary school), which is part of the Educational Standard of the subject of Technique. In the next item, we asked respondents whether the structure of the individual worksheets was suitably designed. The results of the responses are presented in Table nr. 1.

As can be seen in table nr. 1, all respondents answered unanimously that the proposed structure of the individual worksheets for students is suitable.

Among the statements of the respondents, we select the following:

- I appreciate the structure of worksheets - introduction to the problem, the setup, solving procedure - experiment, followed by verification of the solved problem and self-reflection,
- the tasks are clear and understandable, considering the age of students, I like the summary at the beginning of worksheet and the form of feedback after each experiment,
- it makes it easier for the student to learn the terminology and it contributes to a better understanding of the learning content,
- the work procedure is comprehensive, the task is clear, and the student knows what to do.

Response	Sex				Length of teaching experience in years									
	Woman		Man		Up to 5		6-10		11-20		21-30		Over 31	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Suitable	13	52	12	48	3	12	2	8	7	28	4	16	9	36
Unsuitable	-	-	-	-	-	-	-	-	-	-	-	-	-	-
∑	13	52	12	48	3	12	2	8	7	28	4	16	9	36

Table 1: Suitability of the structure of worksheets.

These justifications also reflect the fact that the workbook has its positives and is becoming a suitable teaching tool in the teaching of the subject of Technique based on the opinions of the respondents, who are qualified teachers of the subject with different teaching experience.

Each worksheet includes a student's self-assessment record sheet, in which he/she records his/her opinions and views on the experiment and thus provides feedback to himself/herself and to the teacher on how well he/she has understood and mastered the learning content. The answers of the respondents to the designed recording sheet are presented in Figure nr. 1.

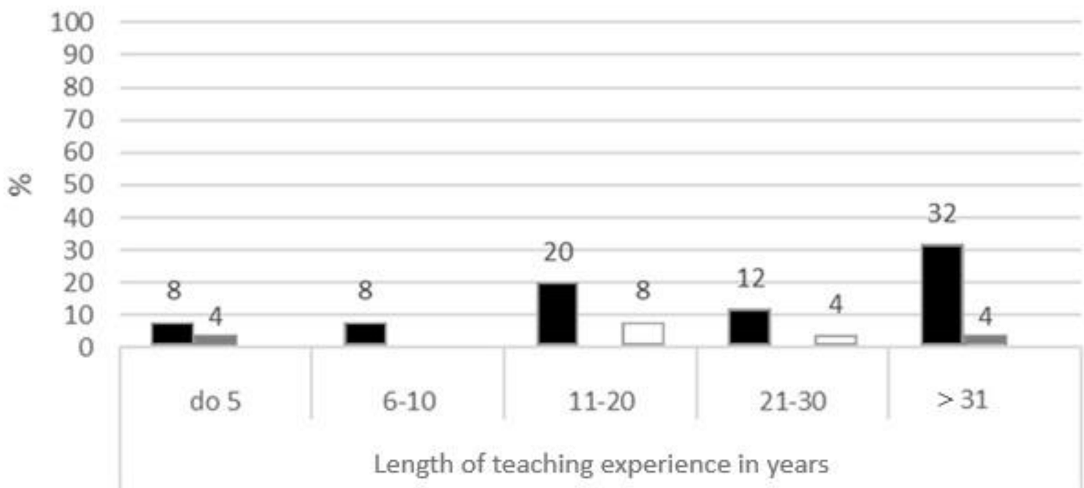

Figure 1: Graphic illustration of the responses.

Explanatory notes*:*

- ■ Self-assessment is important, clear, concise and motivating
- ■ Reformulation of the assessment
- □ Self-assessment may be optimistic and does not reflect reality

We have analysed the answers according to the teaching experience gained. The largest group was made up of men and women respondents in parity, who rated the student self-assessment record sheet very positively. They stated that the self-assessment was important, clear, concise as well as motivating.

The evaluation of the item shows that the design of the student's self-assessment record sheet and its integration in the worksheet is suitable and can be expected to provide an objective and self-critical assessment of the student's performance within the completion of the worksheet, a specific experiment focused on a property of a technical material.

In the next item, we asked for respondents' views on the use of worksheets in the teaching of the subject of Technique. The evaluation of the answers is presented in table nr. 2.

Response	Sex				Length of teaching experience in years									
	Woman		Man		Up to 5		6-10		11-20		21-30		Over 31	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Áno	13	52	12	48	3	12	2	8	7	28	4	16	9	36
Nie	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$\sum$	13	52	12	48	3	12	2	8	7	28	4	16	9	36

Table 2: Use of worksheets in the teaching process.

As can be seen in table nr. 2, all respondents showed interest in the use of worksheets in the subject of Technique and thus we can conclude that the workbook has its place in teaching process and can become an important methodological tool allowing the teacher to work with the students and thus promote the research-oriented model of education. At the same time, the teacher can use the student's self-assessment record sheet and thus apply the student's self-assessment, which develops another competence of the student's personality.

4.2 Verification of working hypotheses

Based on the analysis of the worksheets completed by the students, we interpret the results which are related to the verification of the working hypotheses and the main hypothesis.

Verification of hypothesis *H1* - Solving the designed experiments will statistically significantly affect the level of students' understanding of the curriculum*.*

Hypothesis *H1* was verified by evaluating the students' answers to the following questions in the self-assessment recording sheets included in the worksheet:

- I understood how ....,
- I can name the property ....

We have determined working hypotheses *H1₁* and *H1₂*:

- H1₁ Solving the designed experiments will statistically significantly affect the level of students' understanding of the curriculum.
- H1₂ Solving the designed experiments will statistically significantly affect the ability of students to name the phenomena.

The statistical method of χ^2 - goodness-of-fit test was verified at significance level = 0.05 and for k = 2. We explored if the empirical (observed) frequencies were statistically significantly different from the expected (theoretical) frequencies consistent with hypothesis $H1_1$.

We first verified the level of understanding. We formulated null and alternative statistical hypotheses:

Null hypothesis $H1_{10}$*:* The frequencies of the formative assessment of students in terms of level of understanding are the same.

Alternative hypothesis $H1_{1A}$*:* The frequencies of the formative assessment of students in terms of level of understanding are different.

By entering the values obtained from the evaluation of the self-assessment record sheets into the statistical software, we obtained the values shown in table nr. 3. The statistical software calculated the critical value of the test criterion $\chi^2_{0,05}$ (*2*) = 362.05. In the statistical tables, for a significance level of α = 0.05 and k =2, the critical value is given as 5.991. Since the calculated value of 362.05 > 5.991, we reject the null hypothesis H_0. The software also calculated a numerical *P*-value (P = < .0001), which is used in statistical hypothesis testing. If the statistical package is tested using the null hypothesis H_0 at the significance level α and by using the χ^2 - goodness-of-fit test, if the *P* - value is less than the significance level α, we reject the null hypothesis H_0. In our case, we set the significance level α = 0.05, i.e., we reject the null hypothesis, and it is true that the frequencies of formative assessment of students in terms of level of understanding are different.

Category	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	395	191	0.33333333	+106.81%	+14.76
B	147	191	0.33333333	-23.04%	-3.18
C	31	191	0.33333333	-83.77%	-11.58
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

Reset Calculate

[Note that for df=1, the calculated value of chi-square is corrected for continuity.]	[For df=1, this is the uncorrected value of chi-square.]
chi-square = 362.05	
df = 2	[P is non-directional]
P = <.0001	

Table 3: Calculation of test criterion χ^2 for the level of understanding of the curriculum.

We used the same statistical method to test how students assessed their ability to name the phenomena they explored in individual experiments. To verify this, we formulated the following statistical hypotheses:

Null hypothesis $H1_{20}$: The frequencies of the formative assessment of students' ability to name phenomena are the same.

Alternative hypothesis $H1_{2A}$: The frequencies of the formative assessment of students' ability to name phenomena are different.

By entering the values obtained from the evaluation of the self-assessment record sheets into the statistical software, we obtained the values shown in table nr. 4.

Cate-gory	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	282	191	0.33333333:	+47.64%	+6.58
B	219	191	0.33333333:	+14.66%	+2.03
C	72	191	0.33333333:	-62.3%	-8.61
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

Reset Calculate

[Note that for df=1, the calculated value of chi-square is corrected for continuity.]		[For df=1, this is the uncorrected value of chi-square.]
chi-square =	121.6	
df =	2	[P is non-directional]
P =	<.0001	

Table 4: Calculation of test criterion χ^2 for the ability to name phenomena.

Due to calculated value 121.6 > 5.991, we reject the null hypothesis H_0. Similarly, the null hypothesis H_0 can be rejected because the numerical *P*-value (P = < .0001) is much less than the significance level α = 0.05 set by us. The alternative hypothesis H_{2A} is valid - frequencies of the formative assessment of students' ability to name phenomena are different.

Statistical testing of both working hypotheses $H1_1$ and $H1_2$, used to verify hypothesis H1, demonstrated that we have to reject the null hypotheses for both working hypotheses, i.e., we accept the hypothesis H1, and it is true that solving the designed experiments will statistically significantly affect the level of students' understanding of the curriculum.

Identically, we also verified working hypothesis H2 and came to the result, that we accept hypothesis H2, i.e. solving the designed experiments will statistically significantly affect the level of students' mastering of the curriculum.

Since we have statistically confirmed the working hypothesis H1 and working hypothesis H2, we conclude that the main hypothesis H formulated as follows has also been confirmed:

Solving the designed experiments in the workbook will statistically significantly support the research-oriented model of education in the subject of Technique.

5 Conclusion

The quantitative and qualitative analysis of the individual items of the questionnaire show that we have found the answers to our questions, and we can therefore conclude that:

1. Experiments to support a research-oriented model of learning in selected curriculum of the subject of Technique with the application of formative assessment of students are suitably designed for students in the 6th grade of primary schools.
2. A self-assessment record sheet, in which students can express their opinion in the form of a self-assessment of the acquired knowledge and understanding of the curriculum, is suitably designed for students in the 6th grade of primary schools.

It follows from above that the workbook reflects the content, but especially the performance standard in given thematic unit. It can be viewed as a suitable methodology tool in teaching the subject of Technique, it is expertly designed, well produced and research oriented.

The designed and produced set of worksheets served us as a didactic tool for the application of formative assessment of students in course of the repetition and consolidation of the curriculum. On the basis of the research results, we can conclude that the didactic tool used had a statistically significant impact on the level of students' understanding and mastery of the knowledge from the given topic.

The research-oriented model of learning in the subject of Technique has all the prerequisites to make the learning attractive, motivating and experiential for the students. It includes student activities that make a significant contribution to the fulfilment of the objectives of the subject. By exploring and discovering new facts in the classroom, students learn, among other things, to solve problems and to think creatively and to develop the skills necessary for 21st century - critical thinking, teamwork, personal responsibility, decision-making, the ability to learn, etc.

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Foster young people's creativity and shape their competencies

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Abstract

Creative teachers are essential for fostering pupils' creativity. This paper explores the education of pre-service chemistry teachers, whose training encompasses both professional and pedagogical preparation. As part of their curriculum, they undertake courses such as *Laboratory Exercises in Analytical Chemistry*. Analytical chemistry, a branch of chemistry focused on the identification and quantification of substances, involves chemical analysis and the development of laws, criteria, and methods for determining qualitative and quantitative composition. Conducting laboratory exercises provides an optimal environment for enhancing the creative abilities of both pupils and pre-service teachers. This paper presents proposals, methodologies, and selected laboratory exercises aimed at fostering creativity and developing essential skills among pre-service chemistry teachers.

Keywords: Laboratory Exercise in Analytical Chemistry, Development, Creativity

1 Introduction

Creativity is specifically understood as the ability to think innovatively or to generate new ideas by combining existing elements in novel ways, whether in processes, objects, or knowledge. More recently, however, creativity and its practical implementation have come to be viewed as being in a dialectical relationship (McIntyre, 2011). Creativity (derived from Greek, meaning 'to create' or 'to make') can be characterized from multiple perspectives. From a didactic standpoint, it refers to the development of pupils' creative abilities. Creative teachers play a crucial role in the development of pupils' creativity because they create an environment that encourages open thinking, experimentation and innovation. Teachers' ability to introduce new approaches and stimuli supports pupils in developing knowledge, problem-solving skills, as well as expressive and collaborative abilities. Their creativity is

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reflected in their use of modern methods and technologies, as well as in their capacity to recognize pupils' individual needs and inspire them to explore their potential. Creativity can be trained and taught in a variety of different ways, both through direct, active teaching of creativity concepts and techniques and through more passive and indirect means, such as the development of creativity-supporting contexts (Thornhill-Miller & Dupont, 2016; Hrmo, Miština, Jurinová, Krištofiaková, 2020). In the educational process, creativity represents a complex of special, attitudinal qualities of a pupil, a student, the ability to find new, original solutions, and all internal and external factors that determine the learning process (Turek, 1996).

The education of pre-service chemistry teachers at universities is focused on ensuring high-quality instruction in science disciplines. The goal is not only to equip future teachers with subject-specific knowledge but also to prepare them for practical teaching. This includes developing their ability to engage students, foster interest in science, and promote critical thinking. An essential aspect of their training is the development of pedagogical and didactic skills. These skills play a crucial role in fostering students' effective engagement in laboratory work, promoting active problem-solving in real-world contexts, and encouraging discussions on scientific issues. Developing creativity in students preparing for the teaching profession is crucial for a number of reasons (Scheme 1).

Innovations in teaching

- Creative teachers can use innovative approaches that motivate students and make learning more effective and attractive.

Problem-solving

- The ability to respond flexibly to challenges, solve problems and adapt to different learning situations is essential in teaching.

Preparing for the practice

- Developing creativity in pre-service teachers enhances their ability to prepare students for a dynamic and changing world where critical and creative thinking are increasingly important.

Personal and professional growth

- Creativity is not only a professional tool but also a part of personal development that contributes to teacher motivation and satisfaction.

Scheme 1: Developing the creativity of pre-service chemistry teachers.

Creativity is the prime source of innovation, which in turn is acknowledged as the main driver of growth and wealth creation, as key to improvements in the social field and as an essential tool in addressing global challenges such as climate change, health care and sustainable development. Creativity is a multifaceted phenomenon that can be approached from many different angles (Thornhill-Miller et al., 2023). The point of creativity is for each individual to reach a higher level and also to be active in practical activities such as laboratory exercises. Current trends in education emphasise the promotion of interdisciplinary connections and the importance of understanding chemistry in the context of society, the environment and technology. Pre-service teachers need to be able to relate theory to practice, incorporate modern digital tools and respond to the diversity of learners in their classrooms. Quality education for pre-service teachers thus contributes to shaping a generation that will be better prepared to face global challenges.

The main aim of this paper is to analyse and present the educational process of pre-service chemistry teachers, focusing on the development of their creative abilities in the *Laboratory Exercise in Analytical Chemistry* course. This analysis includes identifying key elements that foster creativity, evaluating the effectiveness of educational strategies, and providing recommendations to enhance the creative potential of pre-service teachers.

1.1 Analytical chemistry and its role in chemical education

Analytical chemistry is the branch of chemistry concerned with the identification and determination of substances (chemical analysis), the search for and formulation of laws, criteria and methods enabling the determination of their qualitative and quantitative composition (Záruba, 2016). Analytical chemistry uses knowledge from other branches of chemistry, other natural science disciplines (biology, physics), and selected engineering disciplines to develop effective chemical analysis procedures.

Analytical methods and their instruction can serve both as a means and an object of teaching (e.g., studying the properties of substances and chemical reactions). Teaching analytical chemistry fosters students' creativity, enhances their problem-solving abilities in areas such as ecology, encourages the development of new approaches to problem-solving, and provides a broader perspective on chemistry and its connections with other disciplines.

For both theoretical and practical teaching, it is necessary for every teacher to take an interest in developing the creativity of their pupils, both in the form of the teaching aids used and the experiments conducted. Analytical chemistry, which is divided into qualitative and quantitative branches, offers the necessary foundation for both knowledge acquisition and the development of creativity of pre-service teachers and pupils. This approach emphasises the need for the purposeful and systematic development of creativity in the preparation of pre-service teachers, and chemistry education offers an ideal environment for fostering these skills through experimentation, analysis and synthesis of knowledge.

According to Lubart et al. (2013), based on multivariate models of creative potential), there are cognitive factors (e.g., divergent thinking, mental flexibility, convergent thinking, associative thinking, selective combination), conative factors (openness, tolerance of ambiguity, intuitive thinking, risk taking, motivation to create), and environmental factors that all support creativity.

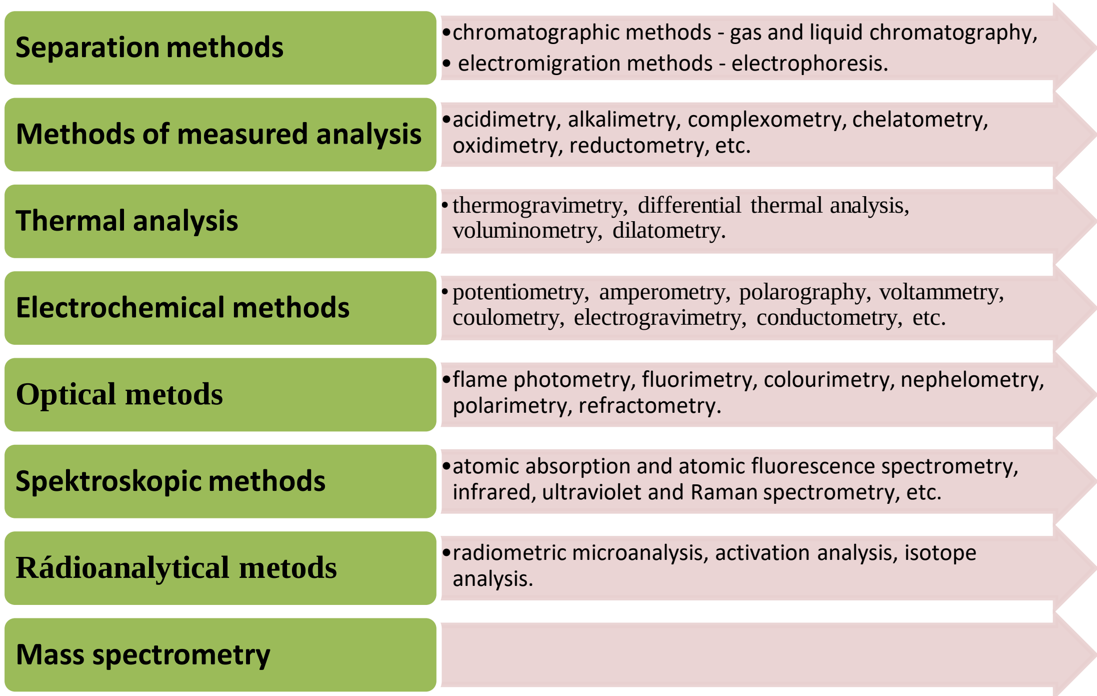
Given the multi-dimensionality of the notion of creativity, the environment can positively influence and help develop creative capacities (Thornhill-Miller et al., 2023). Learning strategies can enhance students' critical and creative thinking skills in the acquisition of scientific knowledge (Zulyusri et al., 2023).

The theoretical foundations supporting creative and laboratory-based learning in future teachers are based on a number of pedagogical, psychological and didactical approaches. They are intended to emphasise the active participation of student-pre-service teachers in the learning process, experimentation and the development of higher cognitive skills. There are many theoretical backgrounds that support creative learning and learning based on laboratory work, all of which are applicable in laboratory work, such as constructivist theories of learning (Piaget, Vygotsky), Bloom's taxonomy of learning objectives, experiential learning theory (Kolb), heuristic learning, theories of creativity, situated learning, experiential learning theory, etc. The combination of the above theories promotes the acquisition of knowledge in pre-service teachers and the development of skills and attitudes necessary for their creative and effective teaching practice.

1.2 Laboratory Exercises in Analytical Chemistry in the preparation of pre-service chemistry teachers

The importance of laboratory exercises in chemistry for pre-service teachers is based on the development of professional and practical competencies. Pre-service teachers acquire the content knowledge, and the practical skills needed to convey it. They prepare for active teaching. Laboratory tasks and creative approaches prepare them to conduct lessons that will impact on pupils' active participation and knowledge development. Recent work conducted by the OECD exemplifies efforts aimed to foster creativity (and critical thinking) by focusing simultaneously on curriculum, educational activities, and teacher support and development at the primary, secondary, and higher education levels (Vincent-Lancrin et al., 2019; Saroyan, 2022).

Current analytical chemistry uses a variety of methods (Scheme 2) (Skong et al., 2021; Záruba, 2016).



Scheme 2: Analytical chemistry methods.

Classical methods of qualitative inorganic analysis are based on the chemical reaction of the sample being analysed with a suitable reagent, which may be manifested by a change in colour, the formation or dissolution of a precipitate, the evolution of a gas, etc. (Čakrt et al., 1989). The longest-used methods of quantitative analysis are volumetric analysis (titration) and weighing analysis (gravimetry), which have been, and in many cases still are, the main working methods (Prudešová et al., 2016).

2 Methodology

The Laboratory Exercise in Analytical Chemistry (LACH) provides future graduates with new knowledge and practical skills, emphasising laboratory work in the chemical disciplines. The exercise is divided into two semesters and two parts Bachelor studies. Its division into qualitative analytical chemistry (LACH1), dealing with the determination of the type and number of constituents of the sample analysed (analytical proof) and quantitative (LACH2), which determines the amount and relative abundance of each constituent (analytical determination), provides all the prerequisites for the knowledge as well as the development of the creativity of the student-pre-service teachers (Table 1).

Laboratory Exercise in Analytical Chemistry 1 (LACH1)	*Laboratory Exercise in Analytical Chemistry 2 (LACH2)*
-Occupational health and safety in the chemical laboratory.	-Occupational health and safety,

- Separation of cations into classes by successive reactions with group test tubes. - -Separation and proof of cations of class I – a group of insoluble chlorides. - Separation and proof of cations of class II - a group of insoluble sulphates. - Separation and proof of cations subject to hydrolysis. - Separation of iron subgroup cations. - Separation of copper subgroup cations. - Separation of cations: Li^+, Na^+, K^+, NH_4^+, Mg^{2+}. -Proof of anions I. - II. - Final analysis of the unknown sample.	- Weighing in analytical chemistry. Weighing analysis. - Determination of the chemical composition of the sample. - Neutralisation titrations - acidimetry, alkalimetry. - Determination of BOD and COD of wastewater. - Oxidation-reduction titrations. - Analysis of unknown sample. - Precipitation titrations. -Argentometry, drinking water analysis, and determination of chlorides in the unknown water sample. - Complexometric titrations I. – II.

Table 1: Course information sheet Laboratory Exercise in Analytical Chemistry 1-2.

A key role of the above LACH 1-2 disciplines is the professional competencies of future chemistry teachers. Their acquisition will enable them to focus on developing critical thinking and creativity as well as pupils' independence within the educational process. This is one of the ways to activate their future learners, ultimately leading them to develop creativity and analytical-critical thinking and to acquire practical skills. One of the outcomes will then be the development of autonomy and self-assessment skills in pupils. These aspects are essential for preparing students – pre-service teachers for the challenges of the current working environment.

The aim of laboratory exercises in teacher training is that the student:
- apply the acquired knowledge and skills to experimental activities,
- to carry out proof reactions of cations and anions,
- know the principle of weighing analysis and evaluating its result,
- be familiar with the different types of volumetric analysis,
- perform titrations with the required precision and evaluate the result,
- use the acquired qualitative and quantitative analysis knowledge to determine an unknown sample.

The selected laboratory exercise in analytical chemistry oriented to the determination of chlorides is an example that can be included in several didactic concepts within problem-based learning and practical teaching. This type of exercise involves scientific investigation, analytical thinking and active student involvement. Its main orientation fits into the category of Problem-Based Learning (PBL). The PBL model is based on scientific inquiry and encourages students to solve a practical problem, collect data, analyse it, and draw conclusions. Laboratory work is an application of PBL and develops technical knowledge, critical thinking, and scientific work skills. By modelling innovative methods, pre-service teachers learn modern teaching methods that they can transfer to their practice and thus develop professional knowledge, a creative approach, and pedagogical skills.

3 Example of problem-based learning in a laboratory exercise

Problem-based learning is characterised by learning that involves problem-solving and creative thinking. It is a process that is based on the acquisition of knowledge and also on the acquisition of skills with work in the laboratory. An example of problem-based learning in the Laboratory Exercise in Analytical Chemistry is an integration of qualitative and quantitative analytical chemistry.

3.1 Argentometry: an example of a laboratory activity meant to foster creativity, critical thinking, and skill development

A laboratory exercise in analytical chemistry oriented towards argentometry allows students to deepen their expertise in volumetric analysis. The practical skills that students acquire—proper handling of chemicals, precision in performing experiments, and interpretation of results—are a creative approach to learning and problem-solving. Argentometry-oriented laboratory exercises include problems that stimulate creativity, design of experiments, analysis of real samples, and solving non-standard chemistry problems related to practice. This oriented approach teaches students to find solutions and apply knowledge in the context of environmental or everyday problems. Traditional educational approaches cannot meet the educational needs of our emergent societies if they do not teach, promote, and assess in line with the new learner characteristics and contexts of the 21st century (Sahin, 2009).

Educational objective:
-development of independent and creative thinking,
-education for the protection and creation of the environment,
-the importance of water and water resources for life,
-importance of drinking water, protection of the purity of drinking water sources,
-development of intellectual and manual skills (chemical calculations, preparation of solutions, working with pipettes and burettes, weighing),
- volumetric analysis and its principles,
-the importance of chloride determination in practice.

Basic knowledge and skills: chemical concepts: mass concentration, molar mass, measured solution, volume, precipitate, solubility product; *chemical properties of* AgCl, AgBr, etc.; *skills acquired:* pipetting, preparation of solutions (measured, standard).
Form of instruction: laboratory exercise
Experimental task: Chloride content: evaluation of water's hygienic safety and health.

3.1.1 Determination of chloride, according to Mohr

Principle:
Precipitation reactions that proceed rapidly and quantitatively enough are used for volumetric determinations or titrations (Čakrt et al., 1989). The precipitation method used is the volumetric argentometry method. Argentometry is based on the formation of sparingly water-soluble silver salts of halides (Cl^-, Br^-, I^-) and pseudohalides (CN^-, SCN^-) (Purdešová et al., 2016). The volumetric solutions used are 0.01 - 0.1 M solutions of $AgNO_3$ for direct titrations and 0.1 M KSCN or NH_4SCN for back titrations and for the determination of Ag+. NaCl or KCl are used to standardise the $AgNO_3$ stock solution. The end of titration is indicated by methods such as Mohr's, Fajans', and Volhard's (Purdešová et al., 2016).

Chemicals: 0,1M $AgNO_3$, 0,1M NaCl, indicator K_2CrO_4 (w=5%), chloride samples.

Materials: volumetric flask, holder, beaker, titration flask, stand, pipette, burette.

Procedure:
•Prepare a 0.1M standard solution by weighing the required amount of NaCl.
•Prepare a 0,1M volumetric solution of $AgNO_3$ by weighing the required amount of nitrate.
•For standardisation, pipette 25 cm^3 of standard NaCl solution into a titration flask, add 1 ml of the indicator (K_2CrO_4), adjust the volume to about 50 cm^3 with distilled water and titrate with a measured solution of $AgNO_3$ to a permanent reddish-brown colour.
•Repeat the titration 3-times and calculate the concentration of the measuring solution in $mol.dm^{-3}$ from the average consumption.
•Make up the unknown solution in the volumetric flask to 100 cm^3. Pipette 25 cm^3 into the titration flask and add 1 cm^3 of indicator (K_2CrO_4).
•Titrate the solution with standard $AgNO_3$ solution. When a slight brown colour (turbidity) appears, read off the volume on the scale.
•Repeat the titration 3 -times.
•Calculate the chloride content of the water sample from the average volume value.

Reactions:

$$NaCl + AgNO_3 \rightleftharpoons AgCl\downarrow + NaNO_3$$

$$Ag^+ + Cl^- \longrightarrow AgCl$$

Calculation:

$$c(Cl^-)=\frac{V_{pr}\,.\,c_{AgNO3}\,.\,35{,}45}{V_{\,vzorky}}\ [g.dm^{-3}]=\frac{3{,}14\,.0{,}05.35{,}45}{100}\ =\ 55{,}65\ [g.dm^{-3}]$$

where
V (aver.) = average AgNO3 consumption in cm3
c(AgNO3) = concentration of AgNO3 (0.05 mol.dm-3)
V(sample) = volume of water sample in cm3
35.45 = molar mass of chloride M(Cl)

3.2 Problem-based learning procedure during the laboratory exercise

A problematic situation (Scheme 3) in the above laboratory exercise can be created by formulating a relationship for calculating the chloride concentration in a sample:

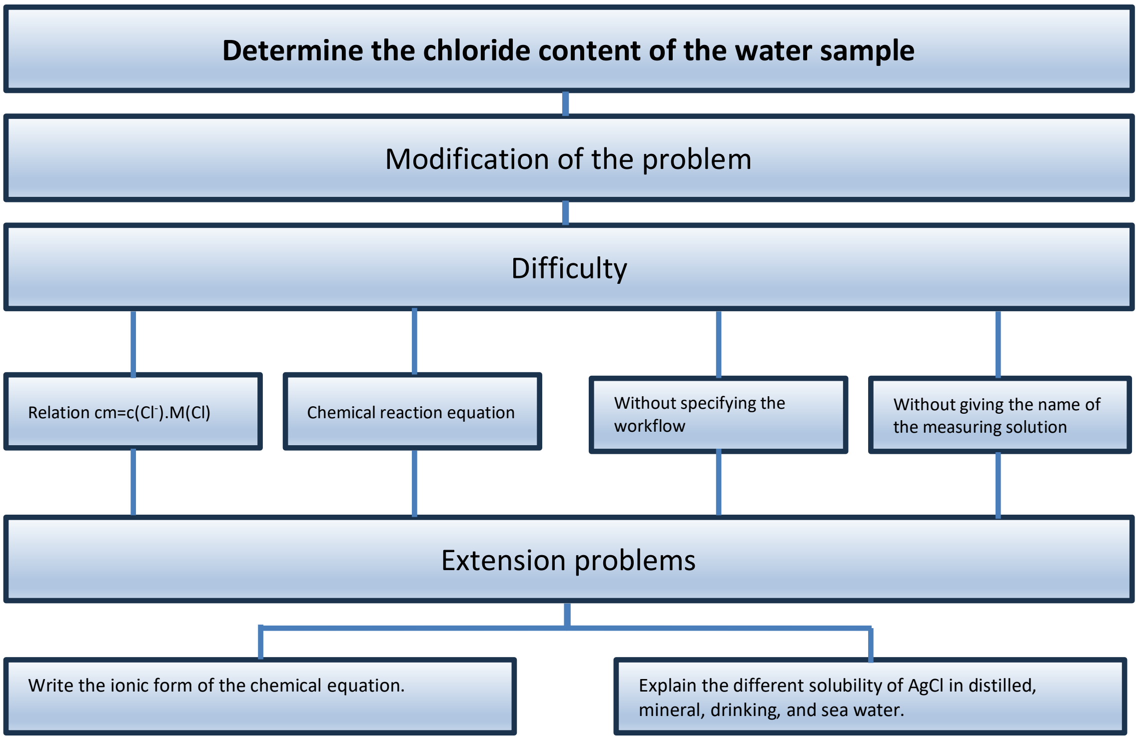
$$c_m = c(Cl^-) \times M(Cl)$$

where
c_m = mass concentration of chloride ($mg.dm^{-3}$) in the water sample
$c(Cl^-)$ = mass (mole) concentration of chloride ($mmol.dm^{-3}$) in the sample
M(Cl) = molar (mole) mass of chloride ($g.mol^{-1}$) =35,453 $g.mol^{-1}$

The substance concentration is calculated from the consumption of a measured solution of AgNO3.

$$c(Cl^-) = \frac{V_{s\,.}\ c(AgNO3)}{V_{sample}} \times 10^3$$

where
$c(Cl^-)$ = the concentration of chloride in the sample ($mmol.dm^{-3)}$
V_s = consumption of $AgNO_3$ measuring solution during sample titration (cm^3)
V_{sample} = the original sample volume (cm^3) during titration
$c(AgNO_3)$ = the concentration of the measuring solution $AgNO_3$ ($mol.dm^{-3}$)



Scheme 3: Experimental task.

The values of chloride concentration obtained by titration are compared with the valid Slovak technical norm (STN 75 7221, STN 75 7111) to determine the health safety of the analysed water sample with regard to chloride content. The problem modification (Scheme 3) can be supplemented with data such as the photosensitivity of the precipitate formed to light, which may lead to erroneous data and increase the demand for titration accuracy.
According to STN 75 7221 (1998) and STN 75 7111 (1999), which regulate groundwater and surface quality requirements, chloride (Cl^-) content is assessed as an important indicator of water quality. Chloride content limits may vary according to the intended use of the water (Table 2).

Drinking water	The maximum permissible chloride concentration is 100-250 mg/l (according to other standards such as EN ISO 10523 and EN 12519). The value depends on sensory characteristics (taste, odour) and health limits.
Surface water	For water quality categorisation according to STN: Class I (high quality): < 50 mg/l Class II (good quality): 50-100 mg/l Class III (acceptable quality): 100-250 mg/l Higher chloride values are typical for waters affected by anthropogenic activities, e.g., industrial discharges or the use of spreading salts.

Table 2: Surface and groundwater quality – chloride content (STN 75 7221, STN 75 7111).

4 Conclusions

The purpose of the laboratory exercises is to identify potential solutions and actions that contribute to the development of skills, critical thinking and creativity among students – pre-service teachers. The objective is to foster not only professional knowledge but also creative approaches and pedagogical skills, ultimately enhancing the quality and effectiveness of education. This objective extends to the *Laboratory Exercise in Analytical Chemistry* course, where a systematic and purposeful focus on the educational functions within the learning process is emphasized. Laboratory exercises play a crucial role in preparing pre-service chemistry teachers, as they deepen professional knowledge in analytical chemistry while providing practical experience for effective teaching. Through these exercises, students develop pedagogical skills, gain experience in presenting results, explaining chemical concepts, and preparing practical activities that are suitable for classroom instruction.

The course shapes pre-service teachers, equipping them with the ability to teach analytical chemistry theoretically and inspire pupils to develop a greater interest in chemistry through engaging and interactive laboratory activities. The problem-based learning approach discussed here serves as an example of how the skills acquired can be translated into innovative teaching methods.

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R&E SOURCE

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To the Roots: Engineering Pedagogy

Modern Teaching Methods for Economics Subjects

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Abstract

The article examines modern methods of teaching economics subjects through the use of information and communication technology (ICT), highlighting both the advantages and disadvantages compared to conventional forms of education. The primary objective is to provide a comprehensive evaluation of the practical applicability and extent of modern, active teaching methods in economics education. From one perspective, these methods facilitate the rationalization of the teacher's workload, reduce repetitive tasks, and enhance pupil engagement and participation. On the other hand, the reception of these methods by pupils remains a key consideration. The advantages of ICT include flexibility and convenience, as well as the opportunity for pupils to learn either in school or in the comfort of their homes. The article further describes modern, active teaching methods in detail, including procedures and examples of their application in the educational process at management-focused secondary vocational schools.

Keywords: Information Technology, Communication Technology, Interaction, Survey

1 Introduction

In the introductory section, it is essential to consider the current aspects of teaching processes, specifically comparing conventional and innovative, modern approaches to education. In recent years, teaching has received significant attention from society, with critical opinions often outweighing praise for how education is conducted in schools. In reality, both teaching practices and their outcomes remain inadequate. The prevailing opinions on

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education are those that argue there is insufficient innovation and modernization in the teaching process. However, the authors of this paper do not align with these views. Instead, they support the perspective that more innovation is needed in schools.
In seeking the causes, it is crucial to address the following questions: How should the teaching process be conducted? What should its goals be? What should it focus on?
These questions can be answered through three different approaches, based on the opinions held:
1. The first approach emphasizes the development of students from within, rather than under external pressure. Their needs should be addressed, and they should not be compelled to adopt adult-like roles. Their spontaneity should be nurtured, and they should not be forced to engage in activities dictated by rigid methodologies. Instead of solely focusing on the prescribed curriculum, emphasis should be placed on developing their personal experiences. Discipline should be maintained through engaging activities, rather than through coercion.

2. In the second approach, pupils' individual personalities should be explored and recognised, with their active engagement encouraged through an understanding of their interests. Teaching should capture the pupils' attention, and the classroom should be structured in such a way that pupils perceive it as their community. Pupils' creativity should be fostered, and their unique personal traits should be respected.

3. The third approach should focus on connecting the school with real-life experiences, fostering the active development of pupils' knowledge through their personal experiences, activities, and even their mistakes. The teaching process should support the growth of creativity, critical thinking, and other social skills. The curriculum should consist of meaningful content, supported by effective methods, forms, and resources, as well as a positive school atmosphere. Customised approaches should be central, tailored to the pupils' individual potential and educational needs.

Professional literature offers a wide range of perspectives on conventional teaching. It is an approach where the teacher is more active than the pupils, with pupils primarily listening as the teacher explains the material and following the teacher's instructions. Despite the growing recognition among teachers of the need to adopt alternative approaches, many still struggle to move away from traditional teaching methods and make the teaching process more effective.
Terms such as innovative approaches, innovative teaching, and innovative pedagogy have yet to be clearly defined. Innovative approaches highlight the need for transformation within the education system, with 'innovation' serving as an umbrella term for various changes in education. The key question, therefore, is: "What constitutes modern, innovative education?"
Modern education puts pupils in the centre of attention. It means that pupils' personalities should be considered valuable as they do not exist in a vacuum, but in a space from which

they acquire their knowledge, which affects their emotions, and in which pupils exist as naturally active individuals. The educational process provides them with an opportunity of personal fulfilment and use of their potential – the reality of respect and development of 'sui generis'. Very important is also collaboration among pupils, practically manifested in various forms, in particular collective cooperation, for example when solving projects.

To be innovative and active means to be always ready to engage in something new, try what has not yet been established, examine new methods, work with new technologies, ICT, etc. Innovations are not intended for teachers only, but also for pupils. Pupils should be allowed to express their ideas and actively communicate with their teachers and classmates. They also should be allowed to transpose the reality of this world into the curriculum.

The recent pandemic has brought a transition from the in-class form of study to the remote form, including the use of online teaching; this gave rise to multiple new stimuli that contribute to the development of digital literacy not only of teachers, but also students. However, online teaching has certain negative consequences, mainly in the social and interpersonal fields. The purpose of using ICT (Information and Communication Technology) in remote education is to give all pupils a chance to learn how to use ICT to support their own learning, even though the pandemic is probably over. Pupils can only be able to use ICT in the learning process if the suitable ICT is available to them when they need it, while the ICT must correspond to the purpose of satisfying their individual educational needs. The ICT that is appropriate for that purpose includes not only the technologies available to pupils, it also covers the ICT support they receive when using the ICT, while such support should meet their individual needs to the maximum possible extent.

All pupils, including those who are disabled or have special educational needs, need support from their teachers and other experts in order to achieve progress from the obsolete methods of work with ICT and become self-confident users of ICT to support their own learning. In order to achieve that, pupils must gradually develop they ICT skills.

2 Material and Methods

It is essential that teachers apply structured procedures of assessing the ICT-related needs in order to identify the practical needs of their individual pupils related to concrete ICT tools. That will enable pupils to learn how to assess and manage their own approaches to ICT and their preferences as to assistive technologies. ICT may only serve as an efficient tool for individualised learning if teachers clearly understand the ICT potential in terms supporting the 'learning to learn' strategies (meta learning) and active approach to education (pages 22–24 of 'ICT in Inclusive Education' – a European Agency for Special Needs and Inclusive Education document).

In this regard, it is necessary to focus on a particular teaching process and apply modern teaching methods. In this article, modern techniques of teaching economics subjects are discussed with the aim of formulating concrete proposals how to increase the efficiency and innovate the process of teaching Economics in the School of Business study branch, based on a questionnaire survey.

3 Information and communication technology in practice (a case study)

The evaluation of answers to the questions contained in the questionnaire is presented in tables below. For the sake of clarity, two tables were compiled – for Year 1 and for Year 2. Genders were categorised as female (F) and male (M). The tables are presented in a comprehensible form of a coordinate system, while the individual questions are assigned values indicating the number of answers chosen from the available options.

Answer		3	4	5	6	7	8	9	10	12	13	14	16
Yes	F	6	8	4	7	3	0	6	6	7	9	2	4
	M	1	3	1	3	0	1	4	2	3	7	0	0
Mostly yes	F	1	2	1	3	1	1	3	2	2	1	4	0
	M	2	3	0	2	1	0	0	2	3	1	2	1
No	F	2	1	2	0	4	8	0	0	0	0	4	3
	M	0	0	2	0	2	4	0	1	1	0	4	1
Mostly no	F	3	0	2	0	1	2	1	0	0	0	1	1
	M	2	1	3	1	1	2	1	0	1	0	1	4
I do not know	F	1	2	4	3	4	2	3	5	4	3	2	5
	M	3	1	2	2	4	1	3	3	0	0	1	2

Table 1: Questionnaire survey – results of Year 1, 21 students.

Answer		3	4	5	6	7	8	9	10	12	13	14	16
Yes	F	4	2	2	2	6	0	4	7	9	11	2	6
	M	3	0	2	4	2	2	4	1	6	7	0	3
Mostly yes	F	4	3	5	2	2	2	1	0	5	2	2	4
	M	2	3	0	2	0	2	0	2	2	3	0	3
No	F	1	0	2	2	2	6	2	3	0	0	5	2
	M	0	2	2	0	1	0	1	2	1	0	5	0
Mostly no	F	1	6	0	2	4	2	2	0	0	1	2	0
	M	1	2	0	0	6	2	0	1	0	0	2	2
I do not know	F	4	3	5	6	0	4	5	4	0	0	3	2
	M	4	3	6	4	1	4	5	4	1	0	3	2

Table 2: Questionnaire survey – results of Year 2, 24 students.

Based on the answers provided to the individual questions, the following conclusions were made:

Questions 1 and 2: about age and gender.

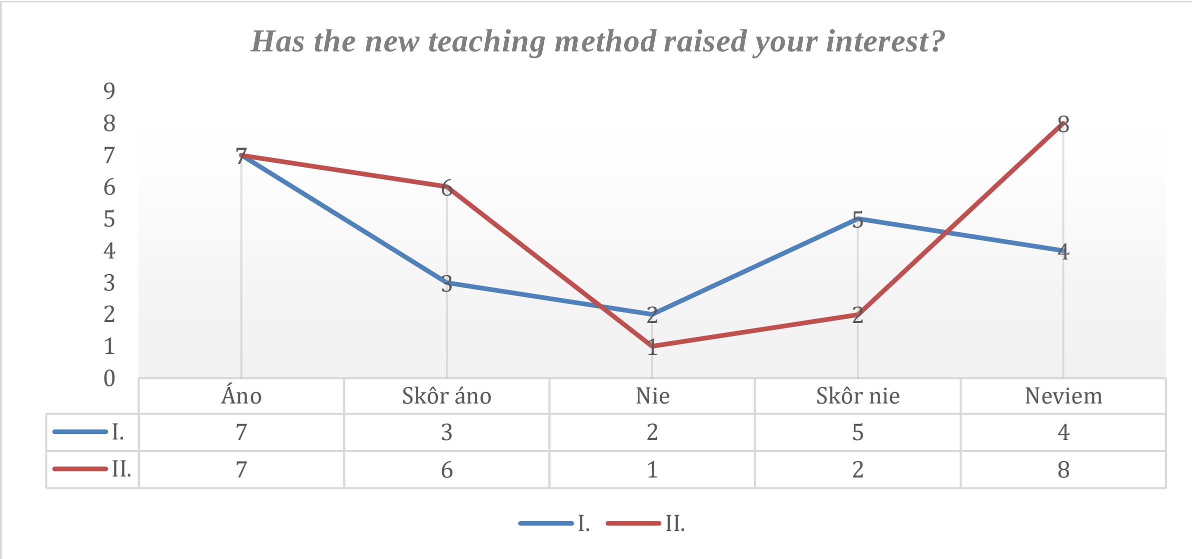
The initial questions related to the gender and the year of study at the school attended by the respondents. There were 45 respondents – 27 girls and 18 boys; the survey group therefore consisted of 60% of girls and 40% of boys. In Year 1, there were 21 respondents – 13 girls and 8 boys, while the remaining 24 respondents were students of Year 2, in particular 14 girls and 10 boys.

Question 3: Has the new teaching method raised your interest?

Year	Gender	Yes	Mostly yes	No	Mostly no	I do not know	TOTAL
I.	F	6	1	2	3	1	**13**
	M	1	2	0	2	3	**8**
	TOTAL	**7**	**3**	**2**	**5**	**4**	**21**
II.	F	4	4	1	1	4	**14**
	M	3	2	0	1	4	**10**
	TOTAL	**7**	**6**	**1**	**2**	**8**	**24**
TOTAL	**%**	**31.11%**	**20.00%**	**6.67%**	**15.56%**	**26.67%**	**100.00%**

Table 3: Interest in the newly introduced method.

Pupils expressed their interest in that form of education. The results of the answers provided are shown in the table below, showing that 31.11% of pupils answered 'Yes' and 20% answered 'Mostly yes', while a total of 51.11% of pupils showed their positive attitude towards the introduction of the new teaching method. Negative answers 'No' or 'Mostly no' were provided by 22.23% of respondents, while 26.67% of pupils were not able to provide their opinion.
The graph below provides a more concise representation of the results; it shows the answers provided, while Year 1 results are in blue and Year 2 results are in red.



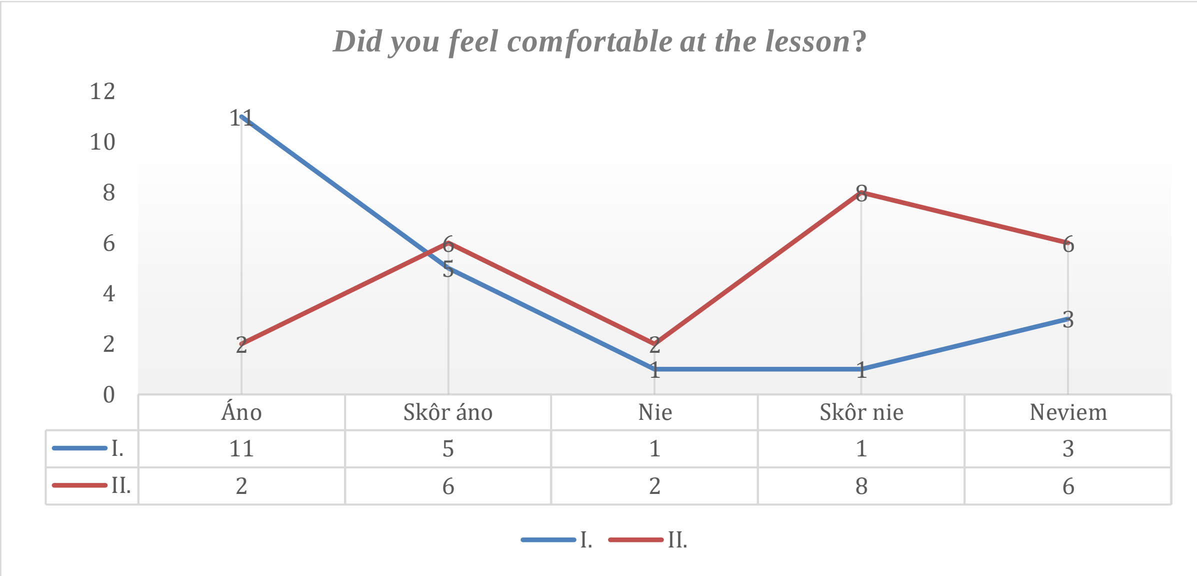
Graph 1: Results of the newly introduced method.

Question 4: Did you feel comfortable at the lesson?

Year	Gender	Yes	Mostly yes	No	Mostly no	I do not know	TOTAL
I.	F	8	2	1	0	2	13
	M	3	3	0	1	1	8
	TOTAL	11	5	1	1	3	21
II.	F	2	3	0	6	3	14
	M	0	3	2	2	3	10
	TOTAL	2	6	2	8	6	24
TOTAL	%	28.89%	24.44%	6.67%	20.00%	20.00%	100.00%

Table 4: Feeling of being comfortable at the lesson.

Pupils from both years provided positive responses, with 53.33% selecting 'Yes' or 'Mostly yes.' In contrast, 6.67% chose 'No' or 'Mostly no,' while 40% selected 'I do not know' of the total number of participants.



Graph 2: Feeling of being comfortable.

Question 5: Was your activity higher than with the previous style of teaching?

Year	Gender	Yes	Mostly yes	No	Mostly no	I do not know	TOTAL
I.	F	4	1	2	2	4	**13**
	M	1	0	2	3	2	**8**
	TOTAL	**5**	**1**	**4**	**5**	**6**	**21**
II.	F	2	5	2	0	5	**14**
	M	2	0	2	0	6	**10**
	TOTAL	**4**	**5**	**4**	**0**	**11**	**24**
TOTAL	**%**	**20.00%**	**13.33%**	**17.78%**	**11.11%**	**37.78%**	**100.00%**

Table 5: Higher activity at the lesson.

The results of the assessment of pupils' activities at the lesson that was taught while applying the new form of teaching, as observed in the questionnaire, were as follows. Answers 'Yes' and 'Mostly yes' were chosen by 33.33% of pupils, i.e. one third of the total number of participants. Options 'No' and 'Mostly no' were selected by 28.89%. Answer 'I do not know' was provided by as much as 37.77% of pupils. The figures above indicate that the answers and perceptions of the pupils were varied, while the highest proportion of them could not decide and eventually answered 'I do not know'.
The questionnaire contained 15 questions and answers provided by pupils; however, only some of them were selected due to a wide scope of the survey.

Evaluation:

In the late 20th century, information and communication technology (ICT) has brought an unbelievable progress in the teaching process; in particular, new technical possibilities and user options were launched for the purpose of sharing information and communication, overcoming the time barrier and spatial limitations. The current 21st century is therefore rightly referred to as the century of information technologies, and our society as the global information society.

New trends require that people are prepared for living in the new millennium – for the active and creative use of novel ICT aimed at increasing the quality of life of individuals, as well as prosperity of the entire society. The information society is associated with an increased availability of occupations that are based on providing services and information, and with the development of knowledge as the source of wealth and power. Economic growth and competitiveness of a country depends on the level of education of its inhabitants. It is therefore necessary to put education in the centre of attention – not only education of children and young people, but also the lifelong learning.

3.1 About the history of information and communication technology

ICT has been developing since the invention of a telephone by Alexander Graham Bell in 1875, which began the creation of a cable-based communication network. At the beginning, the network covered the American Region only, but it gradually extended into the Transatlantic Region, and eventually became a global communication means, covering almost the entire world.

In years 1910–1920, technologies based on a wireless communication network started to appear, manifested in the first AM radio broadcasting. This wireless voice communication further developed into the audiovisual communication – the television broadcasting, introduced in 1940. In 1943, the first electronic computer was invented, and since then increasingly used as an essential tool in the application of ICT all over the world.

The ICT abbreviation has become part of our everyday language. Not long ago, the IT (Information Technology) abbreviation was typically used, as stated in a paper by A. Halašková (2004, p. 128–129). However, with the launch of the latest communication technologies, such as the internet, mobile phones, communication satellites, the IT abbreviation was supplemented with letter C. ICT is an umbrella term for computational and communication tools, which are used to support, in multiple ways, studying and other educational activities, as well as information processing and sharing.

Fig. 1: Development of information and communication technology.

As also stated by A. Halašková, ICT includes:

- Traditional media, e.g. television, video projectors and radio
- Personal computers with the multimedia support
- Input and output equipment, tools for digitalisation, recording, control and measurement
- Internet and related services
- Integrated educational programmes (complex computer environments for learning)
- Technical tools for video conferences
- E-mail
- Electronic and programmable toys
- Automatic scanners, recorders, and devices for automatic data evaluation.

According to J. Kolejnička (1997, p. 21), ICT is a system of methods, programmes, procedures and activities aimed at the maximum potential utilisation of near and remote sources of information, kept on a wide range of information media, or the creation of such sources, through communication in computer networks, with a goal to find optimal solutions to the existing problems and determined tasks, or achieve one's intentions, or satisfy one's needs. Information technology (IT) is among the 12 pillars of the National Programme of Education and Training for the Next 15–20 Years, in particular in the Millenium project. The goal of the Millenium project, under the IT pillar, is to connect all schools to the internet and train all teachers in working with the internet.

3.2 Prerequisites for using ICT in education

According to V. Stoffova and L. Kis-Tóth (1998, p. 150), the most frequent prerequisites for using ICT in education include the following:

- Mastering work with the Windows operating system.
- Preparation of texts and tables in Word and Excel.
- Mastering work with the Internet and electronic mail.
- Presenting a school on the internet.
- Mastering work with scanners and printers.
- Use of multimedia CD in the teaching process.
- Application of ICT in teaching subjects.

According to E. Petlák (1997, p. 8), modernisation of education is not limited to changes in the methods and forms of education and the modification of the schools' structure and equipment; it also means changing the style of work with an emphasis on the development of creativity and independent work of students. Some of the options how to use ICT in a creative manner are listed by I. Turek (2002), for example the following:

- Search for values, data and information
- Making computations
- Revision of the curriculum; development of skills and habits
- Presentation of information and curriculum; modelling and simulation
- Control of the teaching and learning processes; learning through problem solving
- Diagnosis of students
- Programme teaching
- Project teaching, etc.

Other benefits of ICT may include, for example, the following:

- High degree of motivation
- Making accessible the situations that are difficult to access
- Exclusion of dangerous situations
- Simulation of long-lasting processes in a relatively short time
- Interactivity – students may directly interfere and change conditions
- Creativity development.

The information and communication technology increases the productivity and attractiveness of the learning process. As a result:

- Pupils ask more questions in such situations
- ICT makes the search for information easier
- Pupils have more courage to risk since ICT is flexible and offers the option of return
- Pupils use richer and more varied sources, and more media

- Pupils' motivation is higher since they can find the latest information in the ICT environment
- Pupils may design, construct and use systems for data control, collection and measurement
- Pupils communicate and collaborate to a greater extent.

In the current knowledgeable society, access to adequate ICT must be regarded as an issue related to human rights. At various political scenes – in the European Union, at the World Summit on the Information Society in the UN – ICT is regarded to be an integral part of many aspects of life of the citizens, while the emphasis is put on the importance of ICT as a tool for supporting more intensive social inclusion. When ICT is used efficiently, it facilitates the inclusive education in schools and across the whole education system, as well as the support of activities performed by schools as educational communities. The role of ICT is to increase the respect for diversity as a step towards providing education across entire communities.
Access to ICT, which supports the inclusion, requires having generally accessible, available, and affordable technologies. Another requirement is the access to adequately customised and accessible teaching materials that provide equal educational opportunities to all pupils. Digital exclusion is a complex issue that affects gaining experience in the field of education, as well as gaining broader social experience by people – and not only hose with disability or special educational needs. The access and support regarding the use of standard, as well as special assistive technologies, which reduce digital exclusion, requires taking a systematic approach to the policy making and the practical application, with the participation of all relevant stakeholders.

4 Conclusion

On 15 March 2017, the Ministry of Education, Science, Research and Sport published the National programme for the development of education titled 'Learning Slovakia', which represents the basis for a substantial reformation of the education system. The document was drawn up based on the theorems for regional and higher education, addressed by a team of experts. However, the transformation of the education system requires a transition from the directive educational strategy to the creative and humane strategy, focusing on the pupils' personalities and the overall development of their personalities. Unfortunately, the great reformation of the education system, in its current form, cannot be performed. Experts recommend revising it and only then the political support may be addressed.
A present, ICT represents an integral part of our lives. It affects many aspects of the society, including the education, professional training and employment rates. Its most important benefit is that it has become a valuable tool facilitating remote education during the pandemic not only for students, but also for the disabled and people with special educational needs. In this article, information and communication technology is discussed in terms of improving the

quality of life and reducing social exclusion – the issues of global importance, as well as social, economic and political barriers that may exist where ICT is inaccessible.

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Coping with difficult situations in the context of the teacher's managerial competences

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Abstract

In this article, we deal with the issue of managing stressful situations in working life in the context of the teacher's managerial competencies. We draw attention to the importance of stress management strategies and challenging situations teachers have to face in their daily work. The teaching profession places significant demands on the teacher's personality, which also plays an important role in managing the workload. It is currently necessary to find out the overall level of stress and the ways in which teachers manage stressful situations. Knowledge of load management principles can be beneficial for everyone. They have the potential to significantly facilitate coping with challenging work and life situations. The more we learn about ways to handle difficult situations, the more we learn about the impact of stress and its effective management in the work environment.

Keywords: Stress Management, Stress Management Strategies, Stress Prevention

1 Introduction

Burden and stress are an integral part of every person's life from early childhood to death. In adulthood, when a person is usually actively involved in the work process, we can also encounter the problem of work stress. As working life and pace have changed significantly in recent years, much higher demands are placed on workers.

Ordinary life situations that a person encounters on a daily basis can never be described as purely positive or purely negative. In most cases, it is a mixture of favourable and unfavourable circumstances that a person experiences in his work and personal life. In the workplace they

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have to individuals face many serious or less serious problems on a daily basis and must effectively solve various intrapersonal and interpersonal conflicts (Rozvadský, Gugová, 2010). According to Pašková (2022), the teaching profession belongs to those helping professions, which in our society are characterized by psychological demands, but on the other hand, relatively poor financial and social evaluation. The issue of managing the workload as well as the choice of coping strategies that teachers use when coping with challenging situations is therefore extremely interesting.

Every teacher encounters various stressful situations during their career, which can negatively impact their professional life. Throughout their teaching activities, teachers are exposed to a wide range of stressors, starting with a demanding workload, concerns about poor relationships at the workplace, fear of job insecurity, and long working hours. These hours often include morning teaching sessions, afternoon preparation, and the correction and assessment of students' work in the given subject. In class, teachers most often have to deal with common complications related to the developmental specifics of students. A certain amount of work stress is beneficial, it contributes to employees being able to maintain their attention, to remain alert, to be able to respond flexibly, appropriately and effectively to current challenges and new tasks. The problem arises when the load accumulates, in which case work productivity, overall work performance may decrease, and the decision-making processes of individuals may be weakened (Barnová & Krásna, 2018).

It is obvious that, for example, presenting one's thoughts and attitudes in front of students, resolving conflicts between students, conducting controlled conversations with students, ensuring the assessment of individual students, etc. it can be a normal routine job for one teacher, which he does not perceive as stress, a burden, an unpleasant situation. On the contrary, for the other teacher, the same situation can be highly stressful, unpleasant, the solution of which requires maximum effort and control from him. Some of them perceive this type of situations as a threat, stress, even in terms of their impact on teachers. Inversely, other people can see it as a challenge, an incentive to start something new. It is clear from these illustrations that the fact of demandingness and stress must be interpreted in the context of situational characteristics and personality traits of a particular person.

If a teacher feels angry, depressed, nervous and disappointed, when he feels anxiety or tension due to some fact related to his teaching work, we talk about teacher stress. The specific sources of stress experienced by individual teachers vary considerably from case to case. The common denominator is that stress triggers a feeling of threat, self-esteem, well-being. It appears that most teachers experience some stress at times and that a significant number of teachers experience high stress quite often. Stress occurs most often when we feel that the circumstances in which we find ourselves place too demanding demands on us and we are unable to fulfil them in an adequate quality. The essence of stress in this case is precisely the feeling of threat.

2 Stress in the teacher's pedagogical activity

Stress is a part of life; it is a state in which the organism reacts and is put on "standby" when it is affected by stressors. Stimuli can be various psychological factors - we talk about psychological stress as a state of excessive mental load (Košč, 1994). In everyday life, everything that puts pressure on us, overloads us and makes us uncomfortable is usually referred to as stress.

Burdensome things that affect us from the outside are called stressors. After being exposed to stressors, our body and soul can experience a stress reaction (Praško, 1996). The understanding of the given situation will influence whether we will consider the situation as a stressor or not. So the stress reaction will not only depend on what happened, but mainly on how we understand it. Therefore, the most important factor in changing the stressful experience can be changing oneself. A characteristic response to stress is the "fight" or "flight" reaction – this reaction is called so because it prepares people in many situations to run away from the threat or, on the contrary, to fight it.

Stress is the result of a psychological and physiological reaction to a stressor (a stressful situation, event, factor, anything that a person considers threatening some of the important values). (Bratská, M., 2011). The key factors in terms of the occurrence of stress can be considered: time constraints and overly broad workload, emotional tension at the workplace, stress resulting from the job position, i.e. conflict between the demands of superiors and subordinates and conflict between work and private life.

Stress itself is considered a serious source of psychological burden. Difficult or unusual sensorimotor conditions for the performance of activities, time deficit, pressure of threat and responsibility are considered stress factors (Bedrnová, 2009, in Bedrnová et al.).

Lazarus and Folkmanová (1984, In Baumgartner, 2001) created a transactional definition of stress, which is based on the study of interactions between a person and the environment. Stress is "a specific relationship between a person and the environment, which the person perceives as strenuous, or exceeding her personal resources and at the same time threatening her subjective satisfaction.'

However, the authors do not quite clearly agree on whether stress and burden are synonymous. Uzel (2008, p. 4) talks about load as a measure of stress that is inherent in life and is common in life. According to him, stress occurs when the load is unbearable. Hošek states that stress and load are words with the same meaning (Hošek, 1999, p. 7).

In relation to stress, we can come across different terms related to stress, depending on whether they refer to a low or high intensity stressful situation.

Hyper stress – stress exceeding the limits of adaptability, the ability to cope with stress. Hypo stress – stress that has not yet reached the usual stress tolerances.

According to how stress affects a person, Selye characterized stress as negative, i.e. distress and positive i.e. eustress.

Both eustress and distress are physically manifested in a similar way. From a health point of view, it is a measure of stress, mainly in the frequency of its occurrence.

The teaching profession is also one of the most demanding professions where teachers come into contact with stressful situations. The teacher has to cope with both time and psychosocial pressure. In many of our and foreign research on teachers' workload, it can be seen that at least a third of interviewed teachers consider the workload associated with the performance of their profession to be very strong, even extreme, and definitely greater than the workload of their lives outside of their jobs.

The teaching profession places significant demands on the teacher's personality, which also plays an important role in managing the workload. This fact should already be considered when choosing adepts for the teaching profession, who should have personality characteristics leading to more effective handling of the workload.

The causes of this stress include, for example, factors such as lack of time, bureaucracy in education, poor material equipment of schools, but also stressors in the field of interpersonal relations (with pupils, colleagues, superiors).

According to Grecmanová and Urbanovská (2007), a major source of burden for the teacher is the teaching activity. Before the actual teaching, however, it is necessary to prepare for it. This preparation is usually carried out in the evenings, on weekends or holidays. The teacher is very often faced with a lack of time.

Urbanek (2005) divided the psychological burden felt by teachers into five groups:

1. load in the area of perceptual demands – increased attention at work, control of pupils, etc.,
2. load in the area of cognition – demands on thinking, application of professional knowledge, etc.,
3. burden in the emotional area – controlling one's own emotions, relationships with students,
4. burden in the social area – communication with parents, pupils,
5. burden in the field of self-regulation – self-evaluation and self-control.)

Symptoms of stress can be registered at the individual level of the teacher, including chest pains, nervous breakdowns, irritability, lack of concentration, increased consumption of alcohol or other addictive substances, but also, at the organizational level. The main symptoms of stress at the organizational level can be a high rate of teacher absence, a higher rate of turnover, difficulties in labour relations, but also a decrease in work productivity. All this creates the conditions for frequent manifestations of apathy and occupational accidents at worst possible consequences for the individual worker, but also for the organization.

However, a certain amount of work stress is beneficial, it contributes to employees being able to maintain their attention, to remain alert, to be able to respond flexibly, appropriately and effectively to current challenges and new tasks. The problem arises when the load accumulates, in which case work productivity, overall work performance may decrease, and the decision-making processes of individuals may be weakened (Barnová & Krásna, 2018).

But it is necessary to learn to reduce excessive work stress, as well as stress related to contact with students, parents, colleagues, superiors, etc.

3 Coping with difficult situations in the context of the teacher's managerial competences

From the position of a teacher who has found himself in a difficult situation, the decisive fact is the choice of the procedure for solving it or handling this situation. Stress is a consequence and manifestation of states of stress, it represents their extreme form, which is caused by extreme demands of the environment. The research into the ways in which a teacher manages challenging situations and how he behaves in them is probably also for this reason a significant attention paid by experts, considerably more than attention devoted to the questions of what characterizes a difficult situation, what types of these situations we can specify. From the point of view of successful or failure to cope with a challenging situation, it is not only its size that is crucial, but the whole scale of circumstances, internal and external factors and their combination, which cause some teachers to process the load without anyone even noticing it, while other teachers it can fail and act short even on seemingly small things. Therefore, it is desirable that the methods of handling stressful situations in the teacher's work go hand in hand with the methods and techniques for preventing stress and building resilience to these challenges.

There are a large number of different ways of managing stressful situations and increasing resistance to them, starting from interest in one's own health through rational nutrition, positive thinking, relaxation, use of time management, assertive behaviour, rest, physical activity (yoga, walks, active sports) to education focused on the issue of stressful situations and others. It is up to the teacher to decide which method or technique to choose and apply in coping with stressful situations and building resilience against them. The increasing number of difficult situations in a teacher's life highlights the need for the development of managerial competencies, as well as a growing interest in how to effectively address these situations and their impact on the teacher's psyche, health, and well-being. Overall, solving the issue of the quality of working life logically directs attention to the issue of managing and solving difficult situations. Therefore, it is necessary that part of the managerial competence of teachers is also the handling of difficult situations during their pedagogical practice. Knowledge about the laws of load management can be beneficial for everyone.

They have the potential to significantly facilitate coping with challenging work and life situations. In our and foreign professional literature, it is possible to get acquainted with a wide range of researched strategies for managing difficult situations, which focus on a goal or a process. Goal-oriented models of managing challenging situations represent an effort to change or control environmental factors that are perceived as stressful or to regulate or to manage own unpleasant emotions that arose as a result of a stressful situation. Process-focused models of coping imply tendencies to encounter or avoid a stressor. In another

context, it is possible to distinguish strategies for coping with difficult situations focused on a problem, emotion or detachment from a stressful situation.
According to Ruseilov (2006), stress management strategies represent certain more generalized ways of behaving in different types of stress situations. Effective load management depends on personality characteristics that help coping, characteristics of the social environment and a specific stressful situation.
Kyriacou (1996) describes his breakdown of stress management strategies, while the names of the strategies are synonyms to those mentioned above, namely: direct action coping and palliative coping
Stress management strategies Lazarus and Folkmanová (1984, p. 141) define coping as "a set of cognitive and behavioral efforts aimed at managing, reducing or tolerating internal and external demands that threaten or exceed the individual's resources."

3.1 Research on coping with stressful situations by teachers in Slovakia and abroad

Research by a pair of authors Žitniaková Gurgová and Behúňová (2017) brings identification of the most frequent teacher stressors using the method of a non-standardized questionnaire of their own creation. Their research group consisted of 50 respondents from seven primary schools in the Považská Bystrica district. The authors found that the most common sources of stress for teachers are frequent legislative changes, the presence of a student with special educational needs and the social evaluation of teaching work. Other frequently mentioned sources of stress were salary conditions, holding multiple positions and perfectionism. On the contrary, relationships in the teaching staff, management of pedagogical documentation and relationship with a superior were cited as the least stressful.
The aim of the research by Žitniaková and Behúňová was to find out which stressors are most effective in the work of primary school teachers, what are the manifestations of stress in teachers and the ways in which teachers manage stressful situations. They also investigated the burnout rate of primary school teachers in terms of the length of teaching experience and the level of primary school at which the respondents worked. Based on their findings, they agreed with the authors: Clipa and A. Boghean (2015), Kačmárová, Kravcová (2011), Kopčanová (2005), Popelková (2011), O'Connor, Clark (1990) and others, that the teaching profession is relatively stressful, primary education teachers are more at risk and also teachers with many years of experience. Manifestations of stress mainly include somatic and psychological problems, which in practice are mainly reflected in more frequent absences from work due to health problems. They state that favourable conditions for practicing the teaching profession are not currently set in Slovakia.
In her study, Janšová Martina verified the protective role of spirituality on perceived stress and work burnout. The participants were 95 Slovak teachers between the ages of 20 and 68 (AM = 42.21 years, SD = 11.19; 83.2% women), of which 55.8% worked in primary schools.

Perception of current health was measured by the WHO-5 scale (WHO, 1998). Spiritual Experience Index SEI-R (Genia, 1997), perceived stress scale PSS-10 (Cohen et al., 1983), psychological workload of Meisters were used to measure spiritual experience psychological workload assessment questionnaire. Job burnout was measured by the Slovak version of Shirom Melamed's SMBM burnout method.

The results of the descriptive analysis show significant differences in the perception of stress and spiritual support depending on the length of teaching experience. It was found that the investigated teachers experience an average level of subjective well-being and spiritual experience. On average, they perceive low to medium stress, the level of job burnout was at a medium level for 31.6% of respondents. Correlation analyses confirmed significant positive associations between psychological workload, perceived stress and individual burnout factors. The results of the regression analysis showed that perceived stress and burnout are significant negative predictors of subjective well-being. Despite identifying a significant negative relationship between spiritual openness and monotony experienced in the work of teachers, as well as positive connections between spiritual experience, spiritual support and overload, the buffering effect of spirituality against stress or burnout was not confirmed in this study. The results may be useful in further studies in the field of quality of life and occupational health.

In their research, Kačmárová, Kravcová (2011) brought findings related to sources of stress and coping strategies in the teaching profession, which is rightfully considered one of the most stressful professions today. The results of their research showed that teachers consider the following factors to be the most stressful: psychological demands, low salary, time pressure, underappreciation of the work of a teacher and frequent changes in educational projects and school organization. On the contrary, they have the least stressful effect on them: low possibility of professional growth, low possibility of using innovative methods, problematic parents, use of mobile phones by pupils in lessons and demands for improvisation.

Research by Urbanovská (2011) mapped the most significant work stressors among 223 teachers of various levels of education (kindergarten, primary, secondary, elementary art schools) and educators in school groups. It turned out that teachers are most and most often stressed by the inconsistency of the required work with the assessment and school equipment; feelings of insufficient appreciation and evaluation of their work (financial and personal); a big rush, being overwhelmed with tasks, not being able to take a break, not even following a drinking regimen, not being able to relax and regain strength. In addition, teachers consider sudden and significant changes in education and changes in professional requirements to be a frequent source of stress. Among the least serious stress factors, they included an unpleasant environment, little privacy and physical difficulties, as well as moral problems with work, assigning tasks against one's own beliefs and working conditions in terms of the physical environment (noise, cold, lack of fresh air).

Alex Cristian Brezan and Valentina Georgeta Vartic (2022) from Romania investigated the level of stress in ordinary secondary school teachers and teachers in special schools. The study participants were 60 teachers, of which 30 secondary school teachers from regular secondary schools and 30 secondary school teachers from special education. Of these, 12 were men and 48 were women, the age of the subjects was between 26 and 61 years, the average age was 42 years. Mainstream teachers fall into the following categories: 13.3% achieve low levels of stress and 86.7% achieve medium levels stress. At the same level, special education teachers fall into the following category: 10% achieve a low level of stress and 90% of special education teachers achieve a medium level of stress. The data they obtained through research confirmed their hypothesis that teachers are subject to a significant degree of stress at work, due to a number of factors that affect them, and at the same time teachers at special schools achieve a higher degree of stress than teachers of ordinary secondary schools.

4 Techniques helping teachers to manage stressful situations

Techniques and methods helping to prevent stress and manage stressful situations can be divided into collective and individual measures. It is possible to prevent stress in the work of a teacher by collective measures at the level of, for example, improving the social and social status of teachers, i.e. the status of a teacher, which in today's understanding is at a low level. At the level of work organization within the school, it is possible to prevent with these tools, for example free hours for teachers, breaks at work, limited number of students in classes and, last but not least, improvement of working conditions.

The prevention of stress in the work of teachers can include the establishment of discussion clubs or a rest room for teachers at school, training teachers in the psychology of relationships and ensuring the presence of a psychologist at the school, who will be dedicated not only to students but also to teachers, either individually or in groups. Another important benefit is the provision of an adequate amount of information. Failure to provide the necessary information or insufficient information is a source of uncertainty, on the other hand, too much information, even irrelevant, burdens the worker. This also includes awarding workers even when solving tasks that did not bring maximum success, dedicating space for informal meetings organized outside the workplace of school employees, such as team buildings, visits to various cultural and sports events.

Methods that lead to physical and mental relaxation and at the same time strengthen resistance to stress are self-regulation methods. Through them, we can achieve a balance of emotions, improve the overall state of mind, and reduce tension. Another effect can be a relaxation response that acts as an antagonist to the stress response.

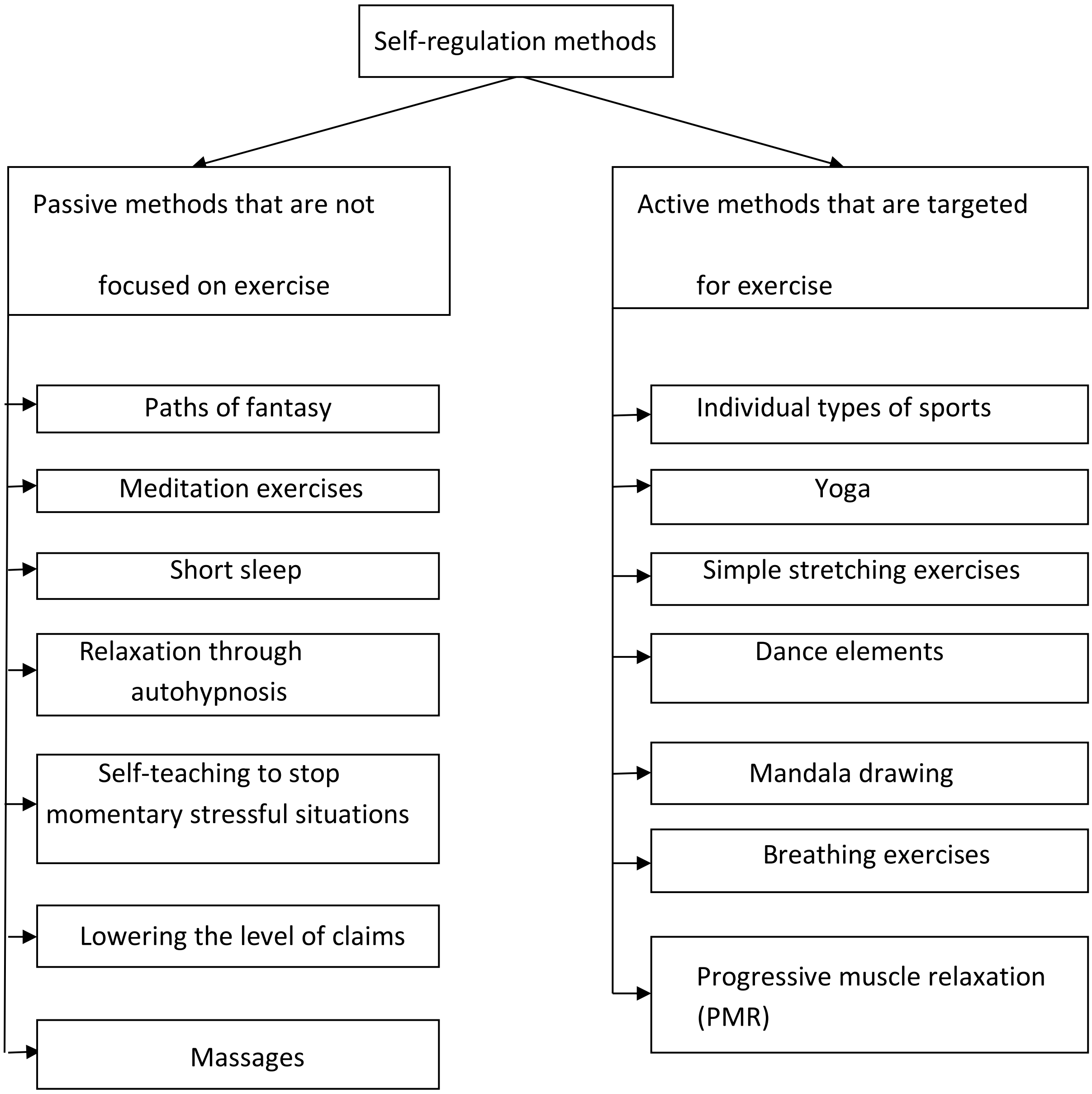

Figure 1: Individual self-regulation methods (Source: Authors' graphical output, 2024)

Active use of preventive measures and stress management methods can significantly eliminate the risk of stress and its consequences. Every teacher should find his own method and technique that would suit him best in terms of resistance to stress and try to protect his physical and mental health and, above all, lead a comfortable life.

5 Conclusion

The work of a teacher is not only a mission to educate but also to shape the next generation. Teachers help students build and develop creativity, shape their personalities, form opinions, and learn how to prioritize life's values. They guide students in developing attitudes toward people, things, and themselves. Teachers strive to raise educated individuals who are prepared to manage and overcome life's challenges, while also pointing them in the right direction. A person is not born a teacher but becomes one. This profession is demanding, not only in terms of mental and physical load but also in terms of time.

Every individual, including teachers, should be aware of their personal strengths and weaknesses, as well as recognize when stress factors are motivating and manageable, and when, conversely, these factors become harmful, hindering their ability to fulfil tasks and achieve goals. Stressful situations are an everyday part of pedagogical practice in today's world. Therefore, it is essential to address this issue more thoroughly and explore ways to enhance teachers' resilience to stressful situations.

In conclusion, it can be summarized that every teacher, and indeed every individual, should be aware of the stressors they encounter at work and actively address the root causes of these stressors. Rather than merely focusing on the symptoms and consequences of stress, it is crucial to tackle the underlying issues that trigger it. Each person should identify the stress management method or technique that works best for them and take steps to protect both their physical and mental health.

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To the Roots: Engineering Pedagogy

Information Literacy of Teachers – Why Does It Matter?

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Abstract

We live in the information age. Today, we no longer face challenges in acquiring information; rather, we are confronted with so much information that we struggle to navigate it effectively. Critical evaluation, verification, and creation of information are among the key competencies of the 21st century. A fundamental prerequisite for the development of a learning society is an individual's ability to continually educate themselves. The rapid increase in information, particularly in the online (digital) space, the growing number of sources, and the expansion of information and communication technologies place higher demands on individuals' competencies in educational processes, professional performance, and personal lives. This article examines the information literacy of teachers at various levels of the education system.

Keywords: Information Literacy, Digital Literacy, Critical Thinking, Competencies, Education

1 Introduction

We live in the information age. Nowadays, accessing information is no longer a challenge; rather, we face an abundance of information, making it difficult to navigate and assess. Critical

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evaluation, verification, and creation of information have become essential competencies of the 21st century. A key prerequisite for the development of a learning society is an individual's ability to continuously educate themselves. The quantities of information, particularly in the digital space, the increasing number of sources, and the expansion of information and communication technologies demand higher competencies in educational processes, professional performance as well as private life (Benyak, 2015; Pankevič, 2023).

The term *information literacy* first emerged in 1974 when Paul G. Zurkowski, then-president of the American Information Industry Association, used the term 'information literates' to describe people capable of effectively utilizing information resources in their work. Thus, information literates are individuals capable of solving problems by working with a wide range of informational techniques and sources (Webber & Johnston, 2017; Hrdináková & Fázik, 2021; Pankevič, 2023). There are numerous other definitions of information literacy. Authors most often define it as a set of human competencies necessary for effectively searching for, evaluating, and using information and information sources to fulfil an informational need or solve a specific problem. The ethical use of information in society is always emphasized in this context.

Defining information literacy is not an easy task. The challenge of defining it reflects the fact that the concept of information literacy is extensive, with partial research and theoretical approaches often addressing only specific contextual factors. Moreover, it is challenging to establish a precise definition because the term (as well as the phenomenon itself) is dynamic and constantly evolving (Hrdináková & Fázik, 2021). Information literacy also has clear intersections with other competency areas, such as reading literacy, technological and digital literacy, computer literacy, internet literacy, cultural literacy, data literacy, critical thinking, and others. For this reason, some authors (e.g., Shapiro & Hughes, 1996) consider it an art.

When defining information literacy, the concept is often based on functional literacy, understood as the ability to actively participate in the world of information (Pankevič, 2023). Functional literacy includes the following areas:

- Literary and reading literacy – the ability to understand perused text and extract needed information from it.
- Document literacy – the ability to utilize specific information sources, differentiate between them, and evaluate their informational value.
- Computer and technological literacy – the ability to use current information and communication technologies to access information.
- Global literacy – the ability to understand various cultures, their interconnectedness, cooperation, and changes in the (informational) world.
- Media literacy – the ability to distinguish and use various information sources to acquire needed information; it also represents an individual's growing capacity to produce and distribute content in various forms. It includes the ability

to communicate effectively with print and electronic media to comprehend, analyse, and evaluate transmitted messages (Levine-Clark & Carter, 2013).

- Internet and digital literacy – the ability to use the internet and online platforms for searching, organizing, evaluating, and communicating information in different digital formats; it includes the ability to understand and use information from various digital sources presented via information and communication technologies (Hrdináková & Fázik, 2021).

Digital literacy is considered to be a subset of information literacy applied to the digital environment. Nowadays, digital literacy is becoming an essential competency for everyone who participates in societal life in any form. The digital space serves as the primary environment where individuals encounter hoaxes, unsubstantiated claims, and tools often exploited in hybrid warfare. With the rise of artificial intelligence and deep-fake constructs, digital literacy can be seen as a critical tool for survival in the modern world.

2 Information Literacy and Critical Thinking

Information literacy, in all its forms and manifestations, is inextricably linked to critical thinking. According to Guilford (1967, 1986), critical thinking is essential for effective information processing, as it encompasses the abilities of evaluation, analysis, and decision-making. Critical thinking is also vital for differentiating the quality of information. Nowadays, the ability to think critically is one of the most sought-after skills in the labour market. Despite being globally recognized as an essential competency, its development is significantly underestimated in the Slovak education system, despite long-standing calls for its prioritization (Kosturková & Ferencová, 2018). Yet, the development of critical thinking can also be supported through the enhancement of reading literacy. Reading teaches individuals to focus on one subject for aa longer time period and actively engage with a text at their own pace (Markoš, 2019).

There are many definitions of critical thinking (Kosturková, 2016). According to several authors, it is a complex phenomenon that encompasses several abilities and skills. For example, Paul (1992) offers a model of 35 components of critical thinking, which he also translated into teaching strategies (9 affective, 16 cognitive macro-skills, and 9 cognitive micro-skills). According to Ruisel (2008), critical thinking is synonymous with high-quality or comprehensible thinking, involving motivation for difficulty, knowledge about the skills of critical thinking, training of structures to facilitate transfer between contexts, and metacognitive monitoring.

Critical thinking is closely related to unfounded beliefs. The belief in unsupported information has been present among people much longer and more frequently than one might think. In the past, unfounded beliefs were primarily related to natural phenomena, extraterrestrial civilizations, parapsychological events, and magic. People often lacked sufficient knowledge, so they naturally feared everything new and unknown. However, the present and recent past, when we have easy access to many scientific explanations, clearly show that belief in unsupported information and the inability to verify information is a very dangerous phenomenon. We encounter unfounded information daily not only in the online space but also on television, in movies, TV shows, advertisements, and books (Ballová Mikušková, 2019). With the popularity of social media, the popularity of influencers with varying levels of character and education also rises, which further complicates the situation, not to mention the existence of troll farms and other tools of hybrid warfare.

Research on belief in unfounded information is extensive and interesting. It is mostly studied in the context of intelligence or education. However, clear conclusions are still lacking. Some studies (e.g., Otis & Alcock, 1982; Aarnio & Linderman, 2005; Bensley, Lilienfeld & Powell, 2014; Ballová Mikušková, 2018) suggest that higher education reduces pseudoscientific beliefs. University students with a higher degree of analytical thinking were less likely to trust unsupported information compared to students from vocational high schools (Aarnio & Linderman, 2005). Similarly, psychology students were better at distinguishing between scientific and pseudoscientific information (Bensley, Lilienfeld & Powell, 2014) compared to the general population. Otis and Alcock concluded in the 1980s that university professors are more sceptical compared to the general population, and they subsequently spread their scepticism among students. On the other hand, many studies suggest that even highly educated individuals, despite their education and higher level of analytical thinking, still believe in many unsupported beliefs (e.g., Kowalski & Taylor, 2009; Swami et al., 2011; Ballová Mikušková, 2018).

Current research offers several explanations for why people believe unfounded information, with the most common being (Kollár Rybanská, Krpálková Krelová & Tkáč, 2024):

- Confirmation bias – people tend to seek information that supports their existing beliefs while ignoring information that contradicts them. This phenomenon was intensely studied, especially in the 1990s (e.g., Kunda, 1990; Nickerson, 1998).
- Lack of critical thinking or underdeveloped critical thinking – some people may have an insufficient ability to think critically, or due to certain circumstances, have not had the opportunity to develop their critical thinking, making them unable to assess the credibility of the information they encounter (Yaqub et al., 2014; Wineburg & McGrew, 2019).
- Emotional appeals – some disinformation and hoaxes may include emotional appeals (e.g., images of wounded people, attacks on dignity, negative emotions like anger, fear, sadness, crying, etc.) that influence a person's emotional experience (Ghanem, Rosso & Rangel, 2018).
- Trust in authorities – research in the 1980s showed that people are more likely to believe information presented by an authority. This phenomenon is also known as the 'halo effect'.

- Insufficient information literacy or lack of information – There are many examples of hoaxes and false information that persist in societies and communities where access to accurate information is limited (e.g., in authoritarian regimes) (Marcellino et al., 2021), or where recipients do not have sufficiently developed information literacy for various reasons.

Naturally, current research also attempts to verify other hypotheses and examines people's susceptibility to believing unsupported information, for example, in relation to their education, life satisfaction, upbringing, and others. Another significant influence comes from various cognitive biases.

From the above mentioned, we can assume that information literacy and critical thinking must now be part of the 'essential equipment' of every person. If a person today cannot orientate in information and information sources, they can easily become a victim of sophisticated scams, but they may also be disadvantaged in the job market and in social life. Therefore, it is essential to assess and develop these skills at all levels of formal education, as well as throughout one's entire life. Developed critical thinking allows us to navigate the information chaos and is a prerequisite for information and digital literacy.

3 Evaluation of Information Literacy

Unfortunately, it is not uncommon for teachers at Slovak high schools and universities to have insufficient information literacy, which can lead to a range of problems, from the spread of hoaxes to young people leaving the country. Evaluation of information literacy is very important because it helps determine the level of information literacy of individuals or entire groups of people, according to specific requirements. Information literacy assessment can provide valuable information about personal abilities to work with information, various information sources, with a current emphasis on working in the digital environment (Hrdináková & Fázik, 2021). Based on the findings, we can further adjust the development processes of teachers within the educational process and prepare them better for their further careers or participation in social life.

There is a large number of models of information literacy and approaches to information literacy, which have been elaborated in detail by authors such as Hrdináková and Fázik (2021). Likewise, there are various ways we can assess or measure information literacy. The most common methods of assessment include standardized and non-standardized tests, essays, questionnaires, structured interviews, scenarios and simulations, portfolios, observations, self-assessments, or different combinations of these. Each of the mentioned methods has its strengths and weaknesses. The choice of tools is usually based on the educational goals or other activities, or on specific requirements. We believe that many of the existing tests for assessing information literacy do not yet respond to the rapid development and changes in the digital space. Although non-standardized tests undoubtedly have many disadvantages, there is currently a need for new tools, especially for high school teachers and university teachers, that consider changes, particularly after the COVID-19 pandemic and the shift in communication to the virtual space.

In our paper we work with one of the most widely used and clear models, 'The Big Six Skills' (Big 6). It is a process-oriented model that was developed in the 1980s. Initially, it represented a framework for information competencies, but later it was developed as a tool for problem-oriented and information- and technology-supported teaching of various subjects (Eisenberg & Berkowitz, 1990). In 2016, a new version of the Big 6 model was published, which serves as a tool for the development of information, communication, and technological literacy competencies (Eisenberg, Murray & Bartow, 2016). Since we believe that information literacy is inherently linked to critical thinking, we consider the Big Six Skills model to be an ideal model for establishing procedures for assessing information literacy. The Big 6 model can also be interpreted as a strategy for solving information problems, which is applicable to many areas of life. The application of critical thinking in the process of solving information problems, according to its authors, brought a fundamental breakthrough in the concept of information education (Eisenberg & Berkowitz, 1988). The Big 6 model sets six steps of problem solving: definition of the problem, choice of strategy of the information research, localization of information sources, analysis of information, synthesis, and evaluation of effectiveness.

3.1 Use of the Big 6 Model for Evaluating Information Literacy – An Example

The individual phases of the Big 6 model will be used to describe a task that could be used to assess information and digital literacy, as well as critical thinking for high school teachers or university teachers. We primarily focus on information obtained from the digital space and on working with disinformation and hoaxes. We believe that modern tools for assessing information literacy should include questions/tasks/items that touch on several overlapping areas of information literacy (mainly literary and reading literacy, internet literacy, ICT, and digital literacy), should be interesting for teachers so they are willing to participate in the assessment, and should be engaging and align with the current situation. We consider it crucial for teachers to be able to orientate in life on social networks, which have become an inseparable part of young people's lives. Majority of them are users of ‘classic' social networks (Facebook, Instagram), new ones that are emerging (Telegram, Discord, TikTok, Threads, X, Snapchat, and others) are for now not very popular between them. Social networks are currently a main source of misinformation and disinformation, which often leads to confusion and belief in unsupported convictions.

We also believe that information literacy can be tested relatively easily, and along with the result, we can gather additional relevant information about teachers' lives, personalities, and thinking so that we can adjust the educational process in their favour.

As an example, we present the following task: "Imagine that you have had the following symptoms for three days: headache, cough, and a temperature of 37.5°C. Your general practitioner is on holiday. You have access to the internet (or any social network). How would you proceed in the next six steps?"

1. Defining the problem: What needs to be done? What information is needed?
2. Choosing a research strategy: Where can I find the needed information? What are the best sources of information?
3. Localization of information sources: Where are these sources located? How can I access them?
4. Analysing information: What information is relevant? How can I use this information effectively?
5. Synthesizing information: How can I combine this information? How can I present it effectively?
6. Evaluating effectiveness and efficiency: Did I accomplish the task effectively? What did I learn? What can I improve?

To the task, we can also add a brief text describing several illnesses that include the mentioned symptoms. This way, we can easily test reading literacy as well. We chose a health-related topic because we are aware that many people search for health information in the digital space. In this simple task, we can test the aforementioned literacies simultaneously and also learn about the thinking process of a particular teacher. In step 6, we will also discover their ability to engage in self-reflection.

Tasks can be much more complex and may focus only on individual steps. Such evaluations of information literacy have their challenges, and it's important to use them with a specific goal and with sensitivity. With this brief example, we mainly wanted to highlight the need to transfer the evaluation of information literacy into the digital space.

3.2 Points for Reflection

In connection with the topic being addressed, we suggest several points for reflection for teaching young generation and how to teach them:

1. The need to talk about freedom of speech – where are the boundaries? Why can't we spread unverified information? Why is an opinion not a fact? How are arguments formed? What is and what is not an argument?
2. What does the anonymity in the online space mean? How should we approach information from anonymous sources (e.g., Wikipedia)? How to engage in discussions with anonymous (anonymized) participants on social media?
3. What does consent mean in the digital information space?
4. What should and shouldn't we post on social media?
5. How to feel safe in the online environment?
6. How does artificial intelligence work? (Gemini, ChatGPT, chatbots, and others)

7. What are the most common scams we may encounter in the digital space? How to recognize hoaxes?

4 Conclusion

This paper aims to summarise the importance of information literacy and its individual components, and their connection with the need for developed critical thinking. Currently, particularly young people (students) often engage in the online space, making it essential for their teachers to be familiar with this environment as well. As early as 2019, the issue of face-to-face communication problems was frequently discussed, largely due to the shift of communication to digital platforms. During and after the pandemic, we are still assessing the damage caused; however, one thing is certain: we are unlikely to be able to escape the online virtual environment. Therefore, it is crucial to evaluate and develop information literacy using new, modern methods that reflect the altered conditions and the shift of communication and information into the digital space. The conditions of the information and knowledge society placed on the individual further emphasise the significance of this concept, which is why efforts are being made to integrate it into all levels of the formal education system, from pre-primary to lifelong learning.

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To the Roots: Engineering Pedagogy

Information-communication technologies in the educational process

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Abstract

This paper explores the transformative role of Information and Communication Technologies (ICT) in modern education, emphasising its potential to enhance teaching methods, improve learning outcomes, and foster essential skills such as digital literacy, creativity, and independent learning. ICT, encompassing tools like computers, interactive whiteboards, and digital teaching materials, has redefined traditional pedagogy, making learning more engaging, efficient, and tailored to individual needs. By integrating multimedia elements, animations, and simulations, ICT enriches the learning experience, facilitates understanding complex concepts, and provides dynamic opportunities for personalised and self-paced study. The paper highlights the symbiotic relationship between digital literacy and ICT, where digital literacy equips individuals to navigate and utilise ICT tools effectively. At the same time, ICT is the foundation for fostering critical competencies like collaboration, problem-solving, and research skills. The advantages of ICT include immediate feedback, error correction, and motivation through gamified learning experiences, significantly improving the clarity and accessibility of educational content. As societal expectations for ICT integration in education grow, the paper underscores its indispensable role in preparing students for a technology-driven world. By leveraging ICT, educators can cultivate a generation of innovative, adaptable learners equipped to meet the demands of a rapidly evolving global landscape. ICT is not a supplementary tool but a cornerstone of contemporary education.

Keywords: Information and Communication Technologies (ICT), Digital literacy, Modern education, Personalized learning, Innovative pedagogy.

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1 Introduction

The expansion of information and communication technologies (hereinafter referred to as ICT), which at the turn of the 20th and 21st centuries recorded a sharp upward trend and became a phenomenon of modern society, has significantly influenced the informatisation of education. Teaching in the classical form, lectures, reading from a textbook, or memorising texts is becoming dull for students. Presentation of the curriculum via multimedia and the Internet is also suitable. This will make teaching all subjects more efficient, better and more modern (Mishra & Koehler, 2006).

An essential part of education is also mastering the methods of searching for information and working with it, as well as its presentation and subsequent use and application in practice. Every educated person must adapt to the requirements of contemporary society, which requires communication and computer literacy. A suitable means of achieving this is using information and communication technologies such as the intranet and the Internet, which should be supplementary to basic general information. ICT is an essential means of supporting teaching, studying and other activities in the field of educational development. ICT allows the learning of mathematics to be more efficient, improved and modernised, as well as other taught subjects. The beautiful motivational potential of this teaching method and the possibility of individualising teaching are undoubtedly among the advantages of using ICT in the educational process (Fu, 2013).

We specify the general goals of using ICT in the educational process as follows (Passey & Higgins, 2011):

- to develop cooperation and communication skills (plan work, identify problems, divide the task, combine partial solutions, publicly present the results in a team);
- to develop the student's personality and creativity (to be able to choose an appropriate medium for creating and expressing their thoughts, opinions and feelings);
- to develop metacognitive communication (to learn by discovering, constructing, and thinking about their abilities in the learning process);
- to create formal and logical thinking, to learn methods for solving problems;
- develop the skills necessary for research work (e.g. carry out a simple research project, formulate a problem, obtain information from appropriate sources, look for solutions and causal relationships, discuss the problem, draw conclusions);
- appreciate and respect intellectual properties (understand that information, data, knowledge, and, for example, programs are products of mental work, are objects of property and have value).

ICT means computers, laptops, interactive whiteboards, visualisers, data projectors, scanners, and teaching software (Warschauer, & Matuchniak, 2010).

1.1 Digital literacy: An essential skill in the modern era

Digital literacy is effectively navigating, evaluating, and utilising digital technologies to communicate, access information, and solve problems. In today's interconnected world, this skill has become indispensable for individuals of all ages, enabling them to participate fully in the digital economy and society. Digital literacy goes beyond basic computer usage—it encompasses critical thinking, ethical awareness, and the capacity to adapt to new technologies. For students, digital literacy is crucial for academic success, fostering skills in online research, collaboration, and creative expression. For professionals, it ensures adaptability in dynamic workplaces, where tools such as cloud computing, data analysis software, and virtual communication platforms are increasingly standard (Fu, 2013).

1.2 ICT: The backbone of modern communication and innovation

Information and Communication Technology (ICT) integrates telecommunications, computing, and digital systems to process and share information. ICT has transformed how individuals, organisations, and governments interact, driving innovation across industries. Businesses leverage ICT for automation, data management, and global outreach, while educational institutions use it to enhance learning experiences through digital classrooms and e-learning platforms. ICT also plays a pivotal role in healthcare, enabling telemedicine, electronic health records, and real-time monitoring of patients. As ICT evolves, it facilitates smarter cities, advanced AI systems, and greater inclusivity, bridging the digital divide and connecting communities across the globe (Livingstone, 2012).

1.3 The intersection of digital literacy and ICT

Digital literacy and ICT are interdependent, reinforcing the effectiveness of the other. Digital literacy equips individuals with the skills to use ICT tools efficiently and responsibly, while ICT provides the platforms and systems necessary for digital literacy to thrive. For instance, digital literacy enables users to discern credible sources of information online, a skill that is essential in combating misinformation in the digital age. Simultaneously, ICT provides the technological infrastructure to access and disseminate such information. Together, they empower individuals to engage meaningfully in a rapidly changing digital landscape, fostering innovation, collaboration, and lifelong learning in an increasingly globalised world (Livingstone, 2012).

The paper explores and demonstrates ICT's transformative role in modern education. It seeks to illustrate how ICT can enhance teaching methods, improve learning outcomes, and foster essential skills such as digital literacy, creativity, and independent learning. The paper focuses on:

- Highlighting ICT as a tool to make traditional teaching methods more engaging, efficient, and aligned with the needs of contemporary society.
- Emphasising the importance of developing critical competencies, such as collaboration, research skills, and formal problem-solving, is necessary for students to thrive in a digital era.
- Showcasing the advantages of using ICT, such as individualised learning, immediate feedback, and the ability to simulate complex events while providing specific examples of its application across educational contexts.

The overarching goal is to advocate for integrating ICT into education, ensuring students and educators can harness its full potential to enhance motivation, accessibility, and the overall quality of the learning process.

2 Use of the ICT tools in the educational process

The use of ICT in teaching is currently not only a possibility but also an accurate expectation of society. It is the expectation of parents and students and must also be the expectation of teachers. ICT offers a wide range of applications in our pedagogical practice, which allows us to expand the base of our methodological tools and develop modern competencies in students, increasing their motivation. ICT tools greatly help us in improving the clarity of teaching. Using animations, videos, and precise, illustrative images will enliven every lesson, regardless of the subject. On the one hand, lessons will be more lively, varied, and exemplary. On the other hand, we will significantly help students with learning disabilities, integrated students and those who are simply slower than others. The teaching material becomes easier for them to understand and follow when they see it in a prepared structure. This will help them in creating their notes later. Dynamically processed teaching materials attract students' attention and facilitate the integration of acquired knowledge into wholes. Thus, students can understand the given topic faster and learn the teaching material more efficiently (Higgins, Xiao, & Katsipataki, 2020).

The use of information and communication technologies in the teaching process enriches our methods and impacts the course of the lesson. They significantly speed up the lessons since we do not have to draw pictures and sketches on the board, but in the explanation phase, we only show further steps and new elements. If we work with a projector, we can add a background to the sketches, pictures, and data to the prepared photographs and tables (Tondeur, van Braak, Ertmer & Ottenbreit-Leftwich, 2017).

Information and communication technologies can be used in the teaching process as teaching using digital teaching materials (animations, computer experiments, video recordings), for solving tasks, practising teaching material using ICT tools (interactive whiteboard, computer classroom), for digital written work, in electronic administration, outside the teaching process as teaching materials available to students online, for easier access to supplementary materials and information, for better understanding and deepening of the curriculum, in tests, and practice tasks (Jenkins, Clinton, Purushotma, Robison & Weigel, 2006).

3 The attitude of students to ICT tools

Students' skills in information and communication technologies primarily develop learning abilities. Secondly, our society also sets certain expectations in this area. The further the emphasis is placed on the so-called computer literacy among young people. Therefore, even elementary schools must provide space for teaching ICT competencies. In school practice, these competencies serve as a means to achieve educational goals and are closely linked to the ability to learn. ICT serves to strengthen the teaching process (Ertmer & Ottenbreit-Leftwich, 2010).

Technical skills consist of the actual use of computers and various information and communication technology devices and different software. This knowledge is not directly included in the teaching process but is an essential means of learning (Voogt, & Roblin, 2012).

Information and communication technologies develop the following abilities and skills of students: student cooperation, presentation skills, independent learning using ICT, and the ability to obtain and process information (Siddiq, Scherer & Tondeur, 2016).

4 Benefits of using ICT in the educational process

There are many advantages of ICT tools in the educational process. The most important benefits of using modern information and communication technologies in teaching include the following.

4.1 Presenting knowledge in an attractive form for students

Modern technology allows you to present information in a completely new way, which can be much more attractively processed visually and, therefore, more interesting and more easily acceptable for students. It is also possible to present knowledge in this form, the presentation of which would otherwise be impossible or would be very difficult to describe in words or individual static images (Henderson, 2020).

4.2 Studying at your own pace

Modern technologies allow students to choose their own pace at which they can study, the time, when and how much they want to research and where they want to study. This allows them to allocate their time much better and, on the other hand, forces them to take on more responsibility for their study results, developing the student's ability to work independently and effectively divide their time between individual activities (Kozma, 2003).

4.3 Immediate feedback

The use of modern technologies provides students with passive access to new information and knowledge and the opportunity to verify the acquired knowledge and skills. Feedback is usually provided to the student in two ways. In the first of these, the student receives feedback immediately. This method is suitable for acquiring knowledge when it is possible to prevent the student from developing bad habits immediately. In the second method, the student receives feedback only after a specific time, for example, after completing a test, answering all questions, etc. In this case, the provision of feedback is often triggered by a specific action of the student by which he requests input (Henderson, 2020).

4.4 Motivation

The use of computer technology expands the possibility of motivating students. For example, many educational programs are processed as computer games. They have a powerful motivational charge, especially for children. Appropriate graphic and audio processing of the presented material also acts as a motivating factor (Kirkwood & Price, 2014).

4.5 Error warning

Students are much less bothered if a computer program warns them of mistakes they make during their educational process than if a teacher, classmate or parent warns them. Students often do not consider a computer program to be a teacher, even though it teaches them and verifies their acquired knowledge (Selwyn, 2012).

4.6 Possibility of simulating events

Modern technology allows us to simulate events in teaching that would otherwise not be possible to include in teaching because they would be too expensive, too dangerous, or take too long (for example, several centuries). In this area of education, the use of modern information and communication technologies is irreplaceable (Kirkwood & Price, 2014).

5 Conclusion

In the rapidly evolving landscape of education, the integration of ICT has emerged as a transformative force, redefining traditional teaching and learning methods. This paper has explored the critical role of ICT in modern education, emphasising its potential to enhance engagement, improve learning outcomes, and equip students with the skills necessary to thrive in a technology-driven society. From fostering creativity and collaboration to enabling personalised learning and immediate feedback, ICT tools provide unparalleled opportunities to make education more accessible, dynamic, and inclusive.

The benefits of ICT extend far beyond mere technological adoption. By enabling visually enriched and interactive presentations, students are more engaged, motivated, and able to grasp complex concepts. ICT facilitates individualised learning, allowing students to progress at their own pace and develop a deeper understanding of the curriculum. Furthermore, its ability to simulate real-world scenarios offers learners a hands-on approach to problem-solving and critical thinking, skills that are essential for personal and professional growth.

Moreover, incorporating digital literacy as a foundational competency underscores the necessity of preparing students for the challenges of the modern era. Educators can bridge the gap between academic learning and real-world application by equipping them with the ability to critically evaluate information, communicate effectively, and use digital tools responsibly. Digital literacy, combined with the infrastructure provided by ICT, creates a synergistic relationship that fosters lifelong learning and adaptability.

The societal expectation for ICT integration in education highlights its growing importance. As parents, students, and educators recognise the value of digital tools in enhancing the clarity and efficiency of teaching, the demand for ICT-enabled education continues to rise. Its applications, from classroom instruction to extracurricular learning and administrative processes, demonstrate its versatility and far-reaching impact.

In conclusion, ICT is not merely a supplementary tool but a cornerstone of modern education. By leveraging its capabilities, educators can create an environment that is engaging, efficient, and tailored to the diverse needs of learners. The ability to present knowledge attractively, provide immediate feedback, and simulate otherwise inaccessible scenarios ensures that education remains relevant in an ever-changing world. As we embrace these advancements, the focus must remain on harnessing ICT to cultivate a generation of critical thinkers, problem-solvers, and innovators equipped to navigate the complexities of the digital age.

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Career counseling

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Abstract

After completing primary school education, each of us is concerned with the question of what to do next, what direction to take, what job and related education to choose. Most often, these questions are addressed by adolescents before entering high school and university. Young generations are increasingly demanding in terms of the quality of education, employment, but above all the quality of their personal lives, and they much prefer their free time, where employment and financial resources are the means to fulfil this time and goals. Work (employment) is therefore not a priority for the youngest generations; rather, it is a means of self-realization. According to a Gallup poll in the US, 62% of adults of all ages would not choose the work they currently do if they could start over. (1997 NOICC/NCDA, Gallup Poll, USA). Choosing a profession is a crucial decision at the beginning of a professional career.

Keywords: Preference, Counselling, Professional Career

1 Work Assignment

To ensure maximum efficiency in employee performance at their posts, as efficiently as possible, it is necessary to consider psychological factors in addition to health and qualifications when assigning work. These include psychological insights from the fields of career counselling and work psychology which are valuable for effectively placing employees within organizations. The old principle of both disciplines—'the right person in the right place'—is well-known and still valid. Consider how often we find ourselves dissatisfied with the work of craftsmen, managers, politicians, or our children's teachers.

Optimal work assignment means finding a job for the employee that allows them to fully utilize their best abilities and qualities and, from the employer's side, allows all functional positions in the organization to be filled by employees who bring the greatest benefit to the company. This benefit lies in labour productivity, worker stability, and possibly even in their innovative activities for the organization. When properly assigned, an employee's abilities,

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qualifications, and motivations are fully utilized to the institution's advantage. If a person is inappropriately employed, they develop their creativity and spend most of their energy outside the work framework. It is known that a person's work and life satisfaction depend on the degree to which they can utilize their abilities, personality traits, needs, and interests in their job—therefore, realizing themselves. More and more people in this new millennium are looking for meaningful employment that provides more than just income to cover basic life needs. For example, according to a Gallup Institute survey in the USA, 62% of adults (of all age categories) would not choose the type of work they have if they could start over (1977 NOICC/NCDA, Gallup Poll, USA).

Career counselling currently has its broad scope, especially within educational counselling at primary and secondary schools, where it is handled by educational advisors. In pedagogical-psychological counselling centres, career counselling is conducted by psychologists. The prevailing form is individual work with students who are undecided or with students with altered work capacity. Psychological examinations are also part of the counselling activities provided by psychologists. Career counselling in the Czech Republic and Slovakia is also developing in the Ministry of Labor and Social Affairs sector. Each employment office has an information and counselling centre—a counselling unit, for which career counselling is a basic job description. Professional counselling is also provided by personnel agencies.

The legislative framework for career counselling in the Czech Republic is formed by Decree 72/2005 Coll. on providing counselling services in schools and (school) counselling facilities and the Council of the European Union decision of July 12, 2005, on the main directions of employment policies of member states (2005/600/EC). Counselling is also provided by employers, who are increasingly taking responsibility for the career development of their employees, as the average adult changes jobs several times during their career (in the USA, an average 20-year-old entering the world of work changes jobs 6-7 times; Carney Wells, 1987, p.3).

Counselling cannot be just a one-time help to a young person at the end of school but should continue throughout the entire working life. This is evidenced by research conducted on a sample of 181 adults who used the services of career counsellors during their university studies. Up to 78% of them were satisfied or very satisfied, and 85% said they followed the advice that concerned further education or a change of profession. (Healy, 2001, p. 364).

In one of the works devoted to career counselling, in the book *Applying Career Development Theory to Counselling*, the author emphasizes the importance of career counselling with fitting words: "The awareness that a few hours dedicated to counselling can change an individual's life is an exciting challenge for a career counsellor." And further: "There are several types of counselling, such as personality counselling, crisis counselling, and psychotherapy, but few counselling situations can have such far-reaching consequences as career counselling." (Sharf, 1992, p.1).

From an economic perspective, the cost of the work produced by an average worker employed for 40 years is over 21 million crowns at today's indicators. Such an investment is usually

decided upon by a commission of experts over several days. Career counsellors, therefore, have a great responsibility for the future of not only their clients but indirectly for the economy's efficiency because tomorrow's resources are in today's school classrooms.
Particularly significant is the fact that the right to career counselling is enshrined in the European Social Charter. (Štefan Vendel, 2008, p. 15-18).

2 Analysis of the Work and Needs of Career Counsellors in Schools

The survey mapped five main areas related to the work of educational - career counsellors in primary and secondary schools. The aim was to create a typical profile of a current school counsellor and also to determine what conditions this counsellor has for providing counselling at school, what their typical job description is, how they, or the school, promote it, who their typical clients are, what topics they most often deal with, and what kind of support, which would improve, streamline, or facilitate their work, these counsellors would welcome.

Who is involved in career counselling in schools?
Each of the contacted schools has a person designated by the principal who directly deals with this issue – usually, it is a counsellor who is sometimes still referred to as educational, sometimes career, and sometimes educational-career. At the same time, teachers who are in daily contact with students and can also deal with topics related to career choice, and who also work on this issue within cross-curricular topics, are also involved in career counselling. In secondary schools, according to respondents, topics of educational and career path choices for students are also dealt with by, for example, special educators or school psychologists.

How do counsellors in schools perceive the role of schools, labour offices, and pedagogical-psychological counselling centres in the field of career counselling?
Counsellors in both primary and secondary schools see an irreplaceable role for the labour office in specific areas that directly fall under career counselling or are related to it. They also recognize the significant role of both primary and secondary schools. Generally, counsellors in primary schools place greater importance on the role of primary education, while counsellors in secondary schools emphasize the significance of secondary education. The role of pedagogical-psychological counselling centres is seen by counsellors from both levels of schools as crucial in the area of testing and diagnosing study potential. Additionally, counsellors at both levels of schools see their role in providing comprehensive individual career counselling. In the areas of career counselling directly related to the labour market and employment, however, respondents view the role of these counselling centres more as complementary (compared to the role of labour offices and schools).

3 Summary

Career counsellors in schools are most often women with pedagogical education, of middle age, with an average of 6 years of practice in educational and career choice counselling. They usually perform counselling alongside teaching and often hold additional roles within one employment contract. They do not have enough real-time space for counselling practice. Only 2/3 of counsellors are involved in preparing or implementing the cross-curricular topic of Man and the World of Work. In terms of offered counselling services, counsellors rate their school's information service for students as the best. However, the provision of career counselling information for the parents of these students is not always sufficient. The promotion of these counselling services outside the school (e.g., for future students) is minimal. The use of web portals differs between primary and secondary school counsellors. Primary school counsellors prefer portals that offer student testing, whereas secondary school counsellors favour those focused-on career choices and professions. Regarding collaboration with other entities in the education and labour sectors involved in career counselling, counsellors consider labour offices and Information Counselling Centres (IPS) to be key partners.

The topics discussed with clients are very similar in both primary and secondary schools, differing mainly in frequency: the level of school (primary vs. secondary) and the type of secondary education (general vs. vocational) determine how often a counsellor encounters certain topics in their practice. Respondents at both levels of schools would welcome support mainly in access to information on career counselling in the Czech Republic and tools they could use during counselling practice (including access to methodologies). In primary schools, access to legislation related to career counselling and the ability to share information with colleagues (through personal meetings) are also highly valued. In the area of education support, the choice of topic significantly influences the choice of form (face-to-face, distance, combined). Overall, respondents preferred e-learning courses and then face-to-face courses. There is a slight preference for basic-level e-learning courses and for interactive, advanced-level face-to-face training (Drahoňovská P., Eliášková I., 2011, p. 48).

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To the Roots: Engineering Pedagogy

On the Influence of the Quality of Education on the Quality of Human Personality

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Abstract

The education of a person in general, is the beginning of the consciously guided birth of their spirit, the determinant of the development of their intellect. Through high-quality teaching of the population, it is possible not only to improve the personality of a person as an individual, but also to condition the positive development of all social relations. A well-educated individual becomes an actor of social progress through high-quality teaching. As a result of education, or teaching as a dynamic process is achieved education as a static state. Only the appropriate motivation of the worker, both material and non-material, always leads to the achievement of the required quality of work. The quality of teaching determines the quality of education and, indirectly, the quality of a person's personality. The quality of any school, particularly universities, largely depends on the quality of incoming students, including their level of motivation. At the university level, the foundation of educational quality lies in the added value provided by university teachers. In order to achieve the required quality of education, which determines the quality of each person's personality, it is necessary to implement rational organisational measures, educational measures and especially conceptual content measures in the heterogeneous system of the Slovak educational system. The problem of approaching or achieving world standards of education quality and achieving a generally accepted level of quality education is a long-term open problem in Slovak social conditions.

Keywords: Teaching, Education, Quality, University

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1 Introduction

The quality of a person's personality is, among other factors, usually directly proportional to the achieved quality of their education. At the same time, a person's education is the result of their learning. Maintaining its essence, the process of educating a person is primarily a sum of knowledge received individually, conveyed to them through the implementation of sophisticated procedures, which are offered to the educated individual by their immediate biological and social environment, including the use of a special institutionalised educational system. Teaching is thus a historically created summary of supporting specific procedures, conditioning the qualitative level of life of an individual and a certain human community. The result of learning is education. In this context, it is necessary to emphasise that the present life of humanity is indisputably a product of its lived past. It can be said that it develops depending on the cosmic, geological, biological, economic, social, political, cultural, religious, legal or other reality.

The past of each individual, forming their 'personal history,' as well as the collective past of humanity, has always been and remains the foundation for shaping the present. Consequently, the present serves as the seed and source of both the near and distant future of the human community. Figuratively speaking, the present 'dresses humanity in new clothes' with which it will present itself to the future. However, humanity cannot 'cut and sew' this 'dress' solely in its own interest or according to the fashionable developmental trends of the times. While the saying 'clothes make the man' is gaining prominence in today's society, we must not forget that it is the individual—and the quality of their spiritual values, not their attire—that is essential for the preservation of life on Earth. Especially because humanity, not only as a biological species, but above all as a rationally organised community with all its material and spiritual attributes, pluses and minuses, is currently going through a developmental stage of total internal transformation. That is, a global psychological, ethical, political, confessional, social, and perhaps even active biological transformation. Considering the current controversial development of human society, absorbing the variable factors caused by these transformations and others associated with them, interfering with the life of mankind, appears to be an extremely complex and global problem.

Solving the problems connected with this latently and already openly ongoing process, 'overflowed' in content with many internal procedures, will undoubtedly have many confrontations. These clashes will create conditions for the emergence of a wide spectrum of 'social brakes', aimed at the very essence, and not only at the simple direction of the already started process of fundamental transformation of the life of human society. Because to 'digest' the results of the complex transformation process, the so-called Western values will be very painful for humanity as a whole, conflicting and in terms of outcome also uncertain, we can expect a really open 'clash of values' of currently existing civilizations. To a considerable extent, if not to a decisive extent, determined by the currently accepted worldview and 'living' according to the rules determined by it. Reducing the tension between individual civilizations and trying to eliminate the emerging value disharmony leading to their confrontation can therefore be effective only through such individuals and their communities that have a moral character with the parameters of mature personalities. However, the personality quality of such individuals is positively determined above all by their education. Insufficiently educated, or an uneducated individual cannot even perceive reality, let alone understand it. It cannot become an integrated personality! In these coordinates, it is necessary to perceive the teaching process as well and closely connect it with the process of raising a person. The quality of teaching and education is therefore a coin that may have more than just two sides. Regardless, its achieved and attainable level depends mostly on two starting subjects, that is, equally on the quality of the teacher as well as on the quality of the student. Like everything in real life, quality also has its roots and spices.

The roots of the quality of each, and especially of a university, mainly depend on the quality of entrances, that is, on the quality of personal training and the achieved degree of motivation of students coming to the university, or in general to the environment of any types and kinds of schools. We remind you that an essential tool, especially for successful university teaching and achieving university education, is the highly individual interest of the student in studying the chosen field. *The spice* of the quality of university education is a certain added value, the bearers of which are university education teachers. They too must have been successful university students at one time. Quality, that is, not only adequately qualified, but also moral. The fulfilment of this requirement, which is based on a legitimate social order, should also correspond to the establishment of the academic function of vice-rector, or vice-dean for quality and its inclusion in the structure of academic functionaries of each university. To the novelty of creating vice-rectors and vice-deans for quality and development at Slovak universities, it is necessary to add that if their work is to have any real meaning, they will have to, from the point of view of university management, focus mainly on the issues for which they were appointed. Already today, tangible attempts to make them a 'girl for everything' will naturally not lead to the set goal. It is, after all, the achievement of a high-quality university – educated personality and, in general, the all-round development of the human spirit!

The question is whether this goal is realistically achievable in Slovak social conditions today. It is essential to start from the thesis that every goal can only be achieved if it is realistic. And in Slovak academic conditions, this means whether an educated person really is, or should be, an attainable goal. The objective reality and the subjectively shaped social environment of Slovak society cannot yet be considered as a sufficient guarantee leading to the fulfilment of the set target horizon, which is the achievement of a dominant, not just sufficient, influence of teaching on the achievement of a high quality of the personality of every educated person (Králik, 2020, pp. 103-126). The problem today is the contradiction between mass and selectivity, and not only in academic education. Until recently, teaching was focused on a person according to its personality disposition, depending on its objective mental prerequisites. Therefore, the teaching of a person always corresponded to the objective personality characteristics of the individual. Natural, both mental and physical. The so-called

Western European value orientation of society has 'erased' such differentiating approaches of educational institutions and their personnel substratum to learning corresponding to human individuality, characterising the individual. Naturally, this is precisely why the 'universalization' of education, which significantly distorts society in perspective, has occurred. Education has increasingly become a commodity offered en masse in the dubious 'educational market.' Its real value and nominal price, reflecting its achieved objective quality, are constantly declining in Slovak educational circles—due to both objective and subjective factors. Moreover, education has been 'detached' from the educational process, leading to its importance for society being increasingly called into question. This fact is directly related to university education.

Therefore, the goal of any Slovak university, funded by public resources, must not be the excessively costly production of qualified illiterates at any price. Additionally, the process of cultivating individuals has become 'detached' from teaching, leading to its importance for society being increasingly questioned. This issue directly concerns university education. Therefore, the goal of any Slovak university, funded by public resources, must not be the excessively costly production of degreed illiterates at any cost. It is therefore necessary to immediately begin filling teaching positions exclusively with individuals who truly have the necessary qualifications and the genuine desire to teach. These are individuals who possess the ability to meet the requirements for their own:

- integrity,
- morality,
- patriotism,
- loyalty,
- qualification,
- competence,
- responsibility.

This is also directly related to the process of selecting academic officers of public and state universities. The belief that an academic title or position awarded 'just for decoration' is a growing tumour on the body of the nation’s teaching and the education of a specific individual has not lost its relevance! And therefore, especially the university itself. Finally, the dubiousness of the quality of a university teacher is clearly presented by the 'production' ensured by them of a number of low-quality but nevertheless published pseudo-scientific products in the content of professional literature in journals and anthologies. The ongoing explosion of the 'production' of dubious university professors and associated professors confirms that the incompetence of the quality of education, not only teaching, is a permanent, everyday Slovak problem. The way out of this intellectual chaos of society certainly depends on the reasonableness, honesty, willingness and responsibility of all those who 'deal and shuffle the cards' today. Above all, this applies to people working in the political and executive branches of power operating in the state. In order to ensure quality teaching of members of

the Slovak nation, it is necessary to immediately eliminate such academic functionaries who represent only 'academic mimicry', and their lifelong work is only a kind of camouflage, covering the mystery of their personal character, morals and insufficient professional maturity.
Therefore, in order to guarantee the material and spiritual prosperity of the population and to achieve the goals in the education of the nation in the future, the sources and causes of defects must always be revealed, analysed and published in a timely manner, including the originators and bearers of negative development tendencies, destroying the individual procedures forming the fiery chains of the teaching process. Teaching must serve the spiritual uplifting of the nation. The task of the current state leadership is therefore to discover, not to defend, the damage already done to the intellectual potential of the Slovak nation by the long-term 'lack of teaching'.
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1 Quality of education vs. the quality of a person's personality

The views of a human and society on one and the same issue, as well as on a person, can naturally change. Change is a natural process, but it does not always act as a clear accelerator of social progress. It often becomes a tool leading to retardation. This statement can also be applied to the historical context of school reforms. These reforms did not always bring the social benefits that society expected from them. Especially because they were often motivated not only by the personal or material ambitions of a specific individual or a certain collective, but also by the simple passage of time. At the same time, it is natural that reforms of the educational process should only be undertaken when the conditions of life in a certain society change more significantly. Therefore, the newly acquired collective experience, based on facts, is closely related to the process of improving the quality of teaching (Králik et al., 2021, pp. 155-170).
With the newly obtained education, acquired through high-quality teaching, confirmed by the newly gathered more sophisticated outlook and insularity of an 'educated' person, the individual's chances for their social application increase logically. It is then logical that the views of different people on the same thing, person, event and situation also vary more and more. This is also the case with the view or opinion on the achieved quality of education. However, teachers and students and their parents have a task of revealing the true essence of the problem of teaching quality to other sections of society. Therefore, it is necessary that

high moral demands are placed on the personal equipment of educators, without distinction, that is, regardless of the level of institutionalised teaching of the population at which they work. Only in this way can teachers, who have consciously and voluntarily linked their fate to that of the people they teach, responsibly fulfil their social mission and work tasks. Special duties performed for the benefit of citizens, i.e. at the historically generally established moral level required, i.e. above all in accordance with 'written and unwritten' rules preserving and defending human dignity. From this point of view, the state has the task of creating objective assumptions, i.e. to create a suitable organisational and institutional basis of public administration, aimed at the fulfilment of specific tasks, the aim of which is to guarantee the successful operation and development of its own teaching and educational system.

The organisational-institutional base of the educational system therefore consists of a compatible school system and its management entities. It should be emphasised that the key personnel base of the educational system, which actually fulfils the tasks required by the company, or by the public, is created by educators. Therefore, it is necessary not only to ensure the requirements and optimal conditions for their work. The convergence of the quality of the organisational-institutional base of the educational system with the quality of its personnel base conditions the quality of the company's performance of assigned tasks. Fulfilling the tasks set by a member of the personnel base of the educational system is not only in the interests of the individual shaping of their own personality, but the teacher must also contribute to the formation of the resulting form of a person as a moral, hardworking, responsible, honest, self-disciplined, constantly self-educating and incorruptible member of the community. That is, potentially also a real professional of a truly professionally functioning state apparatus.

The need for social control and monitoring of the fulfilment of the moral requirements imposed on the implementers of the educational system and the teaching process has been addressed several times more prominently by a wider circle of the Slovak public in recent years or redirected to the environment of universities. This public attention towards universities was often accelerated by mediating the immoral behaviour and actions of some university teachers towards university students, including their academic officials (Čapák, 2024).

Unfortunately, some rectors and deans at Slovak universities have joined this undeniably decadent circle of deformers of the educational process. Naturally, this issue requires special attention from the authorities in positions of state power. Increasingly, it is the media revelations of these contradictions that serve a clear, though rationally determined, goal: to rid the teaching process of those responsible for amoral, and even criminal, acts of destruction. (Valkovičová et al., 2021, p. 115).

Revealing the negative manifestations appearing in the teaching of the young generation is not meant to question and subsequently subvert the historically constructed social arrangement of the Slovak national community! On the contrary, it is particularly dangerous to ignore attempts at the ideological transformation of society carried out in the area of population teaching. And this also from the side of cosmopolitan-oriented political subjects. That is why a 'fragile', i.e. morally and legally non-standard relationship should be characterised as a 'defect: teacher vs. pupil/student' subject of wider and deeper interest of the relevant state authorities, but also of all sections of the Slovak public. It must remain in the centre of attention not only of the relevant state bodies, but also non-governmental bodies and federal institutions, such as e.g. Matica slovenská [the Slovak cultural and scientific institution]. It is necessary to start from the fact that every community of people, regardless of its size and structure, requires a 'thinking head' if it is to function optimally in normal and especially in heated situations. Thus, a collective composed of individuals must have its leader, director, manager, monarch, bishop, pope, or any other designated organiser of the full-fledged life of a collective of people.

The leader of such a diverse association of individuals usually becomes the primary guarantee of the success of the collective led by them. Of course, only if the leader has a natural innate talent or skills to lead a team in a sophisticated manner and at the same time also the relevant, more or less acquired abilities, skills and habits. And actually acquired, not just formally registered education! Above all, however, the moral strength and resilience of the collective leader becomes a fundamental pillar of their own personal growth, which becomes a potential model and example for the behaviour and actions of other members of the community they lead. The leader must lead, positively influence the members of the collective under their guidance, inspire activity that fosters respect, and, without seeking personal aggrandizement, cultivate in them a sense of respect for both natural and external authorities. Of course, the leader of a particular social formation, company, state, or corporation also bears responsibility for the success, development, and well-being of the members and the entire 'managed' collective. Therefore, they must have responsibility directly within themselves. This balance of subjective and objective responsibility has actually been required for millennia from anyone who leads a certain group of people to a certain goal. However, especially an educated person, a personality, most often becomes a natural leader, a spiritual authority that should be worthy of following. This requirement is particularly pronounced in the set of parameters imposed on members of the state’s pedagogical components.

We have already stated that a leader – teacher, if they want to be successful and respected, must meet the specified qualifications, but also beyond this the required character, moral, professional and other personality criteria. Only then does a member of the team of teachers under their leadership perceive the quality of their personality as a guarantee of the quality of the work performed. However, also each of the subordinate members of the team of educators should also incorporate these characteristics of their formal and informal supervisor into their own personality. They should consciously try to apply them in their daily activities, particularly in their behaviour within the collective and in public. At the same time, in the interests of protecting the entire society from the spreading promotion of violent resolution of mutual disputes or war by extremist ideological deviations of some civil communities, the educator should clearly prefer to educate the pupils or students they lead to peace, even lead them directly against the solution of 'resolvable' conflicts by war. An academic official performing leadership roles on campus must therefore, in addition to their own 'internal' character traits, also meet certain 'external' basic conditions, so that their work among their students matures into the desired form and results in the fruits of universally acceptable shaping of their personality. Teaching, a quality pedagogical activity of a quality educator, is therefore an important form of shaping the spiritual base of a person, so that humanity can live for the next millennia of its own existence. Within the range of these conditions and assumptions of accepting the external behaviour of the spiritual leader of the present, i.e. and any teacher and academic functionary, therefore, in principle, it is possible to bet primarily on the demand for their:

a) healthy patriotism,
b) social feeling,
c) respect for traditional values,
d) natural helpfulness,
e) the ability to communicate rationally,
f) ability to motivate,
g) the ability to differentiate responsibility,
h) ability to reward,
i) ability to advise.

A centuries-old Slovak folk proverb states, "A healthy person has a thousand wishes, but a sick person has only one." If we extend this folk wisdom to describe the location and state of social relations developing between today's increasingly polarised Slovak communities, then the mission of the educator in the service of the state can be understood as socially irreplaceable and irreplaceable in the interests of its peaceful maintenance 'in a state of peace' (Králiková & Králik, 2023, pp. 13-22).

The bipolarity and reciprocity of influencing the personal growth of subjects in the teacher-student relationship, the essence of which is teaching (and education), must be adequately balanced and guaranteed by the public authority. The quality of teaching only transforms into the quality of a person's personality. In this context, we refer to a legal principle commonly known from ancient Roman law: *nemini sua liberalitas damnosa esse debet*, which translates into English as "no one should be harmed by their own honesty (or magnanimity)" (Rebro, 1986, p. 174).

However, it seems that even in the 21st century, this principle is still only alive in human society and in the Slovak legal environment it only achieves the form of the wish of a few legal idealists. The moral parameters of a part of the current personnel substrate, and not only of the only Slovak academic workplace, revealed by the observational method, present a real ongoing problem of the dignified position of a person in the workplace, in the work team (Králik & Králiková, 2021, pp. 153-171).

In the end, knowledge of the current social microsphere—which both influences and regulates the social relations that shape it—can be highlighted with these words. This microsphere is primarily represented by the environment of the academic workplace, for which typical social or interpersonal relationships arising, developing and disappearing within more or less closed community. Deformations of interpersonal relations at the workplace, labour relations, arise and metastasize in a deformed, corrupt work environment. Such an unhealthy atmosphere for people and work has a counterproductive effect, especially in the environment that is supposed to provide education to the younger generation. In schools that are supposed to be role models for educated generations of youth. However, if a teacher finds themselves in a workplace heavily fuelled by brutal nepotism, clientelism and bossism, they will desperately try to teach the widest possible range of students who have already been professionally prepared (Králiková & Králik, 2021, pp. 25-37). In other words, to teach productively and with high quality. In other words, to teach productively and with high quality. To the detriment of the efficient, responsible and honest pedagogic worker, in the deformed academic environment of the university, their fruitful publishing activity is often the cause of envy of their unproductive colleagues. If they spend their personal professional energy on finding non-traditional ways and forms of improving the teaching quality of their students, they encounter a similar reality. The voluntary work of such an active teaching staff, beyond the scope of their working hours, but for the benefit of students during the period they have reserved for the use of their free time, is also in vain and undermined by the clientelism of corrupt leading academic officials, e.g. rector, vice-rector, head of department.

A pedagogue who strives to improve the quality of the pedagogical process, who fills classrooms with students, addresses them with their presentations and through thoroughly elaborated innovative projects, is still not a desirable person in some academic workplaces. And if so, then demoralised colleagues, including superior academic officials, often try to interfere with their work. Such ways lead to the moral abandonment of the entire academic workplace. An active, high-quality teacher with excellent work results often has to endure both hidden and open bullying. The danger and threat to the otherwise unproductive working group of 'academics' is often considered to be precisely the person of such a teacher who acts directly, selflessly, creatively and honestly in working relationships. They become dangerous to their morally rotten and stupid surroundings with their own open attitudes, consistency and diligence, morality and character. They are therefore their natural enemy and a 'grateful' target of most career-unsatisfied, but all the more refined intriguers, envious and careerists who crave power (Králiková & Králik, 2022, pp. 37-48).

People who will stop at nothing. An educated and morally strong pedagogue who submits their work in the required quality is, however, an irreplaceable human capital, guaranteeing the high quality of the teaching process carried out by them. However, it is for this very reason that senior academic staff who have succumbed to the deformation of their personality often do not achieve an objective assessment of their work performance. In practice, they are not offered or paid any financial reward for their above-standard and honest work. It is also neglected in moral evaluation. In other words, a staff with poor quality in terms of personnel hides behind the high quality of an individual's work. Colleagues of such an individual who are passive in terms of work and publication participate, but equally, in the target rewards for the work actually performed only by them. From this observed real, true and personally verified academic experience, it follows that for the staffing of positions in a certain academic environment, the requirement of an acute legal solution to the problem of the quality and development of academic education could still apply, because in the Slovak academic environment there is still a long-standing problem of security human dignity in working relationships.

As a result of the mentioned facts, a wider spectrum of social contexts persistently emerges to the surface. Especially the problem of the morality of social relations pulsating in the microsphere. That is, in the micro space of a specific workplace, in which a part of the human population spends the greater part of its biological life in the economically dependent position of employees. Often at the expense of themselves and their family. The truth is that the morality of labour relations can certainly be ignored by employers as a redundant phenomenon, only subsidiarily accompanying the primary goal, which is the economic effect in their interest of the implemented work process. To a large extent, from employers' point of view, the quality of interpersonal relations at the workplace can be ignored and only taken care of if it directly harms the work performance of their employees. However, the reality is that the achieved qualitative parameters of labour relations are directly reflected in the qualitative parameters of economic relations and their results. That is, also to the teaching and education of the nation.

Quality work and its results are interconnected. A company whose primary goal is generating economic profit has an enormous interest in the desired quality of economic relations. Let's also acknowledge the value of moral or spiritual gain, and, importantly, the social profit that comes from ethical, spiritual, or moral considerations. However, this profit is still in a subsidiary position in the current Slovak academic society. It remains more or less degraded in value. It follows that the social positions in the third decade of the 21st century were probably definitely emptied by such a creative academic work team, whose members perceived the social or interpersonal relations at the workplace in terms of mutual respect and self-respect, creation of an atmosphere of justice, respect for each other, mutual participation in achieving work results, cooperative cooperation, professional belonging of work groups operating specifically on campus. The ongoing social situation brings to the surface the facts clearly determined by the immoral non-collegiality prevailing in the academic work team, the incompetence of leading academic workers, the professional lack of control bodies and social irrelevance in relation to academic education. To the control system according to Králik & Kútik (2013, 216 p.)

At the same time, it is an irrefutable fact that in order to optimally ensure the trouble-free operation of both the social microsphere and the work microsphere, the state must create optimal conditions for the performance of quality education of the population. In other words, to shape one's own educational system in a sophisticated way. This can be achieved through a rational and realistic approach to addressing the problem of a person's dignified position in society, particularly within the academic sphere. It is a problem that is always deep and open for a long time, even if it is a social phenomenon that has been resolved but not sufficiently solved, it is necessary to rationalise the structure of the entire school system of the Slovak Republic with special emphasis on the institutional foundations of Slovak university education. The centre of gravity of teaching the population should be shifted or transferred to educational institutions of a private law nature. In the interest of rationalising the budget management of the state, as well as in the interest of qualitative improvement and development of teaching. It can be said that every issue concerning a person's honour and human dignity, including in the workplace, is a "game with their education."

Despite this, it is probably also true in the socio-scientific field, in the exact sciences, and even in everyday life, that every action causes a reaction, and therefore every question has its own answer. If we accept the thesis that crime is undeniably a socially undesirable phenomenon, we must also recognize the view that any malicious disruption of interpersonal relations in the workplace is, in effect, "playing with the devil." Unfortunately, even in the structures of work collectives, even academically focused on the education and teaching of the population, one can notice an excess of such management officials who do not meet the basic prerequisites for qualified leadership, let alone the management of any work collective. Despite this fact, they remain in their positions for a long time for various reasons. It also concerns persons integrated into the performance of the highest academic functions, which negatively affects the organisation of the university and the quality of teaching of its students. Academic officials, whose qualification works can be considered extremely dubious (plagiarism, compilations), try to extract these works from all information databases.

The motive behind the implementation of this society harmful practice is to maintain its functional academic status, otherwise unattainable. It is obvious that such academic officials cannot be expected to have any real interest in improving the quality of the pedagogical process, in guaranteeing the solidity of publication outputs, i.e. ensuring the permanent development of the university they represent. The quality of the personality of the academic functionary of the university directly affects the quality of the other personnel substratum managed by them, while this set of academic subjects, i.e. academic staff, through the performance of a quality teaching process, directly affects the quality of the personality of a person formed by education.

2 Conclusion

A person is essentially a biologically created individuality, a subject, shaped by the centre of gravity of the surroundings in which they move and the environment in which they live. The personality of each person is thus historically formed in a system of objectively existing relationships, which show an economic, moral-political, legal and ideological character, e. g.

(Kovalev, 1967, p. 19). Under certain circumstances, the potential erosion and disruption of social relations is naturally reflected in the process of disintegration and disruption of the personal equipment of a certain part of individuals forming a certain society. At the same time, it is necessary to accept the natural fact that nepotism, mobbing, clientelism, stalking and bossing are to a large extent external manifestations of the internal personal psychological foundation of each individual person and are integrated into the heterogeneous complex of their human character. Although these are socially undesirable manifestations of the essence of a person's character as an individual, at the same time, these traits are also evidence of internal identification with the current social structuring of a certain community. These, in principle, phenomenon's retarding the individuality of a person and society, appearing in human society practically since its division into the strata of those who control and those who are controlled, survive to the present day.

Despite the fact that their demise was assumed in a communist, i.e. classless, society, and they were described as manifestations of the petty bourgeoisie, the truth of this thesis cannot be verified exactly. This is because humanity has never reached the developmental stage of communism. In the first development phase of communism, referred to as socialism, nepotism, clientelism, stalking and bossism existed, albeit in partially obscured, hidden and secretive forms. Slovak society continues to struggle, more or less unsuccessfully, with these manifestations of human character flaws to this day, including educational and academic environments. The aforementioned manifestations of a negative foundation and a defective orientation of the development of human character, as long as they control the personal equipment of the teacher, consequently, have an indisputable destructive effect on the quality of the education process implemented by them.

Criticism and self-criticism should therefore be perceived, especially by the academic staff, in a directed, constructive, calm, matter-of-fact manner, as a stimulus for reflection, and for the correction of the status quo and self-correction. A defective, i.e. low-quality, implemented teaching process directly incites spiritual conformity, retardation of thinking, emotional introspection, social ossification and even panic fear of one's own opinion in the subject of teaching. The insufficient quality of teaching and the education achieved must also be considered as one of the main causes of the backwardness of the individual and the nation. The poor quality and irresponsibility of education and subjects of teaching is a serious accomplice of the long-term persistent undesirable state of Slovak society. It exists as a consequence of the passivity of society as a whole, stimulating directly in its womb the survival and development of greed, laziness, falsehood, pretence, theft, and therefore directs the entire national community to universal decadence. Even criminality, which is transformed into the environment of work collectives, e.g. in the form of latent corruption and open patronage. Anti-social activity committed in this way has a negative impact on the destruction of labour relations. It mainly affects employees working in unprofessionally managed workplaces, which are led by immoral and characterless management employees, including academic officials (Šodor, 2024).

In the atmosphere of fear of losing their own job position and benefits, some 'ordinary' employees often second them in their destructive activity for selfish reasons. As 'favourites of the powerful', they expect certain benefits from their superiors, i.e. unauthorised and above-standard benefits, which are then denied to other 'unpopular' co-workers. The emergence, persistence and non-resolution of a tense situation persisting in interpersonal and, by extension, working relationships developing in educational workplaces, subsequently has a negative effect not only on the quality of the work of the entire team and its cohesion, but also has a destructive effect on the collective of educated pupils and students.

In order to achieve the required quality of teaching, which determines the quality of each person's personality, it is therefore necessary to implement rational organisational measures, personnel measures, economic measures, measures of raising a person and especially conceptual content measures in the heterogeneous system of the Slovak educational system. Otherwise, the problem of approaching, or achieving world standards of education quality and achieving a generally accepted level of quality education in Slovak social conditions will become a problem that will be open for a long time. This means that the problem of the quality of teaching and the quality of the education achieved, including ensuring a dignified position of a person in their workplace, especially in the position of a subordinate subject, is still necessary to evaluate as an open problem.

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Application of Computer Vision Methods for Information Security

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Abstract

Computer vision methods based on machine and deep learning are extensively used in information security for data protection and user authentication. Key applications include biometric authentication (face, iris, fingerprint recognition), which enhances security compared to traditional methods, and real-time video surveillance to detect suspicious behaviour and cyber threats like deepfakes and hacking attempts. Ensuring confidentiality also requires encryption at all processing stages. In the context of teaching computer science, particularly in areas related to cybersecurity and cyber-attacks this research serves as a valuable didactic method. By incorporating real-world applications of computer vision into education, instructors can enhance security measures to protect sensitive data. Through practical experiments, students gain hands-on experience with biometric technologies, deepening their understanding.

This article examines modern computer vision methods for information security, focusing on facial recognition and anti-spoofing in student registration portals, with an emphasis on data protection. Experimental work with students from L.N. Gumilyev Eurasian National University and Almaty University of Technology compared facial recognition to traditional password-based registration. Results demonstrated over 95% accuracy in facial recognition with anti-spoofing, significantly reducing unauthorized access attempts and strengthening data security. These findings indicate that this technology streamlines registration, provides

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enhanced security, and reduces the risks associated with manual or password-based systems on educational platforms.

Keywords: Computer Vision, Information Security, Biometric Authentication

1 Introduction

With advances in technology and the exponential growth of digital information, information security has become increasingly critical. Computer vision, driven by machine and deep learning, is now a key tool for data protection and user authentication. These technologies enable real-time visual data analysis, facilitating applications in biometric authentication and automated video surveillance.

Computer vision methods are applied in network security for detecting attacks or building security solutions, such as phishing attempt detection, malware detection, and traffic anomaly detection (Zhao, J et al., 2020, S. 15). One of the priority areas is biometric authentication, including facial recognition, iris recognition, and fingerprints. These methods not only simplify the identification process, but also increase the reliability of authentication, making them more effective compared to traditional passwords and PIN codes.

„Biometric authentication systems offer increased security and user convenience compared to traditional methods„ (Basare, A. et al., 2023). Computer vision is also actively used in video surveillance systems, where real-time video stream analysis allows you to detect suspicious behaviour and quickly respond to potential security threats. Such systems can detect anomalies in human behaviour or record unauthorized actions, which makes them an important element of modern security systems.

Face anti-spoofing (FAS) is essential for securing face recognition systems against physical attacks. Recent research has focused on long-distance surveillance scenarios, where low image resolution and noise interference pose significant challenges. Deep learning-based face anti-spoofing achieves remarkable performance and dominates the area, covering various novel components and applications (Yu, Z. et al., 2021). At the same time, data privacy issues are becoming a serious challenge, since computer vision systems often process personal information. This requires the implementation of additional measures, such as data encryption and protection at all stages of their processing, to prevent leaks and violations of users' privacy rights.

Computer vision methods are increasingly applied in network security for detecting phishing attempts, malware, and traffic anomalies. These methods leverage the growth of convolutional neural networks to build more secure networked systems (Zhao, J. et al., 2020). Face anti-spoofing (a.k.a. presentation attack detection) has recently emerged as an active topic with great significance for both academia and industry due to the rapidly increasing demand in user authentication on mobile phones, PCs, tablets, and so on (Li, H. et al., 2018).

This article is devoted to the analysis of modern methods and approaches in the use of computer vision to improve information security, a discussion of the risks and vulnerabilities of these technologies, as well as the prospects for their use in information portals, including student registration through facial recognition using anti-spoofing.
This paper is a valuable resource for computer science educators who seek to integrate modern technologies into the educational process, demonstrating to students the practical application of computer vision in ensuring information security. Additionally, the analysis of biometric authentication methods and their vulnerabilities aids in developing students' critical thinking and skills in assessing the security of systems in use.

1.1 Computer Vision in Information Security: Fundamentals of Machine and Deep Learning

Computer vision systems, capable of analysing visual data, are crucial in information security. Machine and deep learning methods form the foundation, enabling accurate object recognition and classification. These technologies are widely applied for data protection and user authentication, enhancing security and convenience.
"Computer vision methods are used in network security to detect attacks, build security solutions, and analyse traffic anomalies" (Zhao, J. et al., 2020). Techniques such as retrieval, indexing, annotation, and relevance feedback are applied to visual data for security purposes. These methods are used in surveillance, biometrics recognition, and digital watermarking to enhance security measures (Tao, D. et al., 2009). Machine and deep learning are the core of modern computer vision methods. Machine learning includes algorithms that can learn from a data set, identifying patterns and making predictions without strict instructions. Key algorithms for computer vision tasks include convolutional neural networks (CNN), which are used for image classification and object recognition, and recurrent neural networks (RNN), which are able to process sequences of images and videos, which is especially useful for analysing video streams in real time.
Deep learning methods like Convolutional Neural Networks, Deep Boltzmann Machines, Deep Belief Networks, and Stacked Denoising Autoencoders outperform previous state-of-the-art machine learning techniques in computer vision tasks like object detection, face recognition, and human pose estimation (Voulodimos, A., et al., 2018). Computer vision tasks also use platforms and libraries such as TensorFlow, PyTorch, and OpenCV, which provide a wide range of tools for building and training models. Using such platforms allows for the development of more complex and accurate models that are suitable for specific information security tasks, including biometric authentication and video surveillance.

1.2 Role in data protection and user authentication

Computer vision algorithms are already successfully used to ensure data security and user authentication. One of the most popular applications is biometric authentication, which allows identifying users by unique physical characteristics, such as a face or fingerprints. This approach significantly reduces the risk of unauthorized access, since biometric data is much more difficult to forge compared to passwords or PIN codes.

Computer vision applications can improve security surveillance by managing face detection, motion detection, person identification, tracking, access control, and interpretation of movement (Abdulhussein, A. et al., 2020). Biometric authentication is increasingly being adopted for data protection due to its ability to provide secure and convenient user identification. This method leverages unique physiological and behavioural traits to verify identities, offering a robust alternative to traditional password-based systems. Combining multiple biometric factors enhances security while maintaining user comfort and reducing login time (Vlasov, K. et al., 2023).

In addition, computer vision algorithms are used to automatically analyse video streams, where they help detect suspicious behaviour and anomalies. For example, the system can recognize attempts of unauthorized access to objects or record suspicious activity in protected areas. This makes video surveillance systems more accurate and reliable, reducing the workload of the operator and minimizing the risk of human error.

Face spoofing detection is crucial for maintaining the integrity of face recognition systems, especially in surveillance scenarios where the risk of spoofing attacks is high. Various methods have been proposed to address this challenge, each leveraging different techniques to improve detection accuracy and robustness. Face spoofing detection in surveillance videos can be effectively achieved using colour texture analysis, which shows excellent results compared to the state-of-the-art methods (Boulkenafet, Z. et al., 2016).

Consider the diagram in Fig. 1, which highlights key applications of computer vision in information security, including image classification, object detection, biometric authentication, and anomaly detection. This visual representation emphasizes the role and relative importance of these applications in enhancing data protection and strengthening security systems.

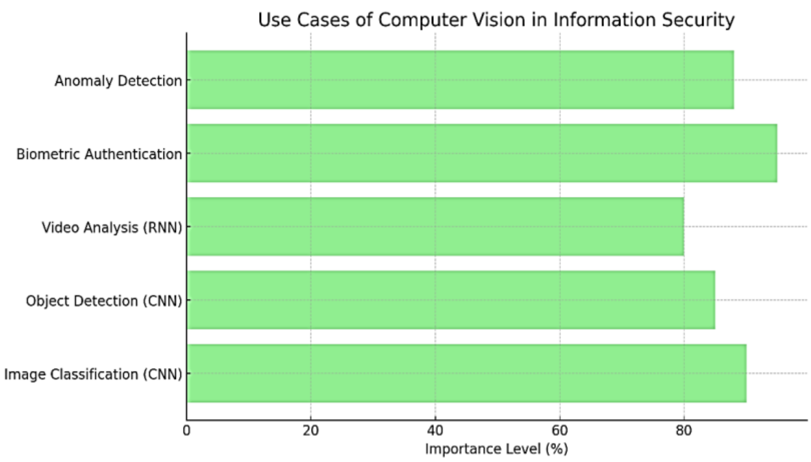

Figure 1: Use Cases of Computer Vision in Information Security.

Computer vision is an important foundation in safety detection due to its advantages in timeliness, accuracy, and intuition (Hu, C. et al., 2022). Thus, machine and deep learning methods in computer vision provide powerful tools for improving data security and strengthening authentication systems, making them indispensable in modern information security systems.

2 Biometric Authentication

Biometric authentication identifies users through unique physical traits, offering higher security than traditional methods like passwords or PINs, as biometric data is hard to counterfeit. Computer vision enables various biometric methods, such as facial, iris, and fingerprint recognition.

This chapter presents some identification methods, their application possibilities, and their advantages over classic data protection methods.

2.1 Facial Recognition: Methods and Applications

Facial recognition, a widely used biometric authentication method, employs deep learning algorithms like convolutional neural networks (CNNs) to analyse unique facial features, such as eye distance and chin shape. These systems generate a digital model of the face, which is matched to stored templates for precise identification.

Computer vision methods, particularly convolutional neural networks (CNNs), are being used to detect phishing attempts and malware by analysing visual features of websites and software (Zhao, J. et al., 2020). Deep Learning-Based Methods: Recent advancements have seen the use of convolutional neural networks (CNNs) and other deep learning frameworks to significantly improve face detection and recognition accuracy, even in challenging conditions (Mamieva, D. et al., 2023).

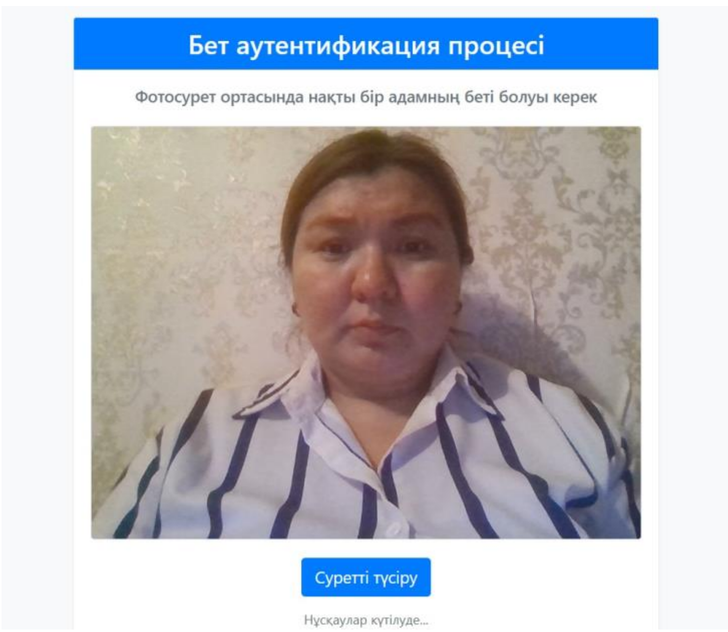

Figure 2: Demonstration of the face authentication process.

The image (Fig. 3) shows the screen of a biometric authentication system that recognizes the user's face for access. The system asks the user to take a photo of their face, and this image is verified in real time. This process highlights the convenience and accuracy of biometric authentication for secure access. Facial recognition is used to provide secure access to devices, objects, and systems. For example, the technology is widely used in smartphones to unlock the device, as well as in access control systems where the user's face serves as a "key" for entry.

Video surveillance with facial recognition helps identify suspicious individuals in real time, making this technology useful for ensuring security in public places. Face recognition is an efficient technique for identifying and verifying individuals in various fields, but faces challenges in unconstrained environments like pose, illumination, ageing, occlusion, expression, plastic surgery, and low resolution (Oloyede, M. et al., 2020).

2.2 Iris and fingerprint recognition

In addition to facial recognition, other biometric methods such as iris and fingerprint recognition are also widely used in security systems. Iris authentication on mobile devices is feasible using spatial histograms, but recognition accuracy is strongly affected by capture conditions (Barra, S. et al., 2015). Iris Recognition: This method is based on the analysis of the unique pattern of the iris, which remains unchanged throughout a person's life. The iris contains many individual characteristics, making it an ideal identifier. This method is especially in demand for protecting access to critical facilities and in situations where a high degree of accuracy is required.

Recent advancements in iris recognition have leveraged deep learning methods, including convolutional neural networks (CNNs) and capsule networks. These methods enhance the robustness and accuracy of iris recognition systems, even under varying lighting conditions and with limited training samples (Zhao, T. et al., 2019). Additionally, artificial neural networks have been explored, achieving high accuracy through various data partitioning techniques and pre-processing methods (Sibai, F. et al., 2011).

Fingerprint Recognition: One of the most common methods of biometric authentication is fingerprint recognition, due to its ease of use and high accuracy. Fingerprint image quality and password authentication require improvement, with graphical passwords showing promise for enhancing password method (Yusuf, N. et al., 2020). The unique line pattern on each person's fingers is used for identification in devices such as smartphones, laptops, and ATMs. This method is used for both personal security and large-scale systems that require large-scale identification.

Fingerprint recognition relies on two fundamental premises: the uniqueness and persistence of fingerprint patterns. Studies have shown that while the uniqueness of fingerprints is well-supported, the persistence over time can be influenced by factors such as the time interval between fingerprint captures and the quality of the fingerprint images. "Genuine match scores tend to decrease over longer time intervals, but recognition accuracy remains stable for up to 12 years if the fingerprint quality is high" (Yoon, S. & Jain, A., 2015). Biometrics-based authentication schemes, such as fingerprints or iris scans, do not have the drawbacks associated with passwords and smart cards, making them more attractive for multi-server environments (He, D. & Wang, D. 2015).

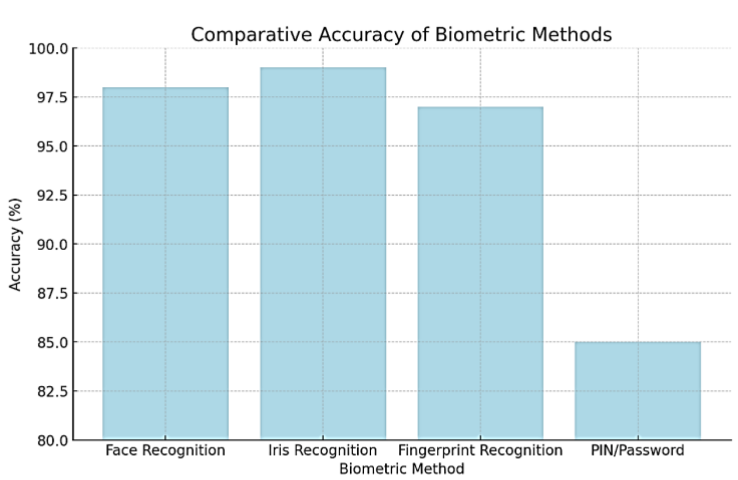

Figure 3: Accuracy of Different Biometric Authentication Methods.

As shown in Fig. 3, various biometric authentication methods such as facial recognition, iris recognition, fingerprint recognition and PIN/Password demonstrate different accuracy, providing a reliable level of security. Comparative accuracy of biometric methods shows that facial, iris and fingerprint recognition biometric methods are superior to traditional passwords and PIN codes in accuracy. These methods significantly reduce the likelihood of unauthorized access, making them more effective than traditional security methods.

2.3 Advantages over Traditional Methods

Biometric authentication has several key advantages over traditional security methods such as passwords and PINs:

- High reliability and security: Biometric data is unique to each person, making it virtually impossible to counterfeit. This significantly reduces the likelihood of unauthorized access and fraud.
- Ease of use: Unlike passwords, which can be forgotten or lost, biometric characteristics are always available to the user. The authentication process through biometrics is usually faster and more convenient for the user.
- Reduced risk of data leakage: Unlike passwords, biometric data is difficult to steal or forge, which reduces the likelihood of data leakage. For example, when using facial authentication in smartphones, the user does not need to enter a password that can be peeked at or stolen.

Consequently, biometric authentication not only provides a higher level of security, but also significantly simplifies the identification process, which makes it a promising alternative to traditional data protection methods.

3 Application of computer vision in video surveillance

Computer vision technologies enhance information security through data protection, biometric authentication, and real-time video analysis. Using machine and deep learning, these methods improve user identification and cyber threat detection. In video surveillance, they enable the detection of suspicious behaviours and unauthorized access, reducing the need for continuous human monitoring.

The application of computer vision in video surveillance has seen significant advancements, leveraging artificial intelligence (AI) and deep learning to enhance the capabilities of traditional surveillance systems (Idrees, H. et al., 2018). These technologies are crucial for securing confidential spaces, like government facilities and campuses, where facial recognition with anti-spoofing can add security, and behaviour analysis can flag unusual activities.

As part of the educational process, studying these technologies helps students understand modern security methods, develop critical analysis skills, and emphasizes the importance of protecting personal data. This awareness fosters responsible attitudes toward privacy and confidentiality in the digital environment.

3.1 Real-time video stream analysis

Real-time video stream analysis is based on deep learning algorithms that allow processing and interpretation of video coming from cameras with minimal delay. Algorithms such as convolutional neural networks (CNN) are used for object recognition and face identification, and recurrent neural networks (RNN) are used to analyse temporal changes, such as behaviour and movement of objects. Systems can detect behavioural anomalies, such as people staying in prohibited areas or aggressive actions and instantly notify the operator of possible violations. Behaviour Analysis from Video Streams: Systems designed for event detection from video streams use modular blocks to detect and track moving objects. These systems stabilize image sequences, extract regions with residual motion, and infer object trajectories to analyse behaviours in real-time. The system detects and tracks moving regions in a video stream, stabilizes the image, and infers their trajectories to generate likely scenarios.

Real-time video stream analysis has become increasingly critical with the proliferation of IoT devices and the growing demand for low-latency applications such as video surveillance, augmented reality, and autonomous vehicles. Effective management and orchestration of video delivery in multi-tier edge/cloud environments are essential for reducing latency and network congestion. Properly distributing video streams according to their requirements can significantly improve the end-user Quality of Experience (QoE). In 2022, 82% of all internet traffic will be dominated by video streaming, and proper management and orchestration of video delivery can considerably increase end-user quality of experience (Gama, E. et al., 2021). The use of video stream analysis is widely used in public places such as airports, shopping malls and transport hubs, where it is important to promptly identify suspicious activity and prevent possible incidents. In such systems, computer vision algorithms can automatically track and record activity, freeing the operator from the need for constant monitoring.

3.2 Detection of suspicious behaviour and cyber threats

Computer vision can detect suspicious behaviour, indicating potential threats. Algorithms trained on large data sets identify deviations like aggressive actions, unauthorized access, and unusual crowd behaviour. One of the current threats is the use of deepfake attacks, in which fake videos are used to deceive video surveillance systems or for disinformation. Computer vision combined with artificial intelligence techniques can identify such fakes by analysing the tiny details and inconsistencies that occur when deepfake videos are created.
Convolutional Vision Transformers, combining CNN and Vision Transformer architectures, have achieved competitive results with 91.5% accuracy on the Deepfake Detection Challenge Dataset (Wodajo, D. & Atnafu, S. 2021). Human ability to detect deepfake images is only slightly above chance, with an overall accuracy of 62%. Confidence in detection is high but not correlated with accuracy, indicating the need for automated detection methods (Bray, S. et al. 2022).
Face anti-spoofing (FAS) is crucial for securing face recognition systems against various physical and digital attacks. This process involves detecting and preventing attempts to deceive face recognition systems using fake representations such as photos, videos, or masks. Image Quality and Resolution: Surveillance scenarios often involve low image resolution and noise interference, which pose significant challenges for FAS. Techniques like Contrastive Quality-Invariance Learning (CQIL) have been proposed to address these issues by enhancing image quality and learning robust features under varying conditions (Fang, H., et al., (2023).
Anti-Spoofing Process in Facial Recognition is an important element of computer vision aimed at protecting against counterfeiting, including deepfake threats. This process includes the stages of image capture, liveness verification, and counterfeit detection, which allows the system to recognize a real person in front of the camera and prevent the use of fake images or videos to fool CCTV. When combined with artificial intelligence, anti-spoofing helps the system analyse the smallest details and detect inconsistencies characteristic of deepfake videos, minimizing the risk of disinformation and unauthorized access.

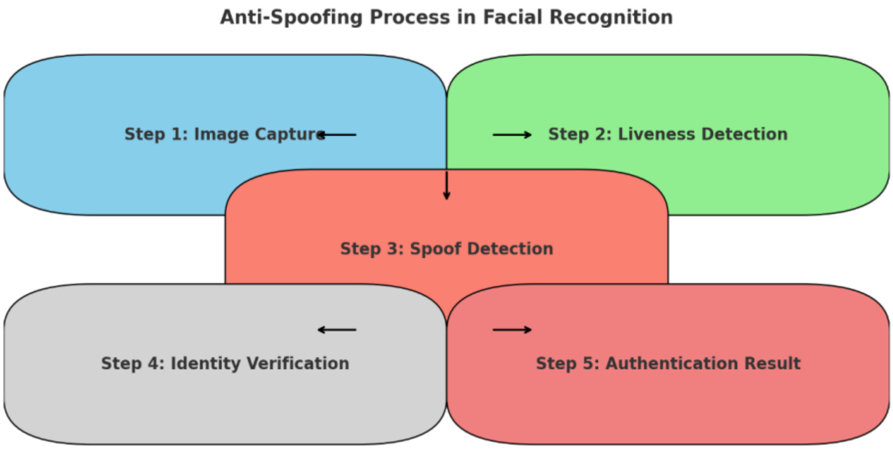

Figure 4: Use Cases of Computer Vision in Information Security.

This Fig. 4 is a step-by-step diagram illustrating the anti-spoofing process in facial recognition, from image capture to authentication and final identification.

The following steps are included:
Step 1: Image Capture – the system captures an image of the user's face.
Step 2: Liveness Check – it is verified that the person in front of the camera is real and not a photo.
Step 3: Forgery Detection – the system detects deception attempts, such as using a photo or video on the screen.
Step 4: Identity Verification – the face is compared with templates in the database.
Step 5: Authentication Result – the system accepts or rejects the access request.

The diagram clearly shows how the system recognizes the real user and excludes forgeries, providing protection against attacks using fake images. The anti-spoofing process in facial recognition involves a combination of contour detection, deep supervision, temporal analysis, semi-supervised learning, generalizable representations, quality-invariance learning, domain adaptation, spoof trace disentanglement, and fine-grained detection. These methods collectively enhance the robustness and accuracy of face anti-spoofing systems, ensuring better security and reliability in face recognition applications (Wang, H. et al., 2023).
These technologies are also used to protect video surveillance systems from being hacked. For example, algorithms can detect suspicious activity on the network, such as attempts to unauthorizedly access cameras and recordings, and warn operators of possible cyberattacks.

3.3 Capabilities and Limitations

While computer vision greatly expands the capabilities of video surveillance, there are certain limitations.

Capabilities:

- High accuracy and automation: Deep learning algorithms allow for high-precision video analysis, automating the threat detection process.
- Real-time response: Fast processing of video streams allows for immediate response to suspicious activity, increasing the effectiveness of security systems.

Limitations:

- Technical challenges: Cameras may have problems in low light, crowded conditions, or adverse weather conditions, which may reduce recognition accuracy.
- Privacy issues: Video surveillance involves data privacy, as cameras record people's movements and actions. It is important to comply with legal regulations and ensure the protection of collected information, especially in public spaces (add citation on privacy issues in video surveillance systems).

As a result, the use of computer vision in video surveillance provides significant opportunities to improve security but requires attention to data privacy and technical limitations.

4 Protection against cyber threats and attacks using deep fakes (deepfakes)

The objective of this section is to analyse some of the threats posed by deepfakes and outline their mitigation methods. Identifying deepfakes is the first step, using deep learning to detect digital artifacts like facial inconsistencies (Müller, N. et al., 2023)

The next step is to protect video surveillance systems from hacking, employing biometric authentication, encryption, and network monitoring to secure data (Vennam, P. et al., 2021). The final part of this chapter discusses algorithms for cyberattack detection, such as CNNs and RNNs, which help detect anomalies in video frames and patterns of suspicious activity (Wodajo, D. & Atnafu, S., 2021).

4.1 Algorithms for detecting fake videos

Modern deepfake technologies pose significant risks for information security by creating realistic fake videos and images that can deceive, spread disinformation, or exploit systems. Detecting such fakes and safeguarding surveillance systems from hacking are top priorities in cybersecurity.

Deepfake detection and anti-spoofing methods have made significant strides, particularly with the use of deep learning techniques. However, challenges such as generalization, computational complexity, and explainability remain. Future research should focus on developing more robust, efficient, and interpretable models to effectively combat the evolving threat of deepfakes (Müller, N. et al., 2023).

To counter deepfake attacks, anti-spoofing algorithms have been developed alongside deepfake detection methods. Anti-spoofing techniques help systems recognize real users versus fake or manipulated visuals, preventing unauthorized access through fake images or videos. Algorithms that detect digital artifacts — such as unnatural facial movements, lighting mismatches, and lip-sync errors — work in tandem with anti-spoofing to secure surveillance and biometric systems.

4.2 Protecting video surveillance systems from hacking

Video surveillance systems often become targets for cyberattacks, where unauthorized users may attempt to access camera feeds or manipulate stored data. Anti-spoofing complements other methods of system protection, such as:

- *User authentication:* Biometric and multi-factor authentication with anti-spoofing prevents unauthorized individuals from accessing the system.
- *Encryption of video streams:* Data transmitted from cameras is encrypted to prevent interception or tampering.
- *Network activity monitoring:* Algorithms that monitor suspicious activity detect hacking attempts and prevent unauthorized access. Conducting systematic reviews of threats, vulnerabilities, and attacks on video surveillance systems and summarizing countermeasures can provide practical security checklists and recommendations for improving system security (Vennam, P. et al., 2021).

These measures significantly reduce hacking risks and secure data in video streams.

4.3 Examples of algorithms for detecting deepfakes and other cyberthreats

Various algorithms have been developed to detect deepfakes and other cyberthreats:

– *Convolutional Neural Networks (CNNs):* Detect anomalies in video frames by analysing image details, often revealing distortions in fakes.
– *Recurrent Neural Networks (RNNs):* Process time sequences to detect unnatural changes in movement and frame sync, characteristic of deepfakes.
– *Combined CNN and RNN models:* By merging spatial and temporal analysis, these models achieve high accuracy in real-time video analysis.
– *Digital Forensics and Anti-Spoofing:* Techniques in digital forensics and anti-spoofing analyse inconsistencies and protect systems from fake data manipulation, thus strengthening surveillance and information security overall (add citation for anti-spoofing and forensics methods).

These algorithms, including anti-spoofing, enhance deepfake detection, protect surveillance systems, and are essential for robust information security.

5 Ensuring Data Privacy in Computer Vision Systems

Computer vision systems in information security process sensitive biometric data, such as facial images and fingerprints, requiring stringent data privacy and anti-spoofing measures. Anti-spoofing technology provides an essential layer of protection by verifying that biometric data is authentic, preventing unauthorized access through fake images or videos. Data privacy efforts include minimizing data collection, informing users about data usage, and obtaining consent, especially in public spaces where surveillance may not be apparent. Data encryption, anonymization, and pseudonymization further mitigate privacy risks.

Adhering to legal frameworks, such as GDPR, and ethical standards is critical to maintain transparency, protect user rights, and build trust in computer vision technologies for security.

6 Experimental work based on educational programs

As part of this study, experimental work was conducted to evaluate the effectiveness of computer vision technology for student registration in educational programs at L.N. Gumilyov Eurasian National University and Almaty Technological University. The primary goal was to test a facial recognition system with anti-spoofing functionality to ensure secure and reliable student authentication on the educational portal.

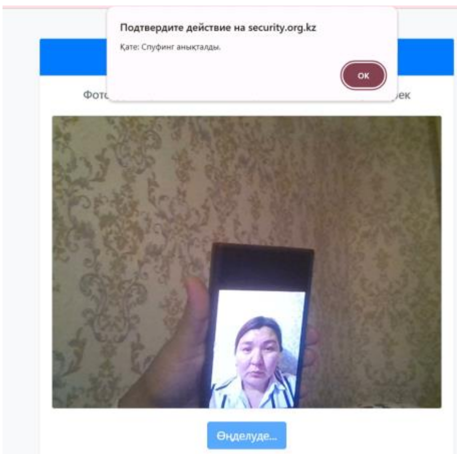

Figure 5: Anti-spoofing.

The image (Fig. 5) illustrates an attempt to fool the system by presenting a photo of a face on a phone. The anti-spoofing technology detected this attempt, flagged it as fraudulent, and blocked access. This example demonstrates how anti-spoofing prevents unauthorized access by distinguishing real users from impostors using fake images.

The experiment involved students enrolled in various programs, such as "6B01511 - Computer Science," "7M01511 - Computer Science," and "M094 - Information Technology." The portal utilized advanced facial recognition algorithms combined with anti-spoofing technology, which uses deep learning to ensure that only a real person—and not an image or video—can gain access. Students' facial images were scanned and matched with stored biometric data in the database to verify their identities. Face anti-spoofing methods often assume that training and testing samples come from the same domain, which limits their generalization capability. An unsupervised domain adaptation scheme addresses this by learning classifiers for target domains based on training samples from different source domains. This approach minimizes the Maximum Mean Discrepancy between latent features in source and target domains, enhancing the generalization capability of anti-spoofing systems in cross-domain scenarios (Qin, Y., et al., 2021).

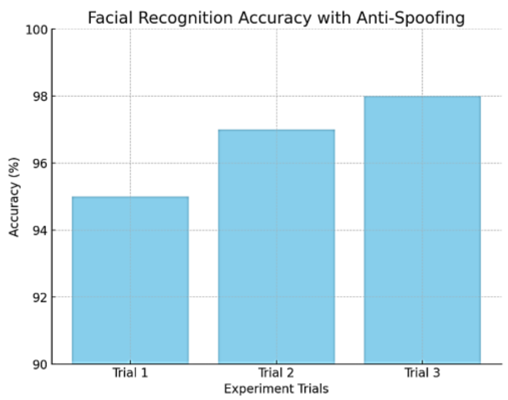

Figure 6: Anti-spoofing.

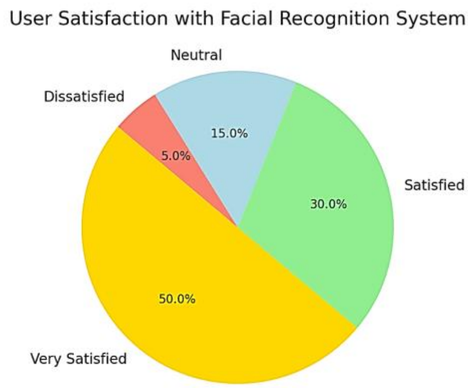

Figure 7: Anti-spoofing.

The Facial Recognition Accuracy with Anti-Spoofing diagram (Fig. 6) shows the results of three trials of the facial recognition system with anti-spoofing, conducted under real-world conditions on a learning portal. The system achieved a recognition accuracy rate exceeding 95% and successfully prevented over 98% of unauthorized access attempts using fake images. The User Satisfaction with Facial Recognition System pie chart (Fig. 7) shows the results of a survey of users assessing their satisfaction with the facial recognition system on the educational portal. The majority of users (50%) indicated a high level of satisfaction, citing the convenience and reliability of the system. Another 30% of users expressed satisfaction, rating the system as easy to use and secure. About 15% remained neutral, and 5% expressed dissatisfaction, noting rare cases of recognition errors.

These results show that most users rated the facial recognition system positively, especially due to the convenience and enhanced security provided by the anti-spoofing technology. Compared to traditional password-based access methods, the facial recognition system demonstrated enhanced security by reducing login time, improving data accuracy, and eliminating password-related issues. Additionally, anti-spoofing enhanced data integrity by preventing common types of visual fraud. These findings indicate that computer vision and anti-spoofing technology can effectively streamline student registration, improve data security, and minimize unauthorized access risks. This approach provides a robust alternative to traditional methods, offering increased protection of student data and better control over attendance and access to educational materials.

7 Conclusion

This study highlights the significant potential of computer vision in information security, especially for data protection and user authentication. Modern machine and deep learning methods effectively tackle challenges in biometric authentication, video surveillance, and defence against cyber threats like deepfake attacks. Experimental work conducted with educational programs using facial recognition and anti-spoofing confirmed high accuracy and robust security in student authentication, demonstrating the practical application of these technologies in registration and access control on educational portals.

Despite these advantages, certain risks and limitations remain. Computer vision systems can be impacted by technical constraints, such as challenging lighting conditions or high-density environments, which may reduce recognition accuracy. Additionally, processing biometric data requires strict adherence to privacy standards, as handling personal information raises privacy and ethical concerns. To mitigate these risks, encryption, anonymization, and access control measures are essential for preventing data breaches. Anti-spoofing technologies, particularly those leveraging deep learning, multi-perspective feature learning, and neural architecture search, are crucial for enhancing the security of facial recognition systems against deepfake and other spoofing attacks. “These advanced methods provide robust, real-time, and comprehensive solutions for detecting and mitigating various types of spoofing attacks, ensuring the reliability and security of facial recognition systems across diverse scenarios” (B, F., Suresh et al., 2023).

The future of computer vision in information security appears promising. Expected improvements in algorithms will likely enhance recognition accuracy and reduce dependency on environmental factors. Furthermore, advancements in anti-spoofing and digital forensics will strengthen defences against emerging cyber threats, including deepfakes. As computer vision technology evolves, it will play an increasingly critical role in building secure systems and protecting data, solidifying its position as an indispensable tool in the future of information security.

The didactic value of this article lies in providing computer science educators with relevant examples of practical applications of computer vision in information security. Studying technologies like anti-spoofing and biometric authentication enables students to better understand modern threats and data protection methods, as well as evaluate the ethical aspects of working with personal information. The inclusion of cases related to the security of educational platforms helps students develop critical thinking skills and problem-solving abilities in the field of cybersecurity.

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To the Roots: Engineering Pedagogy

The Curriculum of Technical Subjects in Primary Schools in Slovakia and Abroad

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Abstract

The curriculum plays a strategic and essential role in advancing education in every country. This research aims to compare the curricula of technical subjects in primary schools across three countries: the Czech Republic, Poland, and Slovakia. The study employed content analysis and synthesis methods, with documentation and literature review techniques used to collect research data. In the content analysis of the documents, we focused primarily on the division of primary schools into stages (cycles), the mandatory nature of the national curriculum, common curriculum topics across different education levels, and specific topics in each country. We believe this overview will be valuable for those who use the curricula of technical subjects in primary schools, both within educational institutions and for research purposes.

Keywords: Curriculum, Technical Education, Comparison

1 Introduction

The curriculum plays a strategic role in education and serves as the foundation for all educational activities in schools. It is a key tool for achieving educational goals (Santika, Suarni & Lasmawan, 2022). However, the curriculum is not static or untouchable—numerous changes to global primary school curricula, along with adjustments within individual educational fields or subjects, reflect this dynamic nature. Social changes are typically reflected in curriculum changes across different types of schools. This has been true for the Slovak primary school curriculum, which has undergone numerous changes since the

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country's independence. Currently, Slovak primary education is preparing for substantial curricular changes set to take effect nationwide in 2026. Other countries are also responding to societal changes by modifying their curricula, some of which share a historical background and similar primary education systems with Slovakia.

In recent years, reforms in the content and organization of primary education have taken place in Poland, the Czech Republic, and Slovakia. In each country, these reforms sparked discussions among both the professional and general public. New educational documents have been in effect in Poland since 2017, in the Czech Republic since 2021, and will be implemented across all schools in Slovakia starting in 2026. These countries share a significant part of their educational history up until 1989. After major societal shifts in these countries, each one began to chart its own path for its education systems. Since then, these nations have implemented several reforms, primarily aimed at modernizing their education systems and aligning them more closely with those of other European countries.

2 Research Methodology

In this article, we aim to focus on the content and organizational changes in recent reforms that have significantly impacted technical education as part of general education in primary schools. We will briefly describe the content of technical education in primary schools in each country and conduct a content analysis of documents to identify common and differing elements in the content of technical education. In this analysis, we will examine the following documents: national educational programs, framework curricula, and content standards for the educational area "Human and the World of Work." We will monitor: the division of elementary school into stages (cycles), the binding nature of the national curriculum for schools, common curriculum topics across educational stages, and specific topics in each country.

2.1 Poland

Elementary school in Poland consists of 8 grades, divided into two levels. The primary level includes grades 1-3, and the lower secondary level includes grades 4-8.

In the primary level, grades 1-3, teaching is not divided into separate subjects. Students participate in integrated learning, where they study topics in Polish language, mathematics, and other subjects without distinct boundaries between areas of knowledge. During a single class, students might learn multiplication alongside reading (Konczal, 2023).

The subject of "Technology" is taught at the lower secondary level, specifically in grades 4-6. The primary goal of the "Technology" subject is for students to acquire practical skills in technical activities by completing simple projects that involve working with various materials using appropriate tools and equipment. Through these hands-on activities, students develop essential skills and habits that are crucial for their future professional lives. They learn how to operate in a real workplace, considering the necessary safety and health requirements. The practical approach in teaching "Technology" aims to make it a subject where students can test and apply knowledge gained in areas such as mathematics, biology, computer science, and physics. In "Technology" classes, students explore their aptitudes, technical and professional interests, and discover their talents and passions in technical fields. The subject serves as an invaluable element in students' career orientation, bridging general and vocational education. It is during these classes that future technicians and engineers may uncover their potential. "Technology" is taught in grades 4-6, with a frequency of one hour per week.

The subject of Technology plays an important educational role, teaching respect for manufactured goods and fostering attitudes of conscious use of technological advancements by adhering to occupational safety and health (OSH) principles, respecting regulations, valuing property, and encouraging teamwork. Technology education prepares young people for the effective, responsible, and safe use of modern technical devices in daily life and helps them navigate an ever-evolving technological landscape (Ministerstwo Edukacji Narodowej, 2017).

The knowledge and skills acquired by students are outlined through general and specific requirements. General requirements define the primary educational goals, while specific requirements encompass the range of knowledge and skills that students are expected to acquire throughout the entire educational stage.

Content of the "Technology" Subject in Grades 4-6:

The educational content is outlined in the curriculum *"Jak to działa?"* ("How It Works?"), which reflects the syllabus from February 14, 2017, and incorporates practical school applications. The curriculum is divided into six areas, allowing technical knowledge and traffic education content to be presented to students in a structured manner. These areas are repeated in each grade. The content of instruction includes:

Work Culture

- School rules in the technology classroom,
- Occupational health and safety rules in the workplace,
- Importance of safety signs (pictograms),
- Care for tools and equipment.

Traffic Education

- The student as a road user in the roles of pedestrian, passenger, and cyclist,
- Traffic signs relevant to pedestrians and cyclists,
- Bicycle maintenance,
- Safety rules.

Materials Engineering

- Construction materials (paper, wood and wood-based materials, metals, plastics, textiles, composite materials, electrical materials),
- Electrical components (resistors, diodes, transistors, capacitors, coils, etc.),
- Properties of construction materials and electronic components,

- Principles of separating and processing waste from various materials and electronic components.

Technical Documentation

- Technical drawings (mechanical, construction, electrical, tailoring),
- Information provided in device manuals, on technical labels, food packaging, clothing tags, electronic components, etc.

Mechatronics

- Principles of cooperation between mechanical, electrical, and electronic components,
- Mechanical, electrical, and electronic tools found in households, including devices and technologies for smart home management,
- Toys, robots, and electro-mechanical models (including programmable ones).

Production Technology

- Types of processing for various materials,
- Schedules for different forms of work organization,
- Measurements using appropriate measuring devices,
- Assembly of individual parts into a whole,
- Various types of connections (detachable and permanent, direct and indirect, static and movable).

In Technology classes, students should develop the ability to plan and execute tasks of varying complexity, helping them form correct habits in technical activities. This also allows them to observe diverse technical elements in their surroundings and gain knowledge about their construction, functionality, and safe use. Schools should provide conditions for students to obtain a cycling license by the age of 10.

The curriculum places a particular emphasis on orienting the educational area toward practical student activities, enabling students to apply their knowledge in practice, plan independently, and perform practical tasks. Starting from grade 4, students work with various materials, learning about their properties, basic technologies, and creating different objects, both static and moving structures. They also become familiar with tools, understanding their construction, proper usage, and the rules for safe operation.

2.2 The Czech Republic

Elementary school consists of 9 grades, divided into two levels: the primary level (grades 1-5) and the lower secondary level (grades 6-9).

At the primary level, the educational content is divided into nine educational areas, one of which is "Human and the World of Work," where technical education is provided in grades 1-5. A total of five instructional hours are allocated for this area across these five grades. The framework curriculum does not specify the exact name of the subject through which this content is delivered. At the primary level, educational content is implemented across all grades, and all four thematic units are mandatory for schools: Working with Small Materials, Construction Activities, Gardening, and Food Preparation.

During the primary level, students should work with various materials, resources, tools, and equipment to understand their properties and potential uses, gain proficiency in handling them, and learn safe handling practices. They should learn to work according to instructions, use templates, sketches, and diagrams in their work, develop independent working skills, and complete tasks on their own.

At the lower secondary level (Grades 5-9) The educational area "Human and the World of Work" is also included in the curriculum. The Framework Curriculum does not specify the subject name through which this content is to be delivered. A total of three instructional hours are allocated for this educational area, which can be taught in any of the grades 6-9. The educational standards for the "Human and the World of Work" area are recommended materials for elementary schools and include the following content:

- *Working with Technical Materials:* Working with materials, choosing tools, work procedures, technical documentation, occupational safety and health.
- *Design and Construction:* Assembly and disassembly of objects, occupational safety and health.
- *Gardening and Animal Care:* Procedures for growing various plants, using flowers for decoration, using and maintaining tools, small animal care, occupational safety and health.
- *Household Operations and Maintenance:* Payment operations and household accounting, operating household appliances, minor household maintenance, occupational safety and health.
- *Food Preparation:* Kitchen equipment and appliances, preparation of simple dishes, occupational safety and health, basic principles of table setting.
- *Working with Laboratory Equipment:* Procedures, instruments, devices, and tools for specific observations, measurements, and experiments; information sources for experiments, measurement protocols, occupational safety and health.
- *Use of Digital Technologies:* Basic functions of digital technology, connecting digital devices, user skills with mobile technologies, cleaning digital devices, occupational safety and health.
- *World of Work:* Work environments and activities in selected professions, prerequisites for careers, information sources and counselling services for career choices, materials for job interviews (Národní ústav pro vzdělávání, 2013, 2021).

The educational area "Human and the World of Work" is unique in that its thematic units for the lower secondary level are offered as options. The thematic unit "World of Work" is mandatory, while schools select at least one additional unit from the remaining seven, based on their conditions and educational objectives. These seven thematic units (Working with Technical Materials, Design and Construction, Gardening and Animal Care, Household

Operations and Maintenance, Food Preparation, Working with Laboratory Equipment, Use of Digital Technologies), despite their diversity, share common framework educational goals.
At the lower secondary level, the "World of Work" thematic unit is mandatory, and schools must select at least one additional unit to be implemented in full. The "World of Work" unit is compulsory for all students in its entirety, and due to its focus on career choices, it is recommended to be scheduled in the higher grades of the lower secondary level.

2.3 The Slovak Republic

Currently, Slovakia follows the Revised National Educational Program, which defines elementary education as comprising nine grades, divided into two levels: the primary level (grades 1-4) and the lower secondary level (grades 5-9).
At the primary level, technical education is delivered through the subject "Work Education," which is introduced in grades 3 and 4 of the primary level, with one class hour per week. For grades 3 and 4, Work Education covers the following thematic units: Human and Work, Creative Use of Technical Materials, Basics of Construction, Food Preparation and Nutrition, Folk Traditions and Crafts (Národný inštitút vzdelávania a mládeže, 2014).
At the lower secondary level, within the educational area Human and the World of Work, technical education is covered by the subject "Technology." The content of Technology comprises two main thematic areas: Technology and Household Economics. The Technology component includes the following thematic units:

- Human and Technology – the relationship between humans, technology, and nature
- Useful and Gift Items, Technical Creativity (creative activities)
- Graphic Communication in Technology
- Technical Materials and Their Processing Methods – including both non-metal and metal materials, and both manual and machine processing methods
- Electrical Energy, Electrical Circuits, Technical Electronics
- Simple Machines and Mechanisms, Household Machines and Appliances, Electrical Appliances in the Household, Home Installations
- World of Work (Revised NEP, 2015)

The content standard for the thematic area Technology is structured by individual grades (5-9). A closer examination of the topics within each thematic unit reveals that they can be grouped into the following categories: The Relationship between Humans and Technology, Technical Communication, Technical Materials and Processing Methods, Electrical Energy and Circuits, Technical Electronics, Household Machines and Appliances, and World of Work.
The thematic area Household Economics includes the following topics: Household Planning and Management, World of Work, Household Maintenance and Upkeep, Food Preparation and Nutrition, Handicrafts, Family Preparation, Gardening and Animal Husbandry. These

topics are not assigned to specific grades, allowing the teacher to choose and allocate them across any grades (5-9).

At first glance, certain thematic units (such as World of Work and Household Maintenance) are nearly identical to units in the Technology area. This inconsistency in the content standard for the subject Technology is a characteristic feature. In practice, Technology teachers are required to dedicate two-thirds of instructional time to topics from the Technology area, and up to one-third to topics from the Household Economics area.

This Technology curriculum is the closest in content to the Czech standard, including topics focused on household operation and maintenance and food preparation.

Since 2023, a new technical education curriculum has been approved for elementary schools in Slovakia as part of a primary education reform under the Recovery Plan. All schools are expected to implement this new curriculum by 2026. The main innovative feature of this reform is the introduction of three consecutive educational cycles: the first cycle will include grades 1 through 3, the second will cover grades 4 and 5, and the third will encompass grades 6 through 9 (Ministerstvo školstva, vedy, výskum a športu Slovenskej republiky, 2023a).

The content designed for the educational area Human and World of Work comprises three components (see Table 1).

	Technology	Career education	Entrepreneurship and initiative
1. cycle	– recognizing material properties (modelling materials, textiles, wood, metals, plastics) – understanding household, transportation technology – construction	– Characterizing selected professions – Identifying personal interests and values	– Setting goals and generating ideas – Basics of financial and economic literacy
1. cycle	– Exploration of technical materials and their properties – Constructions around us – Examination of traditional and modern technical environments	– Self-reflection and feedback – Career portfolio as a tool for developing the student's potential	– Selecting ideas – Human work and its impacts
2. cycle	– Understanding the history of technology and the basics of graphic communication – Utilizing the properties of technical materials in product creation – Exploring the use of simple machines and mechanisms in the household	– Decision-making and creating an action plan – Work-life balance and mental health (well-being)	– Implementation of the idea and verification of its functionality – Problem-solving – Sources of financing ideas

Table 1: Topics within the educational area Human and World of Work from 2026 (Ministerstvo školstva, vedy, výskum a športu Slovenskej republiky, 2023b)

The curriculum for the educational area is designed for each cycle rather than for a specific grade in elementary school. Similarly, the number of instructional hours is allocated per cycle: 3 instructional hours are designated for the 1st cycle, 2 instructional hours for the 2nd cycle, and 4 instructional hours for the 3rd cycle. The subject in which the content of the educational area is taught carries the same name as the educational area itself — *People and the World of Work* — across all cycles of elementary school (Hašková, Lukáčová, 2022).

3 Discussion and Conclusions

Through content analysis of school documents, we attempted to identify the commonalities and differences in the curricula defined for the educational area *People and the World of Work* at the elementary school level. Our analysis of the content intended for the primary and lower secondary levels was complicated by the fact that, in Slovakia, elementary education will be divided into three cycles starting in 2026. In conducting the analysis, we therefore focused on: the structuring of elementary school into levels (or cycles), the binding nature of the national curriculum for schools, common curriculum themes for each level, and specific themes in each country.

Common Features:

In all examined countries, elementary education is divided into two levels. (However, from 2026, Slovak schools will shift to a division of three educational cycles.) Both Poland and Slovakia aim to include one year of pre-elementary education in compulsory schooling. In these countries, the curriculum mandated by the state is binding for schools, with flexibility only in the scheduling of teaching objectives for the educational area. In contrast, the Czech Republic offers a more flexible curriculum, where only one thematic area is state-mandated, and schools choose at least one additional area based on student interests and school conditions.

When identifying themes common to the People and the World of Work curriculum across all countries, the following topics stand out:

- Technical materials
- Design and construction
- Technical documentation
- Safe use of household appliances
- Health and safety at work

These topics constitute a significant part of the People and the World of Work curriculum in all the countries analysed.

Specifics of Each Country:

In Poland, the curriculum for the primary level of elementary school is implemented in an integrative way, without specifying content for each educational area. In the Czech Republic, the curriculum for the educational area "People and the World of Work" includes horticulture, which is not part of the planned curriculum in Slovakia.

At the lower secondary school level, Poland includes traffic education as part of the subject "Technology," where students learn the principles of safe behaviour in traffic as pedestrians and cyclists. Traffic education is not covered in the "People and the World of Work" curriculum in Slovakia or the Czech Republic.

In the Czech Republic, the content of "People and the World of Work" at the lower secondary level also includes topics focused on horticulture and animal care. These subjects are not part of the planned curriculum in Slovakia or Poland. The subject title for the educational area "People and the World of Work" is not specified in Czech schools, and the Czech elementary education system is divided into two levels.

Currently, Slovakia's curriculum also includes topics focused on horticulture, but as of 2026, these will no longer be included in the "People and the World of Work" area. Traffic education topics are likewise absent from the curriculum. In the near future, Slovakia will stand out with three components in its educational area, including career education (similar to the Czech Republic) and financial literacy and entrepreneurship—components not found in Poland's or the Czech Republic's technical education curricula. A significant difference will also be Slovakia's division of elementary education into three cycles, a structure not seen in Poland or the Czech Republic.

The quality and success of an educational institution are closely tied to its curriculum. A well-designed curriculum enhances educational quality, and vice versa (Mukhlason & Tarbiyah, 2022).

The presented elementary school technical curricula reflect each society's technological, scientific, cultural, and economic development and varied approaches to curriculum design. This review and comparison of technical curricula may be helpful in planning changes to technical subject content and supporting teachers, didactics experts, and researchers in their work.

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R&E SOURCE

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To the Roots: Engineering Pedagogy

Enhancing Historical Understanding, Gender Perspectives, and Critical Thinking

Integrating AI-Powered Tools in University-Level British History Education

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Abstract

This study examines the integration of AI-powered tools in university-level British history education, focusing on critical thinking, historical interpretation, and student engagement. First-year students at the Department of British and American Studies at the University of Ss. Cyril and Methodius in Trnava used ChatGPT, Perplexity, and HeyGen to analyse historical figures and create AI-generated presentations. Through a seminar-based workshop, students evaluated AI-generated content, verified historical accuracy, and developed digital storytelling skills.

A qualitative research approach was used, with observation sheets assessing engagement, research validation, collaboration, and argument construction. Findings show that AI tools enhanced participation and creativity but also revealed challenges in source validation and critical analysis. The study underscores the need for AI literacy training and structured reflection to ensure AI complements rather than replaces historical inquiry.

Keywords: Artificial Intelligence in Education, History Education, Critical Thinking Skills, Personalized Learning

1 Introduction

The integration of artificial intelligence (AI) in education is transforming how historical narratives are taught, offering new ways to enhance critical thinking and gender perspectives. In Slovakia, the Ministry of Investments, Regional Development, and Informatization (MIRRI) collaborates with the Ministry of Education to introduce AI in schools and universities. MIRRI's recommendations focus on updating curricula to include algorithmic thinking and AI-related subjects to equip students with digital skills (MIRRI, 2019; AI Watch, 2024). Additionally, an

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expert group is working to align AI applications in education with public and private sector needs. To support AI literacy, introductory AI courses for educators and public employees aim to build a foundational understanding of AI concepts (AI Watch, 2024).

At the European level, the EU promotes the responsible use of AI in education through ethical guidelines and regulatory frameworks. The European Commission's *Ethical Guidelines on the Use of AI and Data in Teaching and Learning for Educators* provide recommendations for teachers integrating AI into their pedagogy (European Commission, 2023). The proposed *Artificial Intelligence Act* classifies AI systems used in education as high-risk, requiring transparency and accountability to ensure fair student evaluation and academic access (All Digital, 2024). These efforts reflect the EU's broader commitment to fostering digital education while safeguarding ethical principles.

This study examines how AI-powered tools enhance historical understanding, gender perspectives, and critical thinking in university-level British history education. AI-driven interactive features, such as talking avatars and AI-generated historical narratives, create immersive learning experiences that challenge traditional interpretations. Given Slovakia's and the EU's growing emphasis on AI in education, this research provides insights into how AI tools can improve learning outcomes and promote a more inclusive approach to historical studies.

2 Theoretical background

2.1 Artificial Intelligence in Education

The use of artificial intelligence (AI) in education has become a widely discussed topic among researchers, with many studies examining its benefits, challenges, and ethical implications. AI-powered applications, such as ChatGPT or Perplexity, have been shown to enhance critical thinking by providing personalized explanations and fostering diverse perspectives (Alderson, 2000; Stranský, 2023). Research emphasizes that these tools can support students in analysing texts, addressing gender biases, and engaging with historical narratives in new ways (Zaghlool – Khasawneh, 2023; Hassan, 2024). However, their effectiveness depends on educators guiding students in critically evaluating AI-generated content and mitigating potential biases embedded within these systems (Gerlich, 2025; UNESCO, 2025). As AI continues to shape higher education, it is essential to balance its advantages with ethical considerations and pedagogical oversight to ensure responsible and meaningful integration in university curricula (Ngo & Hastie, 2024; Papadopoulos, 2024; Pondelíková & Luprichová, 2024).

A recent study by Ullah et al. (2024) analysed publicly available guidelines on the use of Generative Artificial Intelligence (GenAI) tools in universities worldwide. The research examined policies from the world's top 50 universities, revealing that while 41 institutions provided GenAI guidelines, many lacked detailed instructions on algorithm transparency, AI-generated content documentation, and reporting mechanisms for misconduct. The study highlights the need for comprehensive and regularly updated guidelines, AI literacy training for both students and faculty, and clearer institutional policies on ethical AI use.

A similar discussion has emerged in Slovakia, where Pakšiová, Brauner, and Semerád (2023) investigated AI's impact on university education. Their study emphasizes that AI tools, particularly ChatGPT, can enhance personalized learning and real-time feedback. However, concerns arise regarding misinformation, reduced critical thinking, and the absence of clear institutional policies. The authors stress the importance of AI literacy training to help students critically evaluate AI-generated content, aligning with global recommendations for structured AI guidelines in higher education.

Pondelíková's (2025) research on AI integration in British and American Studies at Slovak universities highlights both the benefits and challenges of AI in humanities education. While students readily adopt AI for learning and research, many educators express concerns about academic integrity, plagiarism, and the lack of clear guidelines. The study reveals a gap in AI literacy between students and teachers, emphasizing the need for structured AI training to ensure responsible and effective use. This is particularly relevant for history education, where critically evaluating AI-generated content is essential to avoid misinformation and biases. Pondelíková also advocates for universities to invest in digital infrastructure and establish transparent policies on AI usage. Her findings reinforce the importance of ethical AI adoption in education, ensuring that both students and educators are prepared for its evolving role in academia.

2.2 Critical Thinking Skills in Higher Education

The integration of artificial intelligence (AI) into education has transformed pedagogical approaches, offering opportunities for personalized learning, adaptive assessments, and enhanced student engagement. Critical thinking is a cornerstone of university education, enabling students to evaluate evidence, challenge assumptions, and construct reasoned arguments. Research highlights the effectiveness of active learning strategies, such as problem-based learning and reflective journals, in cultivating these skills (Ding, 2024). However, studies reveal disparities in how critical thinking is taught across disciplines, with history education often prioritizing source analysis and historiographical debate (Mohamed Nor, 2021). The OECD notes that while universities emphasize critical thinking, assessment methods frequently fail to measure it meaningfully, urging institutions to adopt iterative feedback mechanisms (Van Damme & Zahner, 2022).

Balancing AI-driven automation with human intellectual rigor remains a challenge, as overreliance on AI tools risks stifling independent thought (Yin, 2024). AI-generated content can streamline research but lacks the contextual discernment required for historical interpretation (Jagadesh Kumar, 2023). Reports highlight AI's capacity to automate decision-making and detect patterns in educational data, enabling tailored instructional strategies while emphasizing governance to mitigate biases (U.S. Department of Education, 2023). Similarly, UNESCO (2021) underscores AI's potential to address disparities in education but cautions against excessive reliance, which may erode critical thinking and creativity. AI-driven tools also assist in automating administrative tasks, allowing educators to focus on curriculum design and interactive teaching, though ethical concerns such as data privacy and algorithmic transparency remain pressing issues (Yin, 2024).

While AI-driven tools like intelligent tutoring systems and virtual assistants have proven effective in improving learning outcomes in STEM education, their role in humanities disciplines, particularly history, remains underexplored (Ajayi & Yahya, 2024; Lee, 2023; Amdan, Mohammad & Janius, 2024). This gap suggests the need for further investigation into how AI can support historical analysis, critical inquiry, and engagement with diverse perspectives in history education. Understanding AI's potential in history classrooms requires addressing not only its capabilities in information synthesis but also its limitations in interpreting historical narratives, historiographical debates, and social contexts.

3 Research

3.1 Objective, Research Methodology, and Observation

The objective of this seminar lesson was to engage first-year university students from the Department of British and American Studies at the University of Ss. Cyril and Methodius in Trnava, Slovakia, in a revision-based, critical thinking activity related to significant historical figures from Great Britain and Ireland. The lesson aimed to develop students' ability to critically evaluate historical personalities, formulate reasoned arguments, and use AI-powered tools responsibly in historical research. Through collaborative group work, students applied their prior knowledge while enhancing their skills in source validation, digital literacy, and historical analysis. Additionally, the activity encouraged creativity and digital communication by integrating AI-driven talking avatars to present their perspectives.

The study was conducted as a seminar-based workshop for first-year university students enrolled in the *History and Culture of Great Britain and Ireland* course. The methodology integrated revision, collaborative learning, AI-enhanced research, and digital content creation, employing an interactive, project-based approach.

The session began with a brainstorming discussion, where students reflected on historical figures they considered significant and justified their choices in a class-wide discussion. This phase encouraged critical thinking and engagement with historical impact. Following this, students were divided into mixed groups of four and introduced to their task. Each group selected a historical figure and took on the role of that character's descendant, presenting as YouTubers or influencers advocating for or criticizing the figure's actions.

In the research phase, students worked in pairs within their groups. One pair gathered additional information using AI tools such as ChatGPT, Perplexity, or SciSpace, while the other verified the accuracy of AI-generated content through academic sources like Google Scholar, ResearchGate, or Academia.edu. Since these platforms had already been introduced in a previous lesson, students were familiar with their functionalities and had prior experience using them for academic research. This prior exposure enabled them to navigate the tools more efficiently, critically assess the reliability of AI-generated content, and cross-reference findings with credible academic sources. After synthesizing their findings, groups collaboratively prepared a structured, evidence-based script that formed the foundation of their presentation. Once the research was completed, students moved on to creating AI-generated talking avatars using the tool HeyGen. They selected avatars that best fit their historical figure and generated a short video in which the AI avatar presented their argument.

This digital content served as a visual and auditory representation of their research and analysis.

The final phase consisted of group presentations and peer discussion. Each group introduced their video, explained their reasoning, and provided supporting arguments. The class then engaged in a structured discussion, evaluating whether the arguments were well-reasoned, historically accurate, and aligned with the research findings.

Throughout the entire process, the instructor observed students' engagement, collaboration, research quality, and AI tool usage using a prepared observation sheet. This allowed for a structured assessment of how students interacted with AI tools, analysed historical content, and developed critical thinking skills.

The study employed a qualitative methodology, focusing on student engagement, critical thinking, and digital literacy in the context of history education. This approach was chosen because it allowed for an in-depth exploration of students' interactions with AI tools, their ability to evaluate historical narratives, and their engagement in collaborative learning. Qualitative research is particularly valuable in educational settings, as it provides insights into how learners construct knowledge and develop reasoning skills through discussion, inquiry, and reflection (Merriam & Tisdell, 2016).

Observation was the primary method of data collection, enabling the instructor to assess how students applied AI-generated content, verified historical facts, and structured their arguments. Classroom observations allow researchers to capture authentic interactions, thought processes, and learning behaviours, offering a richer understanding of educational experiences than numerical data alone (Patton, 2015). Since the activity required students to critically assess historical figures and present their findings in a digital format, qualitative research was the most suitable method for analysing how they engaged with information, navigated AI tools, and collaborated to produce meaningful content.

The use of observation sheets provided a structured means of collecting qualitative data while maintaining flexibility in evaluating different aspects of student performance. Qualitative inquiry is essential when studying student perceptions, cognitive engagement, and problem-solving strategies, as it allows for a deeper interpretation of their reasoning and decision-making (Creswell & Poth, 2018). Unlike quantitative research, which relies on predefined variables and statistical analysis, this study aimed to capture students' thought processes, creativity, and engagement in real-time, making qualitative observation the most appropriate method.

The research also aligns with constructivist learning theories, emphasizing that students actively build their understanding through inquiry and collaboration (Vygotsky, 1978). By integrating AI tools into the seminar, students were encouraged to question, verify, and reconstruct historical knowledge, demonstrating the critical thinking skills essential for historical inquiry. The study not only examined how students interacted with AI but also explored how digital tools influence the construction of historical narratives and critical engagement with historical figures.

To guide the study, the following research questions were formulated:

1. How do university students critically engage with AI-generated historical content in the learning process?
2. How does the use of AI-powered avatars influence students' engagement and ability to construct historical arguments?

3. What impact does AI-enhanced learning have on students' critical thinking skills in history education?

During the lesson, the observation focused on **student engagement, critical thinking, research validation, collaboration, creativity, and digital literacy**. Engagement was assessed through participation in discussions and group tasks, noting whether students were highly, moderately, or minimally involved. **Critical thinking skills** were evaluated based on students' ability to question AI-generated content, compare sources, and develop reasoned arguments. Attention was given to **research and source validation**, ensuring students cross-checked AI-generated content with academic sources. **Collaboration and group work** were observed to determine how effectively students distributed tasks and worked as a team. Creativity was assessed through the **quality of AI-generated avatars and the coherence of their scripts**, while the **accuracy of historical content** was measured by alignment with factual evidence.
Clarity of justifications was noted based on how well students structured their arguments. Their **AI literacy and digital skills** were evaluated through their ability to navigate AI tools and critically assess the credibility of AI-generated information. Finally, **class discussion participation** was observed, particularly in how students engaged with peer feedback and reflected on the learning process.

3.2 Research Sample

The research sample consisted of first-year university students from the Department of British and American Studies at the University of Ss. Cyril and Methodius in Trnava, Slovakia. The participants were enrolled in two study programs: English Language in Specialized Communication and Pre-service Teacher Training for English Language. A total of 71 students (51 female, 20 male) were from the English Language in Specialized Communication program, while 7 students (6 female, 1 male) were pre-service teachers preparing for their future roles as English language educators.
The 71 students participated in three seminar groups, each consisting of approximately 23 students, who then self-divided into working groups of around four students per group. The pre-service teacher group attended a separate seminar session, where the seven students were divided into two working groups. The organization of seminar groups allowed for collaborative learning, interactive engagement, and effective implementation of the AI-driven activities.
The careful consideration of workshop size, participant age, and group structure was crucial for ensuring the quality of delivery and active engagement in the seminar. By incorporating interactive elements, peer collaboration, and digital tools, the workshop aimed to maximize student participation and enhance learning outcomes. The structured yet flexible format of the working groups facilitated in-depth discussion, research validation, and digital content creation, ensuring that students effectively engaged with both historical content and AI-driven methodologies.

4 Analysis of the Observation Sheets

The observation sheets provided insights into how students engaged with AI tools, approached historical inquiry, collaborated in groups, and developed their critical thinking skills. The seminar workshop aimed to assess how students interacted with AI-generated content, verified historical accuracy, and presented arguments through digital storytelling. The observations revealed both strengths and areas that required further development in integrating AI tools into history education.

Student Engagement and Collaboration

Students displayed varying levels of engagement throughout the activity. Many actively participated in brainstorming discussions, demonstrating enthusiasm when selecting historical figures such as Boudicca, Oliver Cromwell, Elizabeth I, Mary I, Henry VII, Henry VIII, and Queen Victoria. The role-playing element, where students assumed the persona of an influencer or descendant, encouraged some groups to explore their historical characters in greater depth. In some cases, students took leadership roles within their groups, facilitating discussions and guiding research. However, differences in participation were noted, as some students took a more passive role during research or content creation, relying more on their peers. This variation suggests that while collaborative learning was generally effective, task distribution within groups could be improved to ensure equal participation.

Critical Thinking and Research Validation

The research phase provided an opportunity for students to engage with AI-generated content and verify it using academic sources. Some groups demonstrated a strong ability to cross-check AI outputs against scholarly literature, carefully examining whether AI-generated information aligned with established historical sources. Others, however, relied more on AI-generated responses without deeper verification, which occasionally resulted in oversimplified interpretations or historical inaccuracies. The double-checking process using platforms like Google Scholar, ResearchGate, and Academia.edu helped refine students' understanding, but not all groups approached this step with the same level of rigor. The observations suggest that students benefited from AI as a research tool, but additional emphasis on source validation and bias detection would enhance their ability to critically assess AI-generated historical content.

Argument Construction and Justification

The level of historical argumentation varied among groups. Some groups provided well-reasoned, nuanced arguments, particularly when discussing controversial figures like Oliver Cromwell or Henry VIII, where students engaged in more complex discussions about historical impact. Others focused more on a straightforward narrative approach, presenting key facts without fully developing an argumentative stance. During the peer discussion phase, students had the opportunity to question and refine their arguments, which helped strengthen their reasoning in some cases. However, some groups struggled to justify their claims with clear historical evidence, suggesting a need for more structured guidance in constructing well-supported historical arguments.

AI Literacy and Digital Skills

Students demonstrated a range of abilities in navigating AI tools for research and digital content creation. Most were able to use AI-generated content to support their historical research, but their awareness of AI limitations and biases varied. The use of HeyGen for creating AI-driven avatars was generally effective, with students selecting appropriate avatars and synthesizing their research into engaging digital presentations. Some groups prioritized the technical execution of their video over the depth of historical argumentation, indicating a tendency to focus more on presentation quality rather than content accuracy. These observations suggest that while AI tools can enhance engagement and creativity, they should complement—not replace—historical analysis and argument development.

Class Discussion and Reflection

The post-presentation discussion provided valuable opportunities for peer evaluation and reflection. Some students actively engaged in debating the validity of arguments and assessing how well each group justified their historical stance. In cases where groups struggled to provide clear justifications, their peers often pointed out inconsistencies or gaps in reasoning, leading to further refinement of ideas. While many students participated in these discussions, some remained less engaged in the reflective process, suggesting that more structured prompts for discussion could encourage wider participation.

4.1 Key Findings and Recommendations

The observation sheets highlighted how AI tools supported engagement, creativity, and historical inquiry, but also underscored the need for more rigorous source validation and critical questioning of AI-generated content. Students were able to integrate AI-driven research into their presentations, yet some demonstrated a tendency to accept AI outputs uncritically. Encouraging a stronger emphasis on fact-checking, argument depth, and engagement in peer discussion would enhance the effectiveness of AI-enhanced history education. Future workshops could benefit from more structured guidance on AI bias detection, additional peer feedback opportunities, and explicit questioning techniques to ensure deeper analytical engagement with historical sources.

5 Conclusion

The integration of AI-powered tools in university-level British history education presents both opportunities and challenges. The seminar-based workshop demonstrated that AI tools, particularly AI-generated avatars and conversational AI, can enhance student engagement, historical inquiry, and digital literacy. Students actively participated in discussions, constructed arguments, and explored multiple perspectives on historical figures. The role-playing task, where students assumed the personas of descendants and influencers, encouraged critical thinking and creative engagement with historical narratives. However, the observation sheets revealed variability in how students verified AI-generated content and structured their arguments, highlighting the need for stronger research validation skills.

While AI tools provided efficient access to historical information, some students over-relied on AI-generated content without critically questioning its accuracy. The structured peer discussion and feedback process helped refine historical justifications and deepen analytical engagement, but differences in participation suggested that more structured reflection prompts could encourage wider engagement. The study underscores the importance of guiding students in AI literacy, source evaluation, and ethical AI use, ensuring that technology enhances rather than replaces historical analysis.

This research highlights AI's potential to personalize learning experiences and foster deeper critical engagement with historical narratives, aligning with broader discussions on AI's role in education. However, effective integration requires ongoing refinement of AI literacy training, increased emphasis on argument construction, and structured feedback mechanisms. Future research should explore how AI-driven learning environments can further develop students' analytical reasoning, digital competencies, and historical interpretation skills in university education.

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Digital Educational Content of Technical Subjects: New AR and VR Technologies in Elementary School Teaching

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Abstract

In this article, we explore the potential use of digital educational content through augmented reality (AR) and virtual reality (VR) in teaching technical subjects at the upper primary level. Our research highlights innovative learning methods that enhance student interactivity and engagement, assist in visualizing complex projects, and provide opportunities for experimentation in a safe, simulated environment. The study also presents successful outcomes from schools that have integrated AR and VR into their educational objectives. We analyse the practical possibilities for implementing these technologies and discuss how they can help develop digital skills in schools and educational institutions, promoting good practices.

Keywords: Augmented Reality, Virtual Reality, Educational Technologies, Innovation

1 Introduction

Nowadays, technology significantly influences various aspects of daily life, including education. Traditional teaching methods are adapting to modern digital tools, enabling more effective and interactive learning experiences. The development of digital content brings a fresh perspective on acquiring and retaining knowledge, not only in primary and secondary education. Among the emerging technological trends are AR and VR, which will be discussed in detail in this article. Kesim et al. (2012) and Gavish et al. (2015) highlight Augmented Reality

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(AR) and Virtual Reality (VR) as interesting technologies with the potential to enhance the educational process through experiential learning in simulated environments.

AR allows users to interact with graphic elements, a text, and sound within the real-world environment, using smartphones or AR glasses. The potential of AR in education is vast, enabling students to engage with complex concepts in the classroom without the need for expensive equipment. Lee (2021) provides examples of AR's use in teaching technical subjects at the elementary schools, including interactive models and simulations of engines, machinery, and electrical circuits. These applications allow students to explore individual components in detail, understand their functions, and observe their interactions in real-time. Another practical example is the simulated assembly of circuits in a virtual laboratory, which eliminates the electrical hazard. The technologies required for using AR in the educational process include smartphones or tablets with cameras, as well as software and applications that process and display AR content.

Virtual Reality (VR) is a technology that provides a virtual environment, which users can experience through VR headsets. VR replaces the real-world environment with a simulated one. In education, VR enables students to engage in experiences that would otherwise be dangerous or inaccessible, such as simulated laboratory experiments or virtual field trips (Holdack et al., 2020). Virtual field trips allow students to visit manufacturing plants that are typically not accessible to students, providing them with practical experience and a better understanding of technical processes. Another example includes simulations of physical phenomena, where abstract concepts such as magnetic fields or wave propagation in space are visualized, helping students to grasp these concepts, which would otherwise be difficult to imagine without animated visual aids. These simulations take place in a safe and controlled environment (Gavish et al., 2015; Lee, 2021).

To achieve the best VR experience, the necessary technology includes a VR headset, motion sensors, and controllers that facilitate interaction with the virtual world, as well as software that creates and manages the virtual content (Greenwood & Wang, 2017; Smutny, 2023). AR and VR technologies hold great potential in education in today’s digitalized era. They offer new, engaging, safe, and experiential learning opportunities for students. AR adds digital elements to the real environment, while VR displays a fully virtual digital environment (Dembe, 2024).

2 The Importance and Application of AR and VR in Education

For several years, modern technologies have been integrated into the educational process, transforming traditional teaching methods. Educators strive to innovate teaching materials and adapt them to the contemporary era to make learning engaging and captivating for students. Digital technologies now play a crucial role in the educational process. VR and AR technologies are among the key innovations that offer both students and teachers interactive engagement with educational content. These technologies allow students to explore the subject matter actively and experience interactions within a simulated environment, contributing to more effective achievement of educational goals while increasing student engagement and motivation (Dembe, 2024). Let us describe what both teachers and students can gain from the educational objectives supported by AR and VR technologies (Ghanbaripour, 2024):

- Experiential learning: Students engage in the learning process actively by manipulating virtual objects. This approach enhances their motivation, imagination, and engagement, while also allowing teachers to maintain students’ attention.

- Safety in the educational process: Safety plays a crucial role in education. Through AR and VR, students can experiment and perform exercises safely without the risk of physical injury, damage to equipment, or material costs.

- Self-paced learning: Students can adjust the pace of their learning and training according to their individual needs. Applications can analyse students' progress and adjust the content to meet the performance and needs of both individuals and groups of students.

- Accessibility: Students have guaranteed access to education from anywhere, without the need for geographical relocation. They can participate in virtual field trips to locations they might not otherwise visit, such as laboratories or secure facilities that are off-limits to students.

- Practical skills development: Students acquire practical skills and experience with technologies that will be essential in their future professions.

- Inclusion: A key factor is inclusion, as VR and AR provide support for students with special needs, granting them access to the same educational experiences as other students.

In technical subjects and interdisciplinary contexts, studies and research focus on educational goals that employ Augmented Reality (AR) and Virtual Reality (VR). These technologies introduce innovative approaches that enhance interactivity and deepen students' understanding of technical concepts (Tan, 2022). In mathematics classes, AR can be utilized for the visualization and manipulation of three-dimensional geometric shapes. This teaching method allows students to comprehend better the volume and surface area of 3D shapes (Dunleavy, 2009; Bujak, 2013). During physics the lessons, students can experiment with the motion of objects under the influence of gravity using VR (Makransky, 2018).

In the field of electrotechnics, students can safely test electronic circuits in a virtual environment. Through experimentation, they acquire essential knowledge about electronic components and their capacity limitations (Psotka, 1995).
Robotics studies often necessitate expensive robotic arms for laboratory use, and careless handling could lead to injury or equipment damage. However, with virtual robotic laboratories, students can program and control virtual robots without risk, utilizing VR (Merchant, 2014). Students, under the guidance of their teacher, can visit manufacturing plants and technical workshops through virtual field trips without leaving the classroom (Pantelidis, 2010). AR and VR enable students to disassemble mechanical devices and gain a better understanding of their functionality (Dunleavy, 2009).
The use of AR and VR according to these examples not only increases student engagement and motivation but also fosters a deeper understanding of technical domains while providing a safe environment for experimentation without the need for expensive laboratories.

2.1 Strengths of Using AR and VR in the Educational Process

AR and VR introduce new possibilities into the educational process, significantly enriching traditional teaching methods. These technologies fundamentally transform how students receive information by engaging multiple senses. AR and VR can increase student interest by offering visual and auditory experiences through cutting-edge technologies. With VR, students can enter a digital world where they can explore various objects and scenes and interact with the environment through their activities. AR and VR allow students to complete interactive tasks, engaging them actively in the learning process. Students can solve problems using AR and VR, an approach known as problem-based learning, where students can be tested, rewarded, and assessed in a fun and motivating way based on their memorized and practiced knowledge. By completing tasks, students demonstrate their practical skills.
Technological advancements enable students to work in groups in virtual environments where they can communicate and collaborate as a team. Teachers can organize virtual meetings where students discuss, study, and learn in real time within the virtual space. AR and VR technologies enable the visualization of complex technical concepts, making them easier to understand by presenting them as complex 3D structures that students can rotate, tilt, and examine from different angles. These technologies also allow for the creation of animations that guide students through dynamic processes, such as chemical reactions or the functioning mechanisms of machines and devices in a safe environment. Before operating real machinery, students can test and verify these processes in a virtual setting, ensuring they have acquired the necessary knowledge and training to handle real-life situations safely. This is particularly important when real-world experiments could be dangerous and life-threatening (Georgy, 2016).
Training through AR and VR includes practicing medical procedures, repairing machines and devices, assembly techniques, and rescue operations during earthquakes. Properly designed applications can save lives, reduce material damage, and prevent losses that could occur due

to unskilled or untrained procedures. The interactive elements of AR and VR provide immediate feedback, helping students quickly identify and correct errors, allowing them to proceed with the correct approach (Ong, 2013). These technologies have the potential to transform educational goals in technical subjects and improve students' learning outcomes.

2.2 Weaknesses of Using AR and VR within the Educational Process

Despite the numerous advantages that AR and VR bring to education, there are challenges and limitations associated with their implementation in the educational process. One of the primary concerns is the high acquisition cost of these technologies. VR headsets, AR glasses, and the development of applications for technical subjects can represent significant financial burdens for schools. Additionally, it is crucial to continuous update the content of these applications to ensure relevance. VR applications often demand high hardware specifications for the computers to which the VR headsets are connected (Radianti, 2020).

From a health perspective, prolonged use of VR headsets can lead to eye strain, dizziness, and headaches. Users may also risk physical accidents, such as bumping into walls or tripping over objects that are not visible in the virtual world (Samala, 2023).

Another challenge is the need for teachers to be adequately trained to use these technologies effectively. Teachers must possess solid technical knowledge to integrate AR and VR into their teaching. Additionally, educational content may not always be sufficient for every subject, necessitating continuous updates and enhancements. Excessive use of AR and VR might lead to the erosion of traditional skills, such as handwriting, reading from text, and personal communication. Therefore, when planning lessons, it is essential to complement AR and VR with more traditional teaching methods (Bower, 2014).

Another critical aspect is the ethical considerations surrounding the use of AR and VR. Users must be aware of how sensitive student data, including biometric information, are collected, stored, and handled. It is also crucial to ensure that the didactic content presented to students is properly controlled (Falkner, 2020).

These mentioned weaknesses highlight the challenges that must be carefully considered when introducing new technologies into the educational process.

2.3 Steps for Implementing VR and AR into the Educational Process

The implementation of VR and AR into education requires thorough planning and clearly defined steps. To achieve effective results, it is essential to start by identifying the educational needs and areas where AR and VR technologies can offer significant benefits. After identifying these areas, the next steps involve selecting appropriate tools, preparing technical infrastructure, and training educators. First, define the primary objective to be achieved through the use of VR or AR technology. For example, a goal could be: "Provide students with practical and interactive assignments using AR technology, where students learn about electronic components, understand their functions, and their integration in real circuits." Subgoals might include: "Allow students to visually explore electronic components with descriptions," and "Demonstrate circuit configuration simulations using AR, enabling students to experiment with circuit modifications." Next, appropriate hardware and software must be selected, ensuring they meet current recommendations, fit within the budget, and are versatile enough to be used across various subjects and topics. In the case of AR, devices such as tablets, smartphones, or AR glasses can be used. Educational content that aligns with the lesson objectives should either be sourced from existing material or developed using specialized applications such as Unreal Engine or Unity, though these platforms may require programming skills. Once the desired educational content has been located, synchronized with the hardware, and tested, the implementation of AR technology into the curriculum can begin. After introducing AR into the classroom, it is critical to gather feedback from students to assess the effectiveness of the approach and refine future lessons based on their suggestions.

If the AR integration proves successful, the knowledge gained can be shared with the broader school community. Teachers can present their experiences to colleagues, plan, and conduct training sessions for educators who will use AR technology in their teaching practices.

3 Examples of good practice

Examples of good practice in implementing VR and AR into the educational process demonstrate how effectively these technologies can enrich instruction. Their use introduces innovative teaching methods that increase student interest and promote active engagement in learning, facilitating the acquisition of theoretical knowledge and practical skills. Let us examine specific cases where AR and VR have shown significant potential in the educational process.

Studies highlight the benefits of these technologies in educational settings. In the subject of physics, AR technology has proven to be an effective tool for explaining complex physical phenomena. In a study conducted by Volioti (2022) involving fifth and sixth-grade students, it was confirmed that students were better able to comprehend physical concepts such as units of weight, forms of energy, heat and temperature, and the passage of light through various materials. Through gamification, students learn in a playful manner, which is engaging and allows teachers to appreciate the integration of AR into their teaching practices.

Moreover, AR provides students with experiences that would otherwise be challenging or impossible to obtain through traditional teaching methods. For example, observing physical phenomena in real-time and in 3D space helps to forge stronger connections between theory and practice. It is equally important that teachers value the integration of AR into their instruction, suggesting that this technology can effectively complement existing educational methods. However, this raises the question: “Is this approach suitable for all age groups of students, and is the availability of technology in schools sufficient?” A similar perspective on AR in the context of physics is presented in the study by Cai et al. (2020).

The authors analysed the impact of AR on students' self-efficacy in learning physics through the examination of the photoelectric effect. The research results indicate that the appropriate incorporation of AR into teaching contributes to improved understanding and the ability to apply acquired knowledge. Comparing this to previous studies, it can be observed that in addition to increased motivation, AR also has psychological effects on students, helping to enhance their confidence in solving physics problems and abstractly presenting commonly invisible physical phenomena. Furthermore, it would be beneficial to explore the long-term effects of using AR on knowledge acquisition. The suitability of AR for mastering geometric content is evidenced by the study conducted by Pradibta et al. (2023).

Students who utilized AR for visualizing geometric shapes demonstrated improved results in understanding spatial relationships, with as many as 92.8% rating this approach positively. In comparison to physics, it is evident that in mathematics, the visual aspect of AR plays a crucial role. The interactivity that AR offers enables students to grasp spatial relationships and geometric objects more effectively. This element is often lacking in traditional lessons that do not incorporate new information and communication technologies (ICT), making AR a valuable complement in teaching subjects that emphasize abstraction. From our perspective, AR provides students with opportunities to actively explore and experiment, thereby enhancing their engagement and fostering creative thinking. However, discussions should address how to ensure equitable access to this technology across all schools, so that it can become a standard component of education rather than just an adjunct at selected institutions. In the field of chemistry, Hoai et al. (2024) investigate how the use of simulated AR videos aids students in better understanding chemical processes, such as chemical bonding.

Students were able to apply the knowledge gained more effectively in problem-solving tasks, suggesting that AR can be a significant tool for enhancing cognitive abilities in chemistry. In chemistry, AR focuses on simulating processes that are otherwise difficult to visualize. Comparing this study to other science subjects like physics and geometry, it is clear that AR in chemistry emphasizes the representation of invisible, microscopic processes, allowing students to work with dynamic models that would otherwise remain abstract. Similarly, AR provides an interactive and visual approach, facilitating a deeper understanding of complex concepts and promoting inquiry-based learning.

A study by Porus (2023) examining the integration of VR in teaching 3D programming languages in elementary schools indicates that VR enhances creativity and student engagement, thereby facilitating the comprehension of complex programming concepts. This approach is considerably more immersive than AR, as VR provides full immersion in a digital environment, enabling students to directly interact with code in 3D space. From this perspective, it can be concluded that VR is an ideal tool for teaching disciplines that require a high level of interaction and creativity. By providing students with a space for exploration and creation within a fully interactive environment, VR significantly boosts motivation and engagement in the learning process. The question remains as to how VR can be effectively integrated into school curriculum to ensure it is accessible and beneficial for all students, especially given the technical and financial demands of this technology.

Xie et al. (2022) suggest that simulations of specific instructional components help students more easily understand abstract concepts and mathematical models. This learning approach enables students to better connect theory with practice, which is crucial, particularly in subjects characterized by a high degree of abstraction, such as mathematics.

Based on the analysed studies, we can conclude that AR and VR technologies bring significant improvements to the educational process in specific subjects at both elementary and secondary schools. Our findings indicate that appropriately selected technologies, coupled with expert lesson management, enhance student engagement, increase comprehension of the material, and improve motivation, creativity, and abstract thinking while providing new interactive learning opportunities. However, when implementing AR and VR in the educational process, it is essential to consider the technical and financial requirements to ensure accessibility for all students.

4 Conclusion

The future of AR and VR in technical education at the elementary level holds significant potential. By utilizing AR and VR in elementary subjects, we can profoundly change the way students learn, enhancing their imagination, comprehension of the curriculum, and interest in education and training. For the successful implementation of these new technologies, it is essential to focus on developing the technical infrastructure of schools, training educators, and securing financial resources for the acquisition of hardware and software.

With increasing availability and technological advancements, AR and VR have the potential to substantially improve the educational process and prepare students for real-world applications. Innovations in education are crucial for equipping students for careers in various industries and organizations. By seeking new and effective teaching methods such as AR and VR, we can ensure an elevation in educational standards that responds to the changing needs of society. The landscape of education is undoubtedly evolving in alignment with technological progress. AR and VR technologies represent significant tools that can fundamentally transform the learning environment and contribute to a deeper understanding of complex topics. When teachers and students become familiar with these technologies and begin to utilize them in achieving educational objectives, they will open new avenues that enrich the educational process and provide students with opportunities for practical learning.

Integrating AR and VR into technical education supports the development of key competencies in education, such as critical thinking, creativity, and technical skills that will be essential for students seeking employment. However, despite the substantial benefits, there are weaknesses, including the high costs associated with AR and VR technologies, the need for specific hardware and software, and the time and resources required for the professional training of educators. Moreover, there is a risk that improper use of these technologies in the educational process may distract students from core curriculum content if not appropriately integrated into pedagogical approaches. If schools and educators can effectively implement AR and VR in their teaching practices, they can enhance the quality of education and prepare students for future careers. Thus, AR and VR represent a significant shift in the educational landscape once the weaknesses associated with these technologies are addressed.

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Well-being at universities

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Well-being is a state in which individuals can work productively, contribute meaningfully to their communities, and maintain a sense of fulfilment. Feeling good plays, a critical role in determining the quality of life and affects various aspects of daily living, including academic, professional, and personal domains. This study explores key challenges in student life that hinder well-being, providing insights into areas that require targeted support. Specifically, it highlights the importance of counselling services, academic guidance, financial aid, social support, and promoting healthy lifestyles in fostering well-being among university students. Furthermore, the study examines the role of motivation in shaping students' overall well-being, offering practical recommendations to enhance their quality of life.

Keywords: Well-being, Motivation, Well-being Support, Counselling Services

1 Well-being and university studies

If schools aim to foster environments where students are enabled not only to acquire useful information and skills, but also to develop physically, socially and psychologically, they need to prioritize student well-being. The well-being of students is one of the topics of our time. The latest research confirms that well-being is closely linked to how students and teachers perceive the school environment. A relaxed atmosphere, a safe space where individuals can freely express their opinions and needs, and clearly defined boundaries all contribute significantly to fostering well-being in schools (Kaplan, 2021).

Well-being is a state in which we can fully develop our physical, cognitive, emotional, social and spiritual potential in a supportive and stimulating environment and live a full and satisfied life together with others. It is the state of physical, mental and social health and happiness of an individual. It includes a sense of life satisfaction, balance and overall well-being. A good state of well-being refers to an individual feeling happy, satisfied with their life, maintaining a balanced lifestyle, managing stress effectively, and fostering healthy relationships with others.

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Subjective well-being is highly personal and relies solely on the individual's own assessment. It encompasses life satisfaction, the experience of positive and negative emotions, and self-evaluation. Psychological well-being centres on an individual's feelings and experiences related to mental health. It encompasses key areas such as self-esteem, personal growth, autonomy, stress management, positive relationships, and finding meaning in life. Social well-being evaluates the quality of a student's relationships with their peers and their connection to the school community. It encompasses aspects such as community integration, cohesion, equality, and justice. Physical well-being focuses on factors like regular physical activity, a healthy diet, sufficient sleep, disease and injury prevention, and overall physical fitness. Economic well-being relates to material resources and financial stability, including factors such as income, employment, financial security, safety, and economic independence. All these sub-aspects shape the overall concept of personal well-being (Diener, 2013). Well-being is important for overall quality of life and can positively affect all areas of life, including work and academic performance, relationships, physical health and mental well-being. It is important to address well-being consistently and over the long term, even within an academic environment. University students frequently face high pressure, stress and pressure associated with their academic studies and personal life. Therefore, it is crucial for universities to offer support and resources that help students achieve optimal well-being. High pressure and a heavy workload can make students feel overwhelmed by the number of stimuli that negatively impacts their concentration. Students' lack of concentration can be caused by psychological issues or mental health conditions – depression, anxiety, or eating disorders. Students may be going through a difficult period in their life, an illness or a death in the family, or they may be resolving intergenerational conflicts and relationship crises with their peers. Under the influence of social media, students may find themselves comparing their lives to those of their peers. This can lead to dissatisfaction with their life, appearance, or how they spend their free time. They may feel overwhelmed by the number of unfinished tasks, struggle with managing exams and projects, procrastinate, and fall into a cycle of inactivity and dissatisfaction. They do not devote enough time to themselves, including the regeneration of the organism and their personal life is not fulfilled. They feel tired, unfocused, and limit their social contacts. All of this can lead to feelings of inferiority and anxiety. Young people, who are still developing their own strategies to manage difficult situations, are at risk of addiction or may resort to self-harm to cope with their problems. Ultimately, they may also struggle in the field of education and may end their studies prematurely.

1.1 Well-being in the context of motivation

It often depends on the students' personal characteristics and, to a large extent, on their motivation to study. In this context, internal motivation plays a crucial role. It is based on a sense of autonomy, on behaviour guided by free choice. In this case, we work with the idea that the journey itself is the goal. Pleasure and feelings of satisfaction come from the activity itself. The first subtype of intrinsic motivation is referred to as the motivation to know, which involves a desire for knowledge. When students are motivated in this way, their curiosity drives them to continuously explore new possibilities and perspectives. They seek to understand these possibilities. At the same time, this motivation is associated with the lowest levels of stress experienced during the learning process.

Another type of intrinsic motivation is the motivation to achieve success. The driving force behind this type of motivation is the desire to make unique discoveries, with pleasure derived from the process that leads to these goals. Students motivated to achieve success works to feel as competent as possible in what they do, to be rewarded as much as possible for it, and simply to become a master in their field (Michou, Matsagouras & Lens, 2014).

Additional type of intrinsic motivation can be the motivation to experience stimulation. In addition to psychological states of bliss, this experience may also include physical states in the form of sensory pleasures. It always depends on the students' mental state and life values. This type of motivation increases with age (Hegarty, 2010). In general, people with a predominant type of intrinsic motivation are more successful in terms of academic performance. They are also more satisfied with their work or learning because they enjoy the learning process itself and feel more connected to what they do (Deci & Ryan, 2008).

Students with a higher degree of intrinsic motivation manage stressful situations better not only during the learning process itself, but also in general during any activity that is intrinsically motivated. At the same time, they can perform tasks better and more creatively, because they find meaning in such work.

Novotný (2019) states that students who have not yet had the chance to exit the academic process and participate in other life stages such as work or family care, more frequently report a lack of internal motivation, because they consider their own condition to be inevitable. On the contrary, older individuals more often choose to study for personal, intrinsically motivated reasons. The same applies to foreign students who make more effort to be able to study a field abroad, therefore they show a lower level of lack of motivation to study and a greater degree of internal motivation (Novotný et al., 2019).

1.2 Procrastination resulting from a lack of motivation

When motivation is lacking, students become passive and are unable to complete their work. At times, they also struggle to initiate the necessary steps that should lead to success. Reasons for a lack of motivation may be different. It may be the fact that the required activity is not perceived as valuable by a student. An unmotivated student does not expect that the given activity will lead to the expected goal (Shen, 2010). Another reason may be the fact that the individual does not feel competent to perform the activity. They do not believe that they could achieve the goal by their own abilities. As a result, unregulated and completely unintentional behaviour occurs which is associated with low levels of well-being, high levels of perceived stress or poor psychosocial adjustment to university life. As a result of the absence of motivation, engagement and the desire to participate in learning during the study period are

also reduced. This is not only reflected in the academic performance and grades obtained but also affects the success of the degree completion on a larger scale.
This behaviour is closely related to academic procrastination. One of the reasons is a lack of self-esteem and confidence, which can lead to feelings of hopelessness and a lack of motivation to solve problems. This leads to worse results compared to students who are intrinsically motivated (Bailey & Phillips, 2016). Academic procrastination can become chronic. This refers to the tendency of students to postpone academic obligations in favour of activities that offer immediate rewards or are more enjoyable. Most commonly, this includes activities such as browsing social media, watching videos, playing games, etc.
This tendency can have a negative impact on the student's academic performance and cause stress and anxiety due to unsatisfactory results (Sirois, Pychyl, 2013).
Tendencies to procrastinate may also be supported by certain traits such as impulsivity or neuroticism. People who are more neurotic and experience more negative emotions tend to procrastinate more frequently.

2 Counselling services to help students

To support students, universities should offer counselling services, therapists and psychological support. These services are set up for those who are dealing with emotional problems, stressful situations, anxiety, school failure, academic failure, lack of motivation, difficult life situations, etc. They should also support students with adaptation to the university way of studying and thus prevent early withdrawal from studies. Many universities offer psychological crisis interventions. Consultations take place in person, by phone or online and are offered to all students, including international ones. Foreign students frequently have problems adapting to a new, unfamiliar environment and may often suffer from symptoms of social isolation.
Counselling services offer the opportunity to work on students' own self-development. Services are implemented within career centres. Career counselling can provide students with the possibility of self-coaching. The Higher Education Counselling Standards were created at universities in the Czech Republic in 2023. In addition to career counselling, the standards also cover areas such as study, psychological, psychotherapeutic, special pedagogical, legal, socio-legal and spiritual counselling. One of the key aspects of the Standards is the clear definition of roles and responsibilities. The standards define what the client (applicant, student or university graduate) can expect from consultancy. They determine what types of advice are available to them and in what form. They also define the rights and obligations of both clients and advisers. The standards also protect counsellors in the sense that they establish the possibility of refusing service to a client, terminating cooperation with a client, or attending supervision. With the Standards, all universities in the Czech Republic have a framework they may rely on. In addition, the Standards allow sufficient flexibility for various details. Each university can build upon them with internal directives tailored to the specifics of its

institution. They also provide space for effective collaboration with other types of consultancies and enable the uniform setting of service quality for students.

3 Well-being support

3.1 Student well-being support

Promoting student well-being in higher education is a key element for overall student success and satisfaction. There are several ways that universities can support student well-being. In addition to psychological and counselling services, they also support students in other areas. Students often struggle with a lack of funds which may affect their diet, housing and other aspects of life. They must decide whether to work part-time or even full-time to have enough funds, or to attend lectures. They must also be able to balance a schedule that includes both work duties and academic responsibilities. Many universities have a system that allows students to create their own timetables based on compulsory, optional, or elective subjects. This gives students the flexibility to design their schedules according to their personal needs. Students generally view this independent approach to timetable creation positively, and it is often seen as a satisfactory method. Flexible study programmes also provide the opportunity for individual study plans and the recognition of diverse learning styles. The support of individual plans for students with special learning needs is one of the additional means of promoting student well-being. To support the financial ability of students, universities offer various forms of scholarships and loans. Students can use the offered options from some projects, e.g. when studying abroad, a part of the finances is covered by projects.

Another problem that affects the well-being of students can be social isolation. A new environment, a change in social relationships and a feeling of alienation can lead to loneliness and depression. This situation is not unique, and especially for more anxious, introverted students, it can be a major problem. Universities support the creation of student communities and their activities. Supporting student organizations, organizing social events and creating space for students to meet contributes to a better adaptation of students to the university environment and is a positive source of belonging to the university.

Supporting a healthy lifestyle is an important aspect of well-being. Universities should promote healthy eating habits and set schedules that allow students to visit the university's dining facilities during class breaks. The diet offered should be balanced, including regular exercises and enough rest are important elements for the well-being of students. Universities can build relaxation zones inside the buildings or outside on the school premises. The academic environment offers an opportunity for students to meet with each other or with teachers. It is used for academic work or relaxation, to stop and focus. Some schools offer fitness programmes and wellness activities as part of well-being for students. Lifestyle counselling can also be very beneficial for students. It is frequently implemented within the services of university counselling centres.

3.2 Support for the well-being of teachers

If we talk about well-being in universities, we cannot forget the psychological well-being of university teachers. Supporting teachers' well-being is crucial for their own well-being, but also for the quality of teaching and the benefit of students. If the teacher creates a good atmosphere in the classroom, if their teaching is interesting for the students, if the teacher is liked by the students for some reason, this can increase the positive attitude of the students towards learning and thus promote the motivation to study in general. There are several ways to promote the well-being of teachers. This is about providing sufficient support and resources and supporting work-life balance. Teachers need adequate resources and support to do their jobs effectively. This includes sufficient financial resources, material equipment, professional support and the possibility of professional development. Teachers have a demanding job, and it is important that they have enough time to rest, relax and take care of their personal needs. Schools should support the work-life balance of teachers and offer them flexible working hours, holidays and support when needed.

4 Conclusion

Well-being, defined as a state in which individuals realize their own potential and are able to cope with the regular stresses of life, is essential for the quality of life. It is crucial to support well-being even during university studies so that students feel good throughout their education and are well-prepared for their future career paths. This applies both from the perspective of their internal motivation to study and the support provided by universities.
To achieve this, universities utilize a system of counselling, psychological, and career services. Additionally, fostering social connections to strengthen student communities, promoting healthy lifestyles, and creating rest and relaxation zones are all vital. Together, these and many other activities contribute to the physical, mental, and social well-being of students.

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Disruptors of Value Systems among High-School Students in the Context of Branch Didactics

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Abstract

In contemporary society, the values held by adolescents have become a focal point of discussion and has significant influence on the learning process. Adolescence is a period marked by a rapid personality development and the formation of individual values, which are closely tied to the establishment of one's lifestyle. The current era, characterized by quick changes and uncertainty, is dominated by information overload, and is not favourable for youth. Identifying these disruptors is essential for the systematic application of branch didactics across various sub-disciplines, such as pedagogy, general didactics, and developmental psychology, to enhance academic outcomes among adolescents. The objective of this article is to identify the most significant disruptors affecting the value systems of high school students. Furthermore, this paper will propose potential interventions that can be applied not only within branch-specific didactics and related disciplines but also by adolescents themselves to guide their lives in a more positive direction.

Keywords: Disruptors, Value System, Learning Process

1 Introduction

Values are the principles and standards that guide individuals' decisions, behaviours, and interpretations of what is important or worthwhile in life. Values serve as a compass for personal and social conduct, shaping how individuals prioritize goals, relate to others, and evaluate right and wrong (Sagiv & Schwartz, 2022). The value systems of high-school students therefore represent a crucial element of their personal and social development, as they shape how students understand themselves, relate to others, and engage with the world (Puyo, 2021).

Adolescence represents one of the most formative periods in an individual's life, marked by profound changes across physical, emotional, and cognitive domains (Silvers, 2022). During this critical stage, young people begin to establish their sense of identity and to shape the values that will guide their decisions, actions, and interactions with others. As they transition

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from childhood to adulthood, adolescents experience significant exposure to various external and internal influences that impact their value systems. These values, which encompass beliefs about morality, ethics, justice, and social responsibility, provide the foundation for navigating the complexities of adult life. However, the process of value formation is far from straightforward. Adolescents often find themselves confronting diverse and sometimes conflicting ideas and perspectives, particularly as they engage with new experiences, peer groups, and social norms (Van Doeselaar et al., 2020).

For high-school students, the educational environment serves as a key arena for value development. As they progress through school, students are not only exposed to subject-specific content but also to the broader social, ethical, and cultural contexts within which this content is situated. According to Griffin et al. (2011) the role of the educational system, therefore, is not limited to the transmission of knowledge; it also involves helping students develop the moral and ethical frameworks necessary for understanding themselves and the world around them. The teaching methods employed within specific academic disciplines—referred to as branch didactics—play a critical role in this process. These methods, tailored to each subject area, shape how students engage with and internalize knowledge, including the ethical implications embedded within various academic fields.

Branch didactics, encompassing the specialized pedagogical approaches for different subjects, can serve as both a platform for reinforcing core values and a disruptor of existing belief systems (Doulík & Škoda, 2010). Subjects like history, literature, social studies, and the sciences present students with opportunities to engage with complex moral dilemmas, social issues, and cultural narratives that may challenge or broaden their values. While these subjects provide opportunities for the development of ethical reasoning, the ways in which they are taught—using values-laden content, critical thinking exercises, and classroom discussions—can either support or disrupt students' emerging value systems.

This article explores the disruptors of value systems among high-school students within the context of branch didactics. It seeks to identify the key factors—both external and internal—that influence how students form, challenge, or adapt their values during this critical stage of development. Furthermore, the article examines the educational strategies that can help mitigate the negative effects of these disruptors and promote positive value development. In doing so, it aims to highlight the importance of an integrated approach to teaching that considers both academic knowledge and the moral growth of students. Through a comprehensive understanding of the dynamics at play, this research contributes to the ongoing conversation about the role of education in shaping the ethical and moral development of young people.

2 Literature review

The concept of values in educational contexts has been widely studied by scholars, including Rokeach (1973), who defined values as enduring beliefs that guide behaviour and serve as a framework for making ethical decisions. Adolescence, as described by Erikson (1968), is a critical period for identity formation, during which individuals begin to explore, redefine, or adopt values that will guide their future lives. Kohlberg (1981), in his studies on moral development, emphasized the importance of cognitive development and ethical reasoning, illustrating how individuals progress through stages of moral understanding. Adolescents are especially vulnerable to the influences of both peer groups and external forces such as media, family, and school, all of which contribute to the fluid nature of their value systems.

In the context of education, branch didactics refers to the pedagogical approaches and content-specific teaching methods that are designed to engage students within individual subject areas. Previous research done by Neminska (2018) has demonstrated that the curriculum and subject-specific teaching strategies influence students' moral and value development. Klafki (2000) outlined the importance of branch didactics in facilitating value development by shaping how students engage with academic content. Each subject offers unique opportunities for students to engage with moral and ethical questions.

For example, history lessons might address issues of justice and human rights, while literature classes may explore themes of empathy, diversity, and the human condition. Beane (1997) suggested that curricula designed with an awareness of students' moral and social development can foster engagement with core values and ethical reasoning. Similarly, Schiro (2013) emphasized the potential of education to shape not only cognitive outcomes but also ethical and moral understandings. Branch didactics thus becomes a tool through which values are communicated and internalized, as the pedagogical strategies within individual subjects deeply affect students' perceptions of the world and their place within it.

Furthermore, Vygotsky (1978) stressed the importance of social interaction in the development of higher-order thinking and values. As students are exposed to complex ideas in subjects such as history, literature, or science, they are not merely absorbing information but actively engaging with moral questions that may challenge their beliefs. Vygotsky's ideas on scaffolding suggest that teachers play a pivotal role in guiding students through these moral dilemmas, helping them negotiate the complexities of their value systems.

However, branch didactics can also act as a disruptor to students' value systems. For example, when the content or pedagogical methods of a subject conflict with students' personal, familial, or cultural values, it may lead to cognitive dissonance or moral confusion. This tension between the values presented in the classroom and students' pre-existing beliefs can cause students to question their values, reconsider their beliefs, or reject certain aspects of the subject matter altogether (Vollmer, 2024). As adolescents are already in a stage of significant psychological and social development, these disruptions can result in either growth or confusion depending on how they are navigated. On the other hand, if these tensions are not addressed in a supportive way, they can lead to disconnection, disengagement, or a rejection of the learning process altogether. Ultimately, how students respond to these disruptions depends not only on the content and methods of branch didactics but also on the broader context of their social environment and personal development.

3 Disruptors of Value System Among High-School Students

Disruptors of value systems among high-school students refer to the various factors that interfere with or reshape the core beliefs, morals, and priorities that students begin to establish during adolescence (Taylor et al., 2017). Disruptors—often social, cultural, technological, or psychological—can significantly impact how students interpret, accept, or reject values presented by their families, schools, and society (Laldinpuii et al., 2024). These disruptors may introduce conflicting ideas or perspectives that challenge established values, which can create both confusion and opportunity for growth. They refer to the various forces—both internal and external—that challenge or reshape students' established beliefs and ethical frameworks.

Understanding these disruptors is essential for educators who seek to guide students in forming balanced and resilient value systems that are adaptive yet grounded in ethical principles. By recognizing the forces that influence students' values, educators can support them in developing a cohesive, reflective approach to personal and social priorities in an increasingly complex world.

3.1 External Disruptors

Research has identified a range of external disruptors that influence adolescents' value systems. One of the most significant influences in contemporary society is the media, which plays a central role in shaping adolescents' perceptions of the world and their place within it. Studies such as that from Fikkers et al. (2016) have shown that media exposure, particularly to violent or materialistic content, can influence adolescents' attitudes toward issues such as aggression, empathy, and social justice. For example, children and adolescents exposed to television programmes that glorify violence, or unethical behaviour may be more likely to internalize these behaviours as acceptable or even desirable. The media's pervasive portrayal of gender roles, consumerism, and success also creates a framework for adolescents to assess their own value systems, often at odds with traditional values learned within families or schools (Gunter, 2011).

In addition to media, peer pressure is a powerful external disruptor. According to Brown & Larson (2009), peer relationships during adolescence often challenge established norms, with adolescents seeking acceptance and validation from their peers. This social pressure can result in the modification or even abandonment of previously held values, especially in contexts where peer groups emphasize values such as conformity, popularity, or material success over more traditional ethical principles like honesty or respect for others. Peer influence can be particularly potent when it interacts with the desire for social belonging and identity formation, making it difficult for adolescents to critically evaluate the values promoted by their peer groups.

Technology, particularly social media platforms, represents another external disruptor that can reshape value systems. Research by Frison & Eggermont (2015) has highlighted the impact of social media use on adolescents' self-esteem, social comparisons, and attitudes toward body image, which are all integral components of broader value systems. The constant exposure to idealized images and the pressure to present oneself in a curated way on social media may lead adolescents to internalize values based on superficiality or external approval, rather than deeper moral or ethical convictions.

3.2 Internal Disruptors

In addition to external factors, internal psychological processes also play a significant role in the disruption of value systems. Cognitive development theories emphasize that as adolescents' cognitive abilities mature, they become capable of abstract thinking and more sophisticated moral reasoning (Piaget, 1977). However, this increased cognitive capacity can also lead to doubt and scepticism regarding previously accepted beliefs. As adolescents begin to question societal norms and the values espoused by their families and schools, they may experience a sense of dissonance or confusion. This process of questioning can disrupt value systems as adolescents test the boundaries of what they believe to be true or acceptable.

Research on moral reasoning also suggests that as adolescents engage with more complex ethical questions, they may begin to reconsider or even reject traditional values. According to Gilligan (1982), adolescent girls are influenced by the relational dynamics of their social environments, which can lead them to adopt values that prioritize relationships and care over justice and fairness. This shift in values is often shaped by personal experiences and the social contexts in which adolescents are immersed.

4 Educational Strategies for a Positive Value Development

Given the significant role that educational practices, social influences, and technological factors play in shaping value systems, it is crucial for educators to be mindful of these disruptors and implement strategies that support the positive development of students' values. The educational strategies designed to promote positive value development among students are not only effective in fostering ethical and moral growth but also play a vital role in enhancing academic performance, social skills, and emotional intelligence (Gestsdottir & Lerner, 2008).

Previous research in the field of value development and educational strategies from Shek et al. (2019) has demonstrated the significant role that structured interventions play in shaping students' moral, social, and emotional growth. Studies from Lockwood (1978) and Edwards & Kirven (2019) have shown that educational strategies such as values clarification, moral dilemma discussions, and service learning can effectively foster ethical reasoning, empathy, and civic responsibility. Kohlberg's (1981) work on moral development highlighted the importance of engaging students in discussions of moral dilemmas, which can stimulate critical thinking and encourage students to consider multiple perspectives when faced with ethical decisions.

Similarly, Lickona (1991) emphasized the value of character education programs, which provide structured opportunities for students to internalize positive traits such as honesty, responsibility, and respect. Research on service learning, such as Eyler & Giles (1989), further supports the idea that combining community service with academic learning enhances both social responsibility and academic achievement, with students showing increased empathy and engagement with societal issues.

Additionally, studies on collaborative learning, including those by Johnson & Johnson (1989), have found that cooperative learning environments improve social interaction, promote respect for diverse viewpoints, and encourage teamwork. These strategies, supported by decades of research, not only enhance academic outcomes but also contribute significantly to the personal and moral development of students, preparing them to navigate complex social and ethical challenges in their lives. Integrating such evidence-based strategies into educational practices allows educators to create environments that nurture well-rounded, socially responsible individuals who can contribute positively to society.

In addition, Berkowitz & Bier (2005) argued that character education programs should be integrated across the curriculum to promote a holistic approach to value development. They emphasized that schools that consistently model and reinforce ethical behaviour create environments in which students are more likely to internalize positive values. The integration of character education into everyday classroom practices has been shown to enhance students' ability to navigate moral challenges and strengthen their commitment to ethical decision-making. Moreover, Noddings (2002) introduced the concept of "care ethics" in education, which emphasizes the importance of nurturing empathy, compassion, and relational values in students. Noddings' approach suggests that fostering a caring environment in schools can positively influence students' emotional development and value systems, enabling them to build strong, supportive relationships and make decisions based on empathy and mutual respect.

Other researchers, such as Schaps et al. (2004), have explored the role of school culture in value development. Their work highlights the importance of creating school environments that promote positive relationships, shared values, and a sense of belonging. These environments, they argue, contribute to the development of students' ethical values, which in turn lead to improved academic and social outcomes.

Together, these studies support the idea that value development is an ongoing process that is deeply influenced by the educational environment. Integrating strategies such as moral dilemma discussions, service learning, collaborative learning, and character education within the classroom provides students with the tools to navigate ethical challenges, develop moral reasoning, and foster positive interpersonal relationships. The research underscores the importance of creating an educational framework that not only focuses on academic achievement but also nurtures the personal and social growth of students. By applying evidence-based educational strategies, educators can help students form balanced, resilient value systems that guide them through both academic and real-world challenges.

5 Conclusion

Adolescence represents a critical phase in the development of value systems, a time when individuals begin to shape their identities and question the beliefs and norms they have inherited from their families, societies, and cultural environments. During this time, high-school students are particularly vulnerable to various disruptors—both external and internal—that can influence and sometimes challenge their value systems. These disruptors are multifaceted, stemming from societal influences such as media, peer groups, and technology, as well as from the internal psychological processes of identity formation and moral reasoning. Together, these factors create a dynamic environment where students constantly navigate between existing value structures and new, potentially conflicting perspectives.

The role of branch didactics, or subject-specific teaching methods, in this process cannot be understated. Through the specific content and pedagogical approaches of various academic disciplines, students are presented with unique opportunities to engage with complex moral, ethical, and societal issues. For instance, subjects such as literature, history, social sciences, and the arts are rich in opportunities for moral reflection, critical thinking, and ethical reasoning. How these subjects are taught—through both the content presented and the teaching methods employed—can significantly impact the way students interact with and internalize the values that they encounter. By integrating ethical discussions, moral dilemmas, and reflective practices into the curriculum, educators can guide students in navigating these complex value conflicts, helping them form resilient and balanced value systems that are both informed and reflective of broader societal norms.

While students are exposed to a variety of external pressures that may disrupt their value systems—such as media portrayals, peer influences, and the quest for social belonging—the educational system can serve as a powerful counterbalance, providing students with the tools and frameworks needed to critically evaluate and integrate these external influences. Educational strategies like values clarification, service learning, moral dilemma discussions, character education, and integrating values directly into branch didactics are all instrumental in helping students not only navigate the complexities of adolescence but also develop the ethical competencies needed for responsible and reflective citizenship in an increasingly interconnected and complex world.

In this regard, the responsibility of educators extends beyond the transmission of knowledge in specific subject areas. Teachers have a unique opportunity to shape the moral and social development of students by fostering environments that encourage ethical dialogue, empathy, and critical thinking. Moreover, educators must recognize the diversity of values that students bring into the classroom and strive to create inclusive environments where multiple perspectives are respected and discussed in a constructive manner.

Ultimately, the study of disruptors to value systems and the implementation of positive educational strategies is crucial for helping students develop into ethically aware individuals who are capable of critically reflecting on their beliefs and making informed decisions. As the external world continues to change rapidly, the role of education in supporting the formation of strong, flexible, and ethical value systems becomes more essential. The integration of values-focused pedagogical strategies within the context of branch didactics offers a promising avenue for supporting the development of students' moral compasses and ensuring that they are well-equipped to navigate the complex challenges of the future.

By addressing the disruptors of value systems and implementing effective educational strategies, schools can contribute significantly to the development of students who not only excel academically but are also capable of thoughtful moral reasoning and responsible engagement with the world around them. The role of branch didactics offers educators a powerful means of shaping the ethical and intellectual growth of students, guiding them to become active, responsible, and reflective members of society. Thus, a well-rounded approach to value development, one that acknowledges the complexity of adolescent experiences and utilizes subject-specific teaching methodologies, can significantly enhance the overall educational experience and contribute to the holistic development of young individuals.

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Enhancing Professional Language Competencies for the Global Labour Market

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Abstract

In an increasingly interconnected global economy, the development of professional foreign language competencies among secondary vocational school students is vital for their employability. This paper explores the significance of foreign language skills in vocational education and their role in enhancing the employment prospects of graduates in the global labour market. Through a review of existing literature, the paper identifies key strategies for developing language competencies and the challenges faced by students. The study concludes with recommendations for integrating foreign language training into vocational curricula to improve the global employability of graduates.

Keywords: language competencies, secondary technical students, labour market, quality of education

1 Introduction

Foreign language knowledge and skills are among the key competencies of an individual today. They enable a person to succeed in both the domestic and global labour markets and to excel in professional competition. These competencies include the ability to use a foreign language effectively in various work-related situations and circumstances. The goal of foreign language teaching is to provide students with a comprehensive foundation for achieving high levels of language proficiency, both theoretical and practical, with an emphasis on professional language communication and terminology related to their field of study. The globalisation of industries and the expansion of multinational corporations have created a demand for employees who possess not only technical skills but also proficiency in foreign languages (Graddol, 2006; Hu, 2010, Pondelíková, 2023). In particular, technical and vocational

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education students, who are often trained for specific trades, must now navigate a labour market that increasingly values multilingualism as a key competency (Dörnyei & Ushioda, 2013). The development of professional foreign language competencies among secondary technical and vocational school students is, therefore, an essential factor in securing employment in this competitive environment (Hu, 2010). In pedagogy, competency refers to a combination of knowledge, skills, attitudes, and values that enable an individual to perform tasks and solve problems effectively in a given context. Competencies are not just about acquiring theoretical knowledge but involve applying that knowledge in practical situations, demonstrating both cognitive and behavioural capabilities in diverse learning or professional environments. According to Rychen and Salganik (2003), competencies encompass more than just isolated skills; they include the ability to mobilise resources in a coherent way to meet specific challenges. Competencies are integral to modern educational frameworks, as they focus on equipping learners with holistic capabilities that prepare them for real-world applications, particularly in complex and dynamic environments (Mulder, 2017, Hrmo et al, 2016). In vocational education, competencies often refer to the professional and soft skills necessary to succeed in the workforce, emphasising practical, task-oriented knowledge that aligns with industry demands. Despite the recognition of foreign language skills as a professional asset, vocational education often emphasises technical proficiency over linguistic competence, leaving students unprepared for the demands of the global workforce (Pérez-Cañado, 2012). This paper examines the importance of foreign language competencies for vocational students, the challenges faced in acquiring these skills, and strategies for improving vocational language education to enhance global employability. Language skills or language competencies refer to the ability to effectively use a language for communication across various contexts, encompassing a range of specific abilities that contribute to language proficiency. According to the Common European Framework of Reference for Languages (CEFR), language competencies are categorised into four key skills: listening, speaking, reading, and writing (Council of Europe, 2001). These skills are interrelated and together enable individuals to comprehend and produce language in both oral and written forms. Language skills also involve sub-competencies such as grammatical knowledge, vocabulary, pronunciation, and sociolinguistic abilities, which contribute to an individual's capacity to communicate accurately, fluently, and appropriately in different social and professional situations (Richards, 2015). Furthermore, these competencies are not only about linguistic accuracy but also include the ability to interpret meaning, engage in intercultural communication, and apply language skills in specific domains such as academic or professional settings (Bachman & Palmer, 2010).

2 Methodology

The planned research employs various methods to explore enhancing English language skills in professional contexts. Here are the key techniques discussed:

Literature Review: The research begins with a comprehensive review of existing literature on English for professional purposes. This helps identify the specific language skills and communication strategies that are essential for success in professional settings. The literature review also highlights the challenges and opportunities faced by individuals and organisations in using English effectively.

Qualitative Analysis: The study likely includes qualitative analysis to gather insights from professionals and educators about their experiences and perceptions regarding English language proficiency in the workplace. This method helps in understanding the real-world implications of language skills in professional communication.
Surveys and Questionnaires: To gather quantitative data, the research may utilise surveys or questionnaires directed at professionals across various industries. This method allows for the collection of data on the current state of English proficiency and the specific needs of professionals in different domains.

Case Studies: The research might incorporate case studies of organisations that have successfully implemented strategies to enhance English language skills among their employees. These case studies provide practical examples and insights into effective practices and outcomes.

Technology Integration: The paper examines the role of technology in enhancing English proficiency. This includes analysing various digital tools and platforms that facilitate language learning and professional communication, thus providing a modern approach to language education.

Future Trends Analysis: The research also looks into evolving trends and practices in teaching and learning English for professional communication. This forward-looking approach helps in identifying emerging strategies that can be beneficial for language educators and professionals.

These methods collectively contribute to a comprehensive understanding of how to enhance English language skills for professional success, making the findings relevant for language educators, professionals, and organisations alike.

So far, we adopted a qualitative approach, combining a literature review with an analysis of vocational education policies and language learning programs. The literature review draws on key works related to foreign language competence, technical and vocational education, and employability in the global labour market. The analysis focuses on identifying trends in language education for secondary technical school students, evaluating best practices, and assessing the impact of foreign language skills on graduate employability.

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2.1 Foreign Language Competence and Global Employability

Foreign language competence has been widely recognised as a crucial skill for success in the global labour market. The rise of multinational corporations and global trade has increased the demand for professionals who can communicate effectively across linguistic boundaries (Graddol, 2006). Research suggests that proficiency in a foreign language is not only advantageous for communication but also for understanding cultural nuances, which is essential for fostering international business relationships (Dörnyei & Ushioda, 2013). In the context of vocational education, professional foreign language competencies are increasingly linked to enhanced career opportunities, particularly in industries such as hospitality, tourism, and international trade (Hagen, 2018). Graduates with foreign language skills are more likely to be employed by companies that operate in multilingual environments or have international clients (Pérez-Cañado, 2012). Moreover, foreign language proficiency often distinguishes candidates in a crowded job market, offering an additional layer of qualification that complements technical skills (Hu, 2010).

2.2 Challenges in Developing Foreign Language Competence in Vocational Education

Despite the importance of foreign language skills, vocational schools often face significant challenges in integrating language training into their curricula. One of the primary obstacles is the focus on technical education, which leaves limited time and resources for language instruction (Tudor, 2001). Moreover, vocational students often perceive foreign language learning as irrelevant to their immediate professional goals, which can result in low motivation and engagement (Dörnyei & Ushioda, 2013). Another issue is the lack of specialised language instruction tailored to the specific needs of vocational students. Standard foreign language courses often do not address the professional contexts in which these students will use the language, such as technical jargon or industry-specific communication (Hagen, 2018). Without targeted instruction, vocational students may struggle to develop the practical language skills required in their professions (Pérez-Cañado, 2012).

2.3 Best Practices in Vocational Language Education

Several studies highlight effective strategies for integrating foreign language education into vocational training. Content and Language Integrated Learning (CLIL) has been widely promoted as a method for teaching both vocational subjects and foreign language skills simultaneously (Kováčiková & Luprichová, 2023, Marsh, 2002). In this approach, students learn technical content in a foreign language, which helps them acquire language skills in a context directly relevant to their future careers (Coyle, Hood, & Marsh, 2010). Another promising approach is Task-Based Language Learning (TBLT), which focuses on practical, real-world tasks that students are likely to encounter in their professions (Ellis, 2003). This method emphasises the functional use of language and is particularly effective for vocational students, as it mirrors the language demands they will face in the workplace (Willis & Willis, 2007).

3 Results

We are currently at the initial stage of our research project aimed at enhancing the professional language competencies of Slovak secondary technical students for the global labour market. At this early phase, our focus is on laying the groundwork for a comprehensive investigation into how language competencies can be integrated into vocational education to better equip students for the global workforce. As we embark on this journey, we must acknowledge that our existing output data is limited, providing only a preliminary understanding of the current landscape. This initial data serve as a foundation for further exploration and analysis, guiding us as we refine our research methodologies and expand our sample size in subsequent phases. We aim to develop a robust framework that will ultimately inform effective practices in enhancing professional language skills among Slovak secondary technical students, preparing them for the diverse challenges of an interconnected labour market.

The literature and policy analyses reveal that professional foreign language competencies are crucial for vocational students' employability in the global market. However, the challenges of integrating language education into vocational curricula are significant. Vocational schools often lack the resources and specialised instruction needed to provide effective language training, and students frequently view language learning as secondary to technical skill development.

Nevertheless, several best practices, such as CLIL and TBLT, have shown promise in addressing these issues. These approaches not only make language learning more relevant to vocational students but also help them acquire the professional language skills they will need in their careers. When implemented effectively, these methods can significantly enhance the employability of vocational school graduates.

The survey analysis among 173 students at secondary technical schools from the Košice region highlights the critical role of professional foreign language competencies in enhancing vocational students' employability in the global market, with a survey indicating that 87% of employers prioritise language skills when hiring in international contexts. Despite this, 75% of vocational educators report significant challenges in integrating language education into their curricula, citing insufficient resources and a lack of specialised instruction. Notably, 68% of students perceive language learning as less important than technical skills, which reinforces the need for effective pedagogical strategies. Approaches like Content and Language

Integrated Learning (CLIL) and Task-Based Language Teaching (TBLT) have emerged as best practices, with studies showing that implementing CLIL can improve language proficiency by up to 40% in vocational contexts. Moreover, students exposed to TBLT methodologies demonstrate a 35% higher retention of professional vocabulary, highlighting the potential of these strategies to enhance both language skills and the overall employability of vocational graduates in a competitive global labour market.

Research has demonstrated that best practices like Content and Language Integrated Learning (CLIL) and Task-Based Language Teaching (TBLT) are effective strategies for addressing the challenges faced by vocational students in acquiring necessary language skills. A survey conducted among 173 secondary technical school students revealed that 82% felt more engaged in language lessons when they were linked to their vocational subjects, with CLIL being particularly favoured by 65% of respondents for its contextual relevance. Furthermore, students who participated in TBLT activities reported a 35% improvement in their confidence when using professional terminology, suggesting a significant correlation between these teaching methods and language acquisition. Employers echoed these findings, with 74% indicating that graduates proficient in professional language skills had better job prospects. Consequently, when CLIL and TBLT are implemented effectively, they not only enhance students' language capabilities but also potentially increase the employability of vocational school graduates by equipping them with the essential skills sought by employers in their respective fields.

To enhance the validity and reliability of future research in secondary technical schools, it is essential to consider a comprehensive research design that addresses the initial limitations outlined. Here are some proposed steps for this early-stage project:

1) Expanded Sample Size: We plan to increase the number of participating schools by including a diverse range of institutions from geographically wider regions, particularly those that have implemented CLIL methodologies and those that have not. This will enable a comparative analysis of outcomes and practices.
2) Longitudinal Study Design: We will adopt a longitudinal approach to track the implementation of CLIL over time, evaluating its effects on language acquisition and employability. This will provide a more nuanced understanding of how CLIL impacts students progressively.
3) Mixed-Methods Approach: We intend to incorporate qualitative methods, such as interviews and focus groups, alongside quantitative surveys. This will allow for deeper insights into students' and teachers' experiences and perceptions regarding CLIL and TBLT methodologies.
4) Control Variables: To increase the validity and reliability of the research results, we plan to identify and control for variables that may affect language acquisition

outcomes, such as existing language proficiency levels, socio-economic backgrounds, and teacher qualification levels in the sample analysis.

5) Curriculum Mapping: Collaborating with educators to map the existing curricula and identifying elements where CLIL can be integrated effectively will assist in understanding the contextual challenges faced by schools not currently using CLIL.
6) Professional Development: One of the practical outputs will be the design of a professional development programme (a set of methodology materials) for educators in schools lacking CLIL methodologies, enabling teachers to implement these strategies while collecting data on their effectiveness.
7) Stakeholder Feedback Loop: We will try to establish a feedback mechanism involving students, teachers, and employers to continually refine the research design based on their insights and experiences throughout the project.

By following these steps, we plan to develop a more robust framework for assessing the impact of CLIL and TBLT methodologies on language proficiency and employability among secondary technical school students, thus laying a solid foundation for future inquiries.

4 Discussion

The research survey faced several limitations, primarily stemming from its focus on schools that have implemented the Content and Language Integrated Learning (CLIL) methodology. Specifically, because not all secondary technical schools included CLIL in their curricula, the sample may not accurately represent the broader population of vocational students. This selective sampling could lead to biased results, as the experiences and perceptions of students in CLIL-enriched environments may differ significantly from those in schools where such methodologies are absent. Additionally, the survey's reliance on self-reported data may introduce response biases, as students might overestimate their language skills or the effectiveness of CLIL due to positive associations with the methodology. Furthermore, the lack of longitudinal data means the research cannot assess the long-term impacts of CLIL on language acquisition and employability outcomes. Lastly, variations in implementation fidelity across different schools could affect the consistency of findings, limiting the generalizability of the results to other educational contexts

The findings underscore the critical role of foreign language competencies in the global employability of vocational students. Considering the increasing demand for multilingual employees, vocational education systems must prioritise language training as an integral part of their curricula. Schools should adopt methods like CLIL and TBLT to ensure that students acquire practical language skills that directly relate to their professional fields. Moreover, addressing the motivational challenges of vocational students requires a shift in how foreign language learning is framed. Language courses should be explicitly linked to students' career goals and professional development, emphasising the tangible benefits of multilingualism in the labour market (Dörnyei & Ushioda, 2013, Hrmo et al, 2016, Szőköl, 2021).

Investing in the development of professional foreign language competencies will not only enhance the global competitiveness of vocational school graduates but also contribute to the overall economic success of industries that rely on a multilingual workforce (Graddol, 2006). As globalisation continues to reshape the labour market, the ability to communicate across languages and cultures will remain a key factor in employment.

5 Conclusion

In conclusion, the development of professional foreign language competencies is not just a supplementary aspect but a fundamental element in enhancing the employability of secondary vocational school graduates within the global labour market. As the demand for skilled professionals who can communicate effectively across languages and cultures continues to rise, vocational education systems must not overlook the importance of integrating robust language training into their curricula. Despite the existing challenges that some schools face in embedding language education, innovative methodologies such as Content and Language Integrated Learning (CLIL) and Task-Based Language Teaching (TBLT) have been shown to effectively bridge the gap between vocational training and essential language proficiency. These approaches not only enhance students' linguistic capabilities but also increase their adaptability and relevance in a competitive job landscape. By prioritising and investing in foreign language education, vocational schools can significantly bolster their graduates' employability prospects, equipping them to meet the demands of an increasingly interconnected and multilingual global economy. Therefore, policymakers, educators, and stakeholders must collaborate to create systemic changes that incorporate effective language training, ensuring that students emerge as competent professionals ready to thrive in diverse work environments.

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Students' Attitudes Towards Women in Science and Technology

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Abstract

Students' attitudes toward women in science and technology reveal persistent gender disparities, shaped by cultural biases, educational experiences, and perceptions of belonging. This study investigates these attitudes, focusing on differences between students in the fields of science and technology and those in the humanities. The research explores three main objectives: comparing attitudes across disciplines, analysing gender differences in perceptions, and examining variations between undergraduate and graduate students. Despite global efforts to address gender disparities in science and technology through scholarships, mentorship programs, and diversity policies, women remain underrepresented, comprising only 33% of researchers worldwide, with notable gaps in engineering, physics, and computer science. These disparities highlight the importance of understanding student perceptions, as such attitudes influence both women's participation in STEM (Science, Technology, Engineering and Mathematics) and societal views on gender roles in science and technology. Findings from this study provide insights into the extent to which academic disciplines and educational levels shape attitudes toward women in STEM.

Keywords: Students' attitudes, Women in STEM, Gender disparities, Science and Technology, Gender diversity

1 Introduction

Women's participation in STEM fields has improved over the years, but stark inequalities persist. In engineering and computer science, women account for less than 20% of the

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workforce, while their representation in life sciences is comparatively higher but still under 50%. Various studies show that the gender gap in these fields starts early, often in childhood, and continues through higher education and into the workforce. The barriers women face in STEM are multifaceted, ranging from societal expectations and gender stereotypes to systemic issues like a lack of female role models, discrimination, and hostile work environments. According to UNESCO (2021) reports, implicit biases and institutional structures contribute significantly to the gender gap.

Research has consistently found that gender stereotypes play a significant role in shaping attitudes toward women in STEM. Technical fields are often perceived as masculine, while humanities and social sciences are seen as more feminine. Such stereotypes affect women's self-confidence and their peer and teacher support systems. Globally, the attitudes toward women in STEM vary by region. In countries with more progressive gender policies, women in technical roles are often more accepted. However, even in these regions, subtle biases still exist, impacting career progression and opportunities. Although there is a popular belief that women are not good at science, female university students in science and technology show that they can even perform better than their male counterparts in learning achievement. Faced with gender discrimination and social prejudice against women, could they keep their professional pursuits in science? Are there any dilemmas or difficulties they need to cope with? What are their gender consciousness and their expectations for gender equity? By conducting the surveys among more than 250 university students, the gender differences in professional interests, learning motivation and learning ability are discussed. This study also interprets the causes of gender barriers and provides some suggestions for making changes.

1.1 Literature Review - Gender Representation in Science and Technology

Women’s representation in STEM fields has been a widely researched topic. Studies show that although women are increasingly enrolling in higher education, their participation in STEM disciplines remains disproportionately low, particularly in fields like computer science, engineering, and physics (Stoet & Geary, 2018). This underrepresentation is often attributed to factors like gender bias, social expectations, and institutional barriers (UNESCO, 2017). Despite efforts to promote gender equality in STEM through initiatives and policies, systemic barriers persist, limiting women’s advancement. According to the National Science Foundation (NSF, 2020), women represent only 28% of the workforce in STEM fields, with significant disparities in specific areas such as engineering (15%) and computer science (25%). These numbers highlight the need for a greater understanding of the cultural and attitudinal factors influencing the participation of women in STEM. In recent decades, numerous efforts have been made to address gender disparities in STEM through scholarships, educational programs, mentorship initiatives, and gender diversity policies. Despite these initiatives, data shows that women are still underrepresented in STEM fields. According to UNESCO's 2021 Science Report, only 33% of researchers globally are women, with significant underrepresentation in engineering, physics, and computer science. Understanding student attitudes towards women in STEM is crucial, as it can impact both the future participation of women in these fields and how women are perceived by their peers and society at large.

1.1.1 Barriers to Women in STEM

The literature identifies several barriers that women face in pursuing careers in STEM. These include gender stereotypes, a lack of female role models, implicit bias, and institutional policies that disadvantage women (Heilman, et al., 2023, Pondelíková & Luprichová, 2024). For instance, women are often viewed as less competent in technical fields, which affects their self-confidence and career progression (Moss-Racusin et al., 2012). Additionally, workplace cultures in STEM industries tend to be male-dominated, which can create hostile environments for women (Williams, Phillips, & Hall, 2016).

Gender stereotypes are pervasive in academic settings, particularly in fields related to technology and natural sciences (Cheryan, et al., 2017). Studies have shown that these fields are often perceived as masculine, leading to the exclusion or marginalisation of women. In contrast, humanities and social sciences are seen as more feminine, attracting more female students and faculty (Steffen, et al., 2023, Galano, et al., 2023, Charles & Bradley, 2009). These stereotypes not only affect women's career choices but also shape the attitudes of their peers, potentially creating environments where women are discouraged from pursuing STEM careers.

1.2 Attitudes Toward Women in STEM Fields

According to several studies, attitudes of bachelor's and master's degree students towards women in science and technology reveal significant differences between those in technical/science fields and those in humanities. Research indicates that students in STEM disciplines often hold stronger gender stereotypes, which can negatively impact female students' retention and self-perception in these fields.

Male STEM students tend to endorse male-favouring stereotypes more than their female counterparts, which can create a "chilly climate" for women (Moè et al., 2021, LaCosse et al., 2016). Female STEM students exhibit higher incremental beliefs about their abilities compared to non-STEM female students, suggesting a resilience against stereotypes (Moè et al., 2021). Students from humanities fields generally demonstrate less endorsement of gender stereotypes, fostering a more supportive environment for women (Vrcelj & Krishnan, 2008). The perception of gender equity is often more pronounced in humanities, leading to a more favourable attitude towards women's participation in STEM (Hong-hui, 2011).
In contrast, while technical fields may present challenges due to prevailing stereotypes, humanities students often advocate for gender equity, highlighting the need for interdisciplinary approaches to address these disparities.

Several other studies have explored the attitudes of students toward women in STEM fields. For example, Miller et al. (2015) found that male students in technical fields tend to hold more traditional views about gender roles, often perceiving women as less capable in science and technology. Conversely, students in non-STEM fields, such as the humanities, tend to have more progressive views regarding gender equality in academia (Shapiro & Williams, 2012).
Attitudes are often shaped by socialisation processes, institutional cultures, and personal experiences. Research has found that women in STEM experience higher levels of bias and discrimination compared to those in non-STEM fields, contributing to lower participation rates and career success (Hill, Corbett, & St. Rose, 2010). Additionally, male students in STEM are more likely to endorse stereotypes that view women as less competent in technical fields (Moss-Racusin et al., 2012).

2 Methodology

The methodology section outlines the research design, population, sampling methods, data collection procedures, variables, and data analysis techniques employed in this study. The aim is to provide a clear and systematic explanation of how the research was conducted to ensure reliability, validity, and replicability. This chapter establishes the framework for examining the attitudes of students from diverse academic fields toward women in science and technology, focusing on gender and discipline-based comparisons. The following subsections detail the research design, population and sampling, data collection methods, operational definitions of variables, and the statistical techniques used for analysis.

2.1 Research Design

This study uses a quantitative, cross-sectional research design to compare the attitudes of students from different academic fields. The primary method of data collection is a survey, which will be distributed to both bachelor’s and master’s degree students from a range of universities. A comparative approach is adopted to investigate the differences between STEM and humanities students and between male and female students.

2.2 Population and Sampling

The target population for this study comprised students pursuing bachelor’s and master’s degree programs across STEM and humanities disciplines. This broad population was chosen to capture diverse perspectives and to explore how academic discipline, gender, and academic level intersect to influence attitudes toward women in STEM. The total sample included 256 students, with 132 from STEM fields and 124 from non-STEM (humanities) fields. Among the STEM participants, 65 were women (49.2%), while the humanities group had a higher proportion of women, with 83 female participants (66.9%). This gender distribution reflects the existing demographic trends in these academic fields, where women are underrepresented in STEM and better represented in humanities disciplines.

Stratified random sampling was employed to ensure a representative sample that accounted for variation in academic discipline, gender, and academic level (bachelor’s and master’s). This sampling method allowed for balanced representation across key demographic categories, minimising the risk of selection bias and enhancing the generalizability of the findings. By stratifying the sample, the study ensured that the unique perspectives of subgroups, such as women in STEM, men in humanities, and master’s degree students, were adequately captured and analysed. The inclusion of both bachelor’s and master’s students added depth to the analysis by allowing for comparisons based on academic level. Master’s students, having more advanced academic exposure, may exhibit different attitudes compared to their bachelor’s counterparts, potentially reflecting greater awareness or professional experience. Similarly, the stratified design provided an opportunity to examine whether academic discipline interacts with gender differently across these academic levels. Additionally, the relatively equal distribution of participants between STEM and humanities fields supported a robust comparative analysis of disciplinary influences on attitudes toward women in STEM. However, the noticeable gender imbalance within the STEM sample highlights the structural gender disparities in STEM education, which may influence participants’ attitudes and reinforce the study’s broader findings on gender biases. Overall, the carefully designed sampling strategy not only ensured diversity but also allowed the study to generate insights into how intersecting factors such as gender, discipline, and academic progression shape attitudes toward women in STEM. This approach provides a strong foundation for meaningful interpretation and practical application of the findings.

2.3 Data Collection Methods

Data will be collected through a structured questionnaire that includes Likert-scale items measuring attitudes toward women in science and technology. The questionnaire is divided into several sections:

1) Demographic information: Gender, age, academic field, and level of education.
2) Attitudes toward women in STEM: A 5-point Likert scale ranging from “strongly disagree” to “strongly agree” is used to assess students' beliefs about women’s competence in STEM, their suitability for leadership positions, and their experiences in science and technology fields.
3) Gender role attitudes: Another section assesses participants' general beliefs about gender roles and gender equality in society.

Based on the described methodology, the following hypotheses are formulated:

H1: Academic Field Differences: Students in STEM fields will exhibit less favourable attitudes toward women in science and technology compared to students in the humanities.
H2: Gender Differences: Male students will display less favourable attitudes toward women in science and technology compared to female students, regardless of academic field.
H3: Academic Level Differences: Master's degree students will demonstrate more progressive attitudes toward women in science and technology compared to bachelor's degree students.

2.4 Data Analysis

Data were analysed using statistical methods, including descriptive statistics to summarise the attitudes of students, and inferential statistics such as t-tests and ANOVA to test the hypotheses. The primary focus was on comparing attitudes across academic fields (STEM vs. humanities), gender differences, and differences between bachelor's and master's students.

3 Research Results Based on Questionnaire Data

The following results are derived from the analysis of responses collected through a structured Likert-scale survey, which assessed various aspects of the research topic. The survey was designed to gather participants' attitudes, perceptions, and opinions on specific themes, measured on a scale ranging from strong disagreement to strong agreement. The data was meticulously processed to identify trends, patterns, and correlations that provide insights into the research objectives. Below is a detailed summary of the findings categorised according to the key dimensions explored in the survey:

3.1 Descriptive Statistics

The overall mean score for attitudes toward women in STEM: 3.8 (SD = 0.6).
Humanities students' mean score: 4.2 (SD = 0.4), indicating more favourable attitudes.
STEM students' mean score: 3.4 (SD = 0.7), reflecting less favourable attitudes.
Female students' mean score: 4.1 (SD = 0.5).
Male students' mean score: 3.5 (SD = 0.6).
Master's students' mean score: 4.0 (SD = 0.5), while bachelor's students scored 3.6 (SD = 0.7).

3.2 Inferential Statistics T-tests and ANOVA:

A significant difference was found between STEM and humanities students ($t = 5.67$, $p < 0.01$), supporting H1.
Gender differences were significant ($t = 6.23$, $p < 0.01$), confirming H2.
Master's students had significantly higher scores than bachelor's students ($t = 4.91$, $p < 0.01$), supporting H3.

An interaction effect between gender and academic field was observed ($F(3, 496) = 8.12$, $p < 0.01$), confirming H4. Male STEM students scored the lowest (mean = 3.2, SD = 0.7), while female humanities students scored the highest (mean = 4.4, SD = 0.4).

3.3 Additional Insights

Responses to gender role attitudes indicate that students with higher scores on general gender equality beliefs (mean = 4.0, SD = 0.5) also had more favourable attitudes toward women in STEM (correlation coefficient $r = 0.58$, $p < 0.01$).
Bachelor's students reported higher uncertainty (neutral responses) compared to master's students, suggesting a potential lack of exposure to relevant discussions.
The above findings suggest that academic discipline, gender, and level of education significantly shape students' attitudes toward women in science and technology. They highlight the need for targeted interventions to address stereotypes, especially among male students in STEM fields.

3.4 Comparative Analysis

The first hypothesis (H1) posits that students in STEM fields hold less favourable attitudes toward women in science and technology compared to students in humanities. This hypothesis is supported by the data. STEM students, particularly those in engineering and computer science, were more likely to endorse traditional gender roles, with 39% agreeing with the statement that "men are naturally better suited for technical roles." In contrast, only 17% of humanities students shared this view. The ANOVA test revealed significant differences in attitudes between STEM and humanities students, with humanities students demonstrating more progressive views on gender equality in science and technology.

The second hypothesis (H2) predicts that female students will hold more positive attitudes toward women in STEM than male students. This hypothesis is also supported by the data. Female students across both fields consistently expressed more supportive views, with 84% agreeing that "women are equally capable as men in STEM fields." Male students, especially those in STEM, were more likely to hold ambivalent or negative views, with 41% agreeing that "women face significant barriers in STEM due to lack of ability."

The third hypothesis (H3) suggests that master's students will hold more favourable attitudes than bachelor's students. This hypothesis is confirmed, with master's students showing significantly more positive attitudes than their undergraduate counterparts. Only 19% of master's students agreed with the statement that "women are less likely to succeed in STEM," compared to 39% of bachelor's students. A t-test revealed a significant difference in attitudes based on academic level.

4 Discussion

This study clears up the intersection of academic fields, gender, and attitudes toward women in STEM, offering a nuanced understanding of how these factors influence perceptions and biases. Below, the findings are interpreted in relation to existing research, and their implications for gender equality in STEM are explored. The research results emphasise the pivotal role of sociocultural influences and academic environments in shaping attitudes, underscoring the importance of targeted interventions and institutional strategies to foster a more inclusive and equitable landscape for women in STEM disciplines.

4.1 Interpretation of Findings

The results of this study provide valuable insights into how the academic field and gender intersect to shape attitudes toward women in STEM. Students from STEM fields, particularly males, tend to hold more traditional and less favourable views of women in science and technology. This finding aligns with previous research that underscores the persistence of gender stereotypes within STEM disciplines (Moss-Racusin et al., 2012; Heilman, et al., 2023). These stereotypes often position men as inherently more competent in STEM-related tasks, perpetuating biased perceptions and hindering the progress of gender equality in these fields. Conversely, students from the humanities, especially women, exhibit more progressive attitudes toward gender equality in STEM. This contrast can be attributed to the more gender-inclusive and socially conscious culture prevalent within humanities disciplines. Humanities education often emphasises critical thinking about social structures, equity, and cultural dynamics, which may foster greater awareness and rejection of traditional gender norms. Additionally, the findings reveal nuanced patterns that merit further exploration. For instance, male students in STEM may internalize traditional views due to the lack of visible female role models, reinforcing the perception that STEM is a male-dominated domain. On the other hand, the presence of supportive academic communities and discussions about diversity in humanities fields likely contributes to their students' more egalitarian perspectives.

The influence of academic fields also suggests that disciplinary cultures play a critical role in shaping attitudes. STEM fields, which often emphasise technical skills over social analysis, may inadvertently perpetuate traditional gender norms by neglecting to address the social dimensions of science and technology. In contrast, humanities fields encourage engagement with gender theory, social critique, and the broader implications of knowledge production, which can challenge and deconstruct gender biases.

These findings underscore the complexity of gendered attitudes in academia and suggest that cultural and pedagogical factors within academic disciplines profoundly influence students' views on gender equality. Recognising and addressing these discipline-specific factors will be essential for fostering a more inclusive academic environment and reducing gender disparities in STEM.

4.2 Role of Sociocultural Influences and Academic Environment

Sociocultural factors exert a profound influence on shaping students' attitudes toward women in STEM. These factors encompass a range of influences, including cultural norms, family values, societal expectations, and exposure to gender stereotypes from an early age. Students from more conservative backgrounds, particularly those enrolled in STEM fields, are significantly more likely to endorse traditional gender roles. This alignment may stem from deep-rooted societal narratives that associate men with technical competence and leadership while relegating women to nurturing or supportive roles. In STEM disciplines, the academic environment often mirrors these broader societal attitudes. For example, the underrepresentation of women in faculty positions or leadership roles within STEM departments reinforces the perception of STEM as a male-dominated domain. This lack of visible female role models can perpetuate a cycle of exclusion, as it signals to students that success in STEM is not equally attainable for all genders. Conversely, students from less conservative or more progressive sociocultural environments are often exposed to diverse perspectives and egalitarian values that challenge traditional gender norms. These influences are particularly evident in academic fields like the humanities, which tend to emphasise critical engagement with social issues, including gender equality. Such an academic culture fosters attitudes that are more inclusive and supportive of women in STEM, underscoring the interplay between societal context and academic environment.

Furthermore, the findings suggest that the academic environment can either mitigate or amplify the effects of sociocultural influences. In conservative sociocultural settings, STEM programs may reinforce traditional gender roles by neglecting to address issues of diversity and inclusion within the curriculum. On the other hand, institutions with strong commitments to promoting diversity through inclusive teaching practices, gender-sensitive policies, and diverse representation in faculty and leadership can challenge and reshape these attitudes.
The role of peer groups within academic settings also warrants attention. Students are influenced by the attitudes and behaviours of their peers, which can either reinforce or challenge traditional gender norms. In male-dominated STEM fields, group dynamics may perpetuate exclusionary attitudes, whereas more gender-balanced or diverse peer groups are likely to foster inclusivity.

To address these challenges, educational institutions must take a holistic approach to promoting diversity and inclusion. This includes integrating discussions of gender equity into STEM curricula, providing training for faculty and staff to identify and address bias, and creating opportunities for cross-disciplinary engagement where STEM and humanities students can collaborate and share perspectives. By embedding principles of equity and inclusion into both the curriculum and the broader academic culture, institutions can play a pivotal role in reshaping attitudes and fostering a more inclusive environment for women in STEM.

4.3 Limitations and Directions for Future Research

This study is limited by its cross-sectional design, which does not allow for causal inferences. Future research should consider longitudinal studies to explore how attitudes toward women in STEM evolve over time. Additionally, exploring the impact of specific interventions aimed at reducing gender bias in STEM education would provide valuable insights into strategies for promoting gender equality.

5 Conclusion

This study provides a nuanced understanding of how academic fields, gender, and sociocultural influences intersect to shape attitudes toward women in STEM. The findings reveal that these attitudes are not only shaped by individual beliefs but are deeply embedded in disciplinary cultures and societal norms. STEM disciplines, often characterised by a lack of visible female role models and limited engagement with social issues, can inadvertently perpetuate traditional gender stereotypes. In contrast, the humanities foster more inclusive attitudes by encouraging critical engagement with social structures and promoting egalitarian values. The influence of sociocultural factors, such as family values, societal expectations, and early exposure to gender stereotypes, highlights the broader context in which academic attitudes are formed. STEM students from conservative backgrounds are particularly prone to endorsing traditional views, reinforcing the need for academic environments to actively challenge these narratives. Meanwhile, the inclusive culture of humanities disciplines demonstrates the transformative potential of addressing gender equity within educational contexts. The interplay between academic and sociocultural factors suggests that meaningful change requires a multi-faceted approach. Educational institutions must prioritize diversity and inclusion through targeted interventions such as integrating discussions of gender equity into STEM curricula, fostering diverse representation in faculty and leadership, and encouraging interdisciplinary collaboration. These measures can disrupt exclusionary norms, create supportive peer dynamics, and cultivate environments where women in STEM are valued and empowered. Addressing gender biases in STEM is not solely about altering individual attitudes but about reshaping the academic and cultural ecosystems that sustain them. By embracing a holistic strategy that combines curricular reform, institutional policy, and sociocultural engagement, academia can take significant strides toward fostering gender equality in STEM fields.

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To the Roots: Engineering Pedagogy

Emotions and Presentation Skills Development in English Language Teacher Training

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Abstract

This research-in-progress investigates the interplay between negative emotions and the development of presentation skills in English language teacher education. As future educators, English pre-service teachers often face anxiety, self-doubt, and stress, which can hinder their ability to effectively present and engage with students. This research aims to identify the primary negative emotions experienced by pre-service teachers in order to employ strategies for managing these emotions, foster resilience, and enhance presentation competencies.

The ongoing research has recognized the initial emotions of pre-service teachers in a course aimed at improving presentation skills. Observations of lessons and discussions with students are gradually uncovering their needs regarding coping mechanisms and emotional management techniques to improve both their presentation skills and overall well-being.

Ultimately, this research contributes to creating a more supportive and effective learning environment for both educators and students.

Keywords: Emotion, Well-being, Presentation Skills, Teacher Training

1 Introduction

The meeting with 19-year-old students in their first year of English language and literature pre-service teacher studies was unexpectedly full of contradictions regarding their abilities and willingness to perform oral presentations in class. Given that the students had chosen a programme where they would constantly be in the spotlight, we assumed that anxiety—and, in many cases, resistance to performing orally in class—would not be a significant issue.

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In the following chapters, we will explore various studies that show how public speaking, or simply presenting in front of classmates, is often associated with feelings of anxiety. Unfortunately, students often use the term 'anxiety' carelessly when describing their attitudes toward public speaking or in-class presentations. In our personal experience, students tend to blame low scores on their presentations on anxiety related to public speaking. Therefore, we decided to ask more questions and, in the first place, find out the student's emotions to navigate the course to improve their public speaking skills in the right direction.

We used The State-Trait Anxiety Inventory (STAI) to determine students' emotional state during the lesson. The STAI is often used to distinguish between normal anxiety displays and depressive syndromes (Spielberg, 1989; Greene et al., 2017). Furthermore, coming from different educational backgrounds, having various levels of emotional experience, and encountering the pandemic through their teenage studies, more variables will impact public speaking skills. However, in our research in progress, or more specifically, pilot study, we will present the results of a small sample regarding their state anxiety levels, i.e., anxiety triggered by a temporary situation.

Presentation skills are a critical component of teacher education and developing these skills depends on numerous internal and external factors (Dong & Xu, 2022). We consider internal factors to be an individual's emotions, language skills, and personality traits. On the contrary, external factors may include classroom relationships, professional and individual preparation, cultural influence, and experience during the pandemic. Moreover, generational characteristics can be seen as lying on a thin line between internal and external factors that influence pre-service teachers' ability to deliver presentations and perform effectively in front of an audience.

This paper will review how various factors influence presentation and public speaking skills. Based on the pilot study, we will present the results of the STAI questionnaire regarding state anxiety, explain the limitations of the pilot study, and propose recommendations for follow-up research.

2 Generation Z in contradictions

Generation Z is the generation we are working within the lessons and preparing for their professional lives. Also, commonly referred to as Gen Z, is the demographic cohort born between the late 1990s and early 2010s, and they are the first generation to have grown up with the ubiquity of digital technology (Alruthaya et al., 2021). Before the pandemic, Gen Z individuals were known for their strong verbal and non-verbal communication skills due to their extensive engagement in various digital platforms and social media (Anwar,2019). However, the prolonged isolation and social distancing measures implemented during the pandemic have significantly altered the communication patterns of Gen Z and, in some cases, hindered the development of speaking skills. With fewer in-person interactions and increased reliance on virtual communication, many individuals have experienced a decline in their ability to engage in effective face-to-face conversations, read nonverbal cues, and adapt their communication style to different social contexts. Furthermore, the increased use of text-based communication platforms, such as messaging and social media, has led to a shift in the way Gen Z individuals express themselves, with a greater emphasis on informal written communication and a potential decline in their oral proficiency (Alruthaya et al., 2021).

Due to the strong preference for digital modes of communication and information-gathering, the preferences in learning styles have also gradually changed. One of the primary concerns regarding Gen Z's academic performance is their perceived deficiency in traditional communication and social skills. Communication skills are lessened, and active listening and collaboration are also lessened. This has significant implications in language learning contexts, where oral communication and interpersonal skills are essential in academic and later career environments (Janssen & Carradini, 2021, p. 137).

Even though technology competence plays a significant part in forming Gen Z, the cultural context also plays a role in shaping students' presentation skills. Students from Asia, for example, may be more inclined towards a formal, reserved presentation style (Alghamdi, 2021), whereas in European contexts, where English is widely taught as a foreign language, students may exhibit a more expressive and interactive approach. Furthermore, there may be differences in the confidence in delivering presentations due to language proficiency in so-called post-communist European countries (Kralova & Tirpakova, 2019).

However, a number of different studies from various areas agree that one of the fundamental difficulties faced by EFL students is the anxiety and nervousness associated with oral presentations. Students may feel self-conscious, struggle to organize thoughts, or experience a loss of confidence when delivering a presentation in a second language. More specifically, aspiring educators face anxiety, self-doubt, and stress, which can hinder their ability to effectively present and engage with students in their upcoming professional careers (Povedana-Brotons et al., 2024). Razawi et al. (2019) studied how personality traits, preparation, audience interest, and language ability affect student oral presentations. They concluded that all play an essential part as students come from different backgrounds, with different levels of self-esteem and self-confidence, and therefore, they should be treated in the classroom accordingly. They believe that the role of a lecturer is vital, and it is in their competence to accommodate the lessons to serve the students' individual needs.

Pre-service teachers have recognized the importance of emotional education in their initial training, acknowledging the need to develop their emotional competence and that of their future students. (Hernández-Amorós & Solano, 2017, p. 511) However, they have also reported that their university training has been sparse and too theoretical, leaving them underprepared to navigate the emotional complexities of the classroom. (Hernández-Amorós & Solano, 2017, p. 517).

Moreover, different approaches and methods have already been applied in different studies to see what eases students' anxiety levels, for example, by applying a multimodal approach (Zadorozhnyy & Lee, 2024). However, not just the technicalities and knowledge from an oral

presentation but the emotional intelligence and student speaking skills are correlated (Sulistyawati, 2018).
In the end, it all comes down to well-being, and therefore, we need to recognize negative emotions such as anxiety and act accordingly to be able to help students improve their presentation skills.

3 Pilot study

The goal of the pilot study was to assess students' feelings during lessons and evaluate their levels of state anxiety. We decided to use The State-Trait Anxiety Inventory (STAI) to determine students' emotional state during the lesson. The STAI is a validated 40-item self-report assessment device that includes separate measures of state and trait anxiety (Spielberg, 1989; Greene et al., 2017). However, we used the form Y, consisting of 20 self-report items on a 4-point Likert scale with a range from 1- not at all to 4- very much so, determining only state anxiety, i.e., a temporary state influenced by the current situation (Spielberg, 1989).
Scoring is accomplished by summing scores for items. The total score ranges from 0 to 80, where STAI scores are classified as low anxiety (20-37), moderate anxiety (38-44), and high anxiety (45-80) (ibid.).
The pilot study's sample consisted of first-year bachelor students of the English language and literature teacher training programme who signed up for the course Presentation Skills during the summer semester of 2024. The course had 14 students, a mixed group of males and females aged 18-19. The participants were an availability-based sample.
The course, Presentation Skills, is a weekly seminar for bachelor students, preferably in their first year of study in the summer semester, i.e., from mid-February to mid-May. For full-time students, the total workload is 75 hours per semester, whereas in-class seminars comprise 25 hours. The learning outcomes of the course are to know the basic principles of presenting and creating presentations in English, create comprehensible and well-structured performances, and proactively manage and present the results of their work to the public. Besides practicing creating, managing, and presenting presentations, the course covers topics such as critical thinking while working with information and text, communication with the audience, and coping with anxiety. Students are supposed to deliver one individual and one group presentation within the semester.
The course lasted 12 weeks, and the STAI was completed in the fourth week of the course.
At the end of the course, the pilot study participants were asked for non-formal anonymous feedback on their feelings, course expectation fulfillment, or other needs.

3.1 Pilot study results

Out of 14 students, eight students scored an average of 41, which means that their anxiety levels are moderate. Three students scored 36, indicating low anxiety, and three students belong to the group with high anxiety levels with an average number of scores of 52.

Without follow-up questions, it is difficult to explain what could trigger high or even moderate anxiety levels. For instance, individual or group presentations, which were not scheduled for that particular lesson, could have been potential triggers.

Regarding non-formal feedback, students' answers at the end of the course were overwhelmingly positive. They described the lessons as creative, interesting, and inspirational, particularly when watching other examples of famous people's speeches. However, one area for improvement was the need for more time to practice their individual speeches.

As we mentioned, this course is taught in the first year of students' studies. Several feedbacks highlighted how they appreciated the opportunity to get to know each other through the introductory activities in every lesson. During this activity, students had to express opinions and discuss topics they had known and prepared for beforehand.

3.2 Limitations of the pilot study

The study's most significant limitations are the low number of participants and the need for more organization in distributing the STAI at the right time. However, the incentive to find out about students' emotional state came after talking to students about public speaking after the course had already started and after the word anxiety had been reoccurring in our discussion on the students' side. Moreover, it happened in the course mentioned above and other courses where they were supposed to present in front of the class.

Time played a crucial role, and it did not play in our favour. About three seminars were canceled because of various school-related events happening at the same time as the seminar was scheduled, and therefore, students had fewer opportunities to practice. Moreover, not all students were at all lessons due to their personal or health issues.

Moreover, for future research, we will substitute the condensed version of the 20-item STAI self-report with a 40-item self-report questionnaire in order to differentiate between state and trait anxiety by students in more detail.

We will take into consideration the gender of participants and compare state and trait anxiety levels at the beginning of the course and the end of the course.

Pilot studies are essential to the research process, providing researchers with valuable insights and opportunities to refine their methodologies before embarking on a full-scale investigation. They can help detect potential flaws in the study design, assess the appropriateness of the research instruments, and evaluate the effectiveness of the data collection procedures (Mocorro, 2017). Moreover, one key characteristic of pilot studies is their emphasis on availability-based sampling, where the selection of participants is primarily driven by their accessibility and convenience (Andrade, 2020, p.102).

In spite of the limitations, we are now able to accommodate the research design, avoid issues that we encountered during the piloting, and continue with the research to achieve more representative outcomes.

4 Conclusion

In this paper, we briefly reviewed how different factors influence presentation and public speaking skills. We learned that even though the emotional state plays a crucial role, other factors, such as an individual's background, language skills, and opportunities to practice, go hand in hand with emotions. Additionally, the overall characteristics of Gen Z contribute to the student's performance regarding public speaking skills.

Although the pilot study results of the State-Trait Anxiety Inventory (STAI) are statistically insignificant, we plan to further explore the emotional state of the students in this context. We aim to gather a larger sample and use a 40-item self-administered questionnaire to assess state and trait anxiety separately.

In the follow-up study, we will back up the STAI results with context fitting around our sample, taking all the above-mentioned factors into consideration to chain the anxiety levels to the factors.

Hernández-Amorós and Solano (2017, p. 517) emphasized that students require more practice and emotional competence. This aligns with the feedback from students in our sample.

Therefore, we are committed to ensuring that students have sufficient time to practice, regardless of external factors or issues that may arise during the course. Similarly, we will ensure that students feel comfortable around each other, as feedback indicated that getting to know one another helped ease tension and allowed students to relax before giving their presentations.

We are confident that the follow-up research will yield valuable results that can serve as a foundation for improving similarly structured courses.

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R&E SOURCE

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To the Roots: Engineering Pedagogy

Gamification in Economic Education at Secondary Schools Reflecting the Value Orientation of Students

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Abstract

Gamification in secondary economic education mainly aims to produce a more engaging learning environment. In the paper, we argue that the effect of the game elements used with students during lessons should reflect their value orientation. If we want to increase the efficacy of games used in secondary schools, we should choose the educational objectives of each game very carefully and adjust game elements to the most important values recognized by most of the students in each class. Our sample of respondents considered educational values as very important, so teachers should always communicate the educational objectives to students clearly. Understanding the educational value of the game helps to increase students' interest, motivation and engagement in playing the game. For female students, it is even more important and motivating if the game also focuses on interpersonal relationships and helps them develop their social skills. On the contrary, male students especially appreciate practical focus of the game and economic significance of the knowledge or skills they learn while playing.

Keywords: Gamification, Economic Education, Secondary Schools, Value Orientation

1 Gamification in Education and Its Main Elements

The concept of gamification is often considered an innovative approach to enhancing student engagement and learning outcomes in various educational settings. However, the idea of learning through play dates to at least the 17th century, when the Czech scholar John Amos Comenius wrote *Schola Ludus*. Gamification is defined as the application of game-design elements in non-game contexts, leveraging mechanisms such as points, badges, leaderboards,

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and interactive challenges to create a more immersive and motivating learning experience (Deterding et al., 2011). It is often facilitated using digital platforms, aiming to solve problems, increase engagement, and motivate individuals towards their goals (Christopoulos & Mystakidis, 2023). Although most current examples of gamification are digital, the term 'gamification' should not be limited to digital technology. Not only are media convergence and computing all around us blurring the distinction between digital and non-digital, additionally, games are themselves trans medial categories (Juul, 2005). Regardless of its digital or non-digital form, gamification in education involves applying game attributes outside the context of a game to influence students' learning-related behaviours or attitudes. Thus, learning is affected by strengthening the relationship between instructional design quality and outcomes and/or by influencing learning directly. This is contrasted with a serious games approach in which manipulation of game attributes is typically intended to affect learning without this type of behavioural mediator/moderator (Landers, 2014).

Typical examples of game attributes were categorized by Bedwell et al. (2012) in a taxonomy derived from a comprehensive literature review and subsequent card sorts performed by subject matter experts. The categories of game attributes serve to provide a comprehensive collection of attributes, which includes, e.g., clearly defined rules and goals, action language, tracking game progress and assessment, challenge/conflict, control and ability of players to alter the game, human interaction etc.

Besides game elements or typical attributes, they should be based on, it is important to analyse the effects that games can have on student learning. Sailer and Homner (2020) conducted a meta-analysis to synthesise research findings on effects of gamification on cognitive, motivational, and behavioural learning outcomes. They found that the effect of gamification on cognitive learning outcomes was stable, whereas effects on motivational and behavioural outcomes were less stable. They found that the inclusion of game fiction and social interaction significantly moderated the effect of gamification on behavioural learning outcomes. Additionally, combining competition with collaboration was particularly effective in fostering these outcomes. Moreover, aligning game design with students' intrinsic motivations such as their value orientations can enhance the efficacy of gamification by fostering a deeper emotional connection to the learning content. Gamification combines motivational features such as rewards, challenges, and narrative storytelling to foster engagement and learning effectiveness (Jaramillo-Mediavilla et al., 2024). The results of the cited study reveal that gamification significantly influences motivation by facilitating the assimilation of knowledge, the improvement of skills and academic competencies of students, and specifically refers to a wide range of capabilities that can be enhanced through playful and interactive learning experiences.

Economic education at the secondary school level is particularly suited to gamification, given the subject's abstract nature and reliance on theoretical concepts that can often appear detached from real-world applications. That requires innovative teaching methods to make learning more interesting and tangible for students. Gamified learning environments can provide students with simulated economic scenarios where they actively participate in decision-making processes, thereby fostering critical thinking and problem-solving skills. Students' motivation and their understanding of key economic principles can be increased by turning economic theories into interactive experiences. Furthermore, economic education offers an opportunity to integrate value-based learning with gamification since game scenarios simulating real-world economic challenges can encourage students to reflect on their personal and societal values. To maximize the benefits of gamification in economic education, teachers must carefully balance its entertainment value with educational objectives. This includes designing activities that promote collaboration, long-term skill development, and reflective thinking, as well as addressing diverse learning styles and value orientations. By doing so, gamification can transform the classroom into a dynamic space where students not only learn but also develop the values and skills necessary for responsible citizenship in a complex economic world. Research suggests that the effectiveness of gamification increases when it aligns with students' values. For example, economic simulations can include moral dilemmas or sustainability challenges that resonate with students’ environmental awareness and social responsibility. Designing such scenarios fosters personal engagement and encourages learners to apply economic principles to real-world ethical decisions.

2 Value Orientation of Secondary School Students

Values in a person's life determine what they consider essential and what they believe in. They are an important determinant of human behaviour since they are related to motivation. The value orientation of secondary school students is formed under the influence of various factors, such as family, school, friends or the media. Understanding this process helps teachers and other professionals in the field of secondary education understand how and why young people adopt certain values and how they apply them in everyday life. The students' value orientation is related to their motivation, which is a key factor affecting educational outcomes. Also, the educational process can affect the ranking of students' values, which creates a mutual relationship between the students' value orientation and their learning and its outcomes.

Several factors are crucial for shaping the value orientation of students. It is well-known that family has a fundamental influence on the creation of the moral and ethical basis of young people, which determines their future value orientation. Research confirms that teachers and the school environment can also serve as models of behaviour and value systems (Lickona, 1991). Currently, the media and social networks have a growing influence on the value orientation of the youth. Young people are exposed to media pressure that can affect their self-perception, value system and attitudes towards life (Livingstone, 2008).

The student's value orientation can be understood as a system of values that they recognize and that influence their decision-making and actions. For high school students, values are connected to their personal goals, social norms, ethical principles and attitudes towards life. Values also determine an individual's interactions with society. There are different types of values, such as moral, social, material (economic), personal, spiritual, cultural and aesthetic, ecological, etc.

Considering students' values is crucial in the educational process (Jardim et al., 2017). In this article, we do not examine how schools can influence students' value orientations; rather, we assume that students' values influence their school behaviour and approach to learning. Therefore, it is important for teachers to understand their students' value orientations to tailor teaching methods accordingly. For instance, a desire for new knowledge and a sense of responsibility, while consciously perceiving the social importance of learning for one's future activities, are dominant factors supporting student learning (Shuvalova & Korepanova, 2022). Understanding how secondary school students currently rank various values is essential for educators aiming to design effective learning experiences.

Although values are individual, it is usually possible to identify the prevailing values of students in secondary schools as the school environment in which they study has an impact on their value systems. At the same time, the dominant values may differ according to the age of the students, as well as according to their gender, as several studies point to differences in the values and attitudes of students from these points of view. For example, differences in attitudes towards school subjects and school performance according to gender were identified for students of economic subjects in secondary schools in a study published by Novák et al. (2024).

Our research aimed to analyse the contemporary value orientations of secondary school students in Slovakia and identify the most effective game elements for implementing gamification in Slovak secondary schools.

3 Data and Methods

In our research of secondary school students' value orientation, we decided to work with the standardized HO-PO-MO questionnaire (Vonkomer, 1991), as this questionnaire is suitable for comparisons of values between younger and older students as well as between male and female students. We used the first group of the questions in this complex questionnaire, which focus on the value orientation of the youth. In this part, the questionnaire contains 12 situations, but at the same time only 11 x 5 alternative answers, since two of the situations focus only on some of the studied areas of values, complementary to each other. We finally excluded this complementary pair of questions from the research, since more than half of the respondents, despite repeated explanations, filled in the answers incorrectly – as if they were independent questions, i.e. regardless of their complementarity. We do not consider this modification of the evaluated data to be a big problem, since the remaining ten questions provide a sufficient overview of the values that are important to the respondents. The questionnaire divides the value orientation of students into five areas:

- educational,
- aesthetic,
- moral,
- economic,
- social.

In each of the ten questions of the questionnaire, the respondents were asked to arrange five statements (each representing one value area in the given situation) from the most important (5 points) to the least important (1 point). In this way, each area in one questionnaire could have achieved a maximum of 50 points (if in every situation the respondent ranked the statement from that area as the most important) and at least 10 points (if in every situation the respondent chose that area as the least important).

The selection of the research sample was deliberate due to the availability and the need for direct contact of the researchers with the respondents to explain the meaning of the questionnaire and the entire research, as well as to ensure a higher return rate of the questionnaires. We focused on secondary school students in the Bratislava region, where a member of the research team travelled to selected schools in April and September 2024 and personally ensured the implementation of the survey with the students of the current third and fourth years in the respective month. Thanks to this, the return rate of the questionnaires was 100%. The total sample consisted of 179 students, out of which 86 were male and 87 were female (6 respondents did not want to state their gender). 72 of the students were already adults, whereas the remaining 107 respondents were 17 years old or younger.

To evaluate the results, we counted the points for each area for all 10 analysed questions attributed by all 179 respondents (and then separately for male and female respondents as well as for adult students and younger students). From the total sum, within each of these samples, we calculated the average score obtained by each of the investigated areas. The more points within a possible scale from 10 to 50 points the given area received, the more importance the respondents attributed to the value that the area represented.

4 Results of the Value Orientation Analysis and their Implications for Using Games in Secondary Education

On the total sample of 179 respondents, we found that secondary school students attribute the least importance to aesthetic values. The most important area was social values (33.82 points on average) and a very pleasant surprise for the researchers was that they attributed almost the same number of points to values in the educational field (average points = 33.78). These were followed by economic and moral values, as shown in Figure 1.

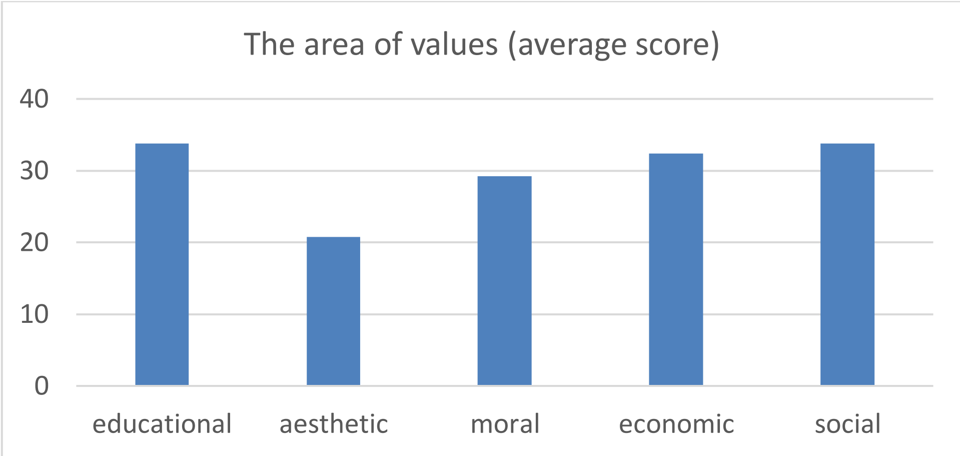

Figure 1: Average score of each area of values (n = 179).

We further analysed whether male and female respondents attributed the same importance to each of these groups of values. We found that the order of values differs between the two sexes (we did not take the six respondents who did not want to state their gender into account in this section, as their answers had no impact on the comparison of the value orientation of male and female respondents). For male respondents, economic values proved to be the most important area (34.52 points), followed by values in the educational area (33.52 points), and the social area came in the third place with a greater distance from the second (32.22 points). On the contrary, in female respondents' answers, the social area dominated on average with up to 35.38 points, closely followed by the educational area (34.24 points), and economic values came third in the ranking (30.20). The remaining two areas came in the same order for both sexes, with the least weight for aesthetic values (20.12 points on average for male students and 21.46 points for female respondents). We can conclude that all respondents see a high value in education, but for male students it was closely exceeded by economic values, while they attribute less importance to social values and, on the contrary, for female students, social values are somewhat more important than education and they attribute considerably less importance to economic values.

Regarding the comparison by age, we divided the whole sample into adult respondents (aged 18 and over) and students aged 17 and under. A comparison of the average point evaluations for individual value areas between these two age groups is summarised in Table 1.

Value area	Younger students (17 and less years old)	Adult students (18+ years old)
Educational	33.50	34.18
Aesthetic	21.08	20.28
Moral	29.50	28.86
Economic	31.48	33.76
Social	34.43	32.92

Table 1: Comparison of value orientation of adult students and younger students.

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Table 1 shows that the field of education was ranked first in the group of adult students, whereas younger students considered it to be the second most important, with social values being at the top of their hierarchy. For adult students, social values seem to be less important as they came third in the ranking with economic values being more important. Younger students ranked economic values as third. A certain difference in the number of points can be noticed for aesthetic values, which were preferred more by younger students than by adult respondents, which confirms slightly more pragmatic value orientation of adult students. Moral values were in the fourth place in both groups of respondents.
If we were to draw a conclusion from these simple research findings for the work of a teacher and his or her teaching in class, they should focus a little more on methods that use or develop interpersonal relationships in the classroom for female students and emphasise the economic aspects and pragmatic benefit of assignments for male students. When using gamification, it is very important that the games follow clear educational goals, and when trying to slightly differentiate them according to gender, games for female students should also aim at the development of interpersonal relationships, while games for male students should be somewhat more practically oriented and show the economic significance of the knowledge acquired by the game for their future lives. Moreover, students' motivation will be increased if they know the educational objectives of each game, understanding clearly that the playful environment and time spent on the game will help them learn something new.

5 Conclusion

Our sample indicated that education has a high value for secondary school students at the analysed schools in Slovakia, which is in line with other research studies carried out in different countries (e.g. Shuvalova & Korepanova, 2022). Female respondents attributed slightly more importance to values from the social domain, while male respondents prioritised values in the economic domain. We can conclude that female students tend to be more socially oriented, with human relationships and social skills being of greatest importance to them, whereas male students in our sample were more economically focused, placing value on the pragmatic aspects of education. Of course, we cannot generalize this conclusion based on a survey with a limited number of respondents for the whole country. However, as educational, social, and economic values were clearly identified as the most significant for all respondents, it is advisable for teachers to consider how didactic games used in education align with these value orientations. If the games employed in the classroom have clear educational objectives, promote the development of social skills and relationships among students, and are connected to real-life problems and practical solutions, their efficacy is likely to be higher. Such games should, therefore, be more effective in fostering engagement and enhancing learning outcomes (Jaramillo-Mediavilla et al., 2024).

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To the Roots: Engineering Pedagogy

Aspects of the Use of Artificial Intelligence in the Work of Teachers of Vocational Subjects in Secondary Schools

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Abstract

The presented study focuses on the specifics of vocational education and continuing professional education of teachers of vocational subjects in the conditions of the fourth age and artificial intelligence (AI). The aim of this study is to define AI in relation to its use in vocational education and to present the main research findings in the field of AI use in the work of vocational subject teachers in secondary schools in the Czech Republic. The results of the research showed that two thirds of the interviewed teachers do not use AI in their teaching whereas one third use it actively. Furthermore, the research showed that a statistically significant majority of teachers use AI in teaching or are willing to use it and are ready for further training in this area.

Keywords: Vocational Education, The Fourth Age, Teacher Training, Artificial Intelligence

1 Theoretical Background

We are currently in the so-called fourth age and the fourth (or even fifth) industrial revolution. With the development of this revolution and the rapid emergence of artificial intelligence (AI), the shape of vocational education is changing significantly. It is therefore necessary to address this issue, and not only in vocational education. Historically, the first age was characterised by the discovery of fire and the emergence of language (100 000 years BC).

This was followed by the second age, when the centres of ancient civilisations - cities - were created. Systematic agriculture also began to emerge at this time (10 000 BC). During the Third Age, the first scripts began to appear, and mankind began to use the wheel (5000 BC). The beginning of the fourth age is dated to the discovery of electricity and the development of

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electronics in the 19th century (Reese, 2022). We are in the Fourth Age and in the time of the fourth (or fifth) industrial revolution, which brought the phenomenon of artificial intelligence, among others, into education.

The Fourth Industrial Revolution is a term referring to cyber-physical systems that introduce significant changes in production processes compared to the status quo. These changes lead to the emergence of so-called smart factories in which some worker activities will be performed by intelligent systems. Production is based on the principle of connecting all elements via the Internet (Internet of Things) with a cybernetic superstructure that allows full automation of the entire production process. If the machines of the previous generation (3rd generation) were capable of independent automatic operation, now these machines are also connected and communicate with each other. The superstructure computer system equipped with artificial intelligence can control the entire production process, optimize it and solve any unforeseen problems based on data obtained from various sensors (Cejnarová, 2015; Pecina & Krištofiaková, 2021).

The first definition of artificial intelligence was published in the 1960s by Minsky. According to this author, artificial intelligence is the science of creating machines or systems that will apply a procedure to solve a task that, if done by humans, would be considered a manifestation of their intelligence (Minsky, 1967; Mařík, 1993). One of the most recent definitions states that artificial intelligence is the ability of a system to appropriately interpret external data to further learn and use it to achieve specific goals, taking advantage of its flexible adaptation (Kaplan & Henlein, 2019). Artificial intelligence can be defined as the ability of computer systems to perform tasks and activities that typically require human intelligence. These tasks include pattern recognition, learning from experience, decision making, and interacting with the environment.

AI can be classified into two main categories: strong AI, which would have the ability to perform any cognitive task, and weak AI, which is specialized for specific tasks. This is undoubtedly an important phenomenon currently being addressed by the entire field of computer science. The subject of its interest is the development of systems that solve diverse tasks (computation, classification, recognition, text processing, etc.). It concerns the ability of computer systems to mimic human cognitive functions such as learning and problem solving. Artificial intelligence includes expert systems, chatbots, personal assistants and machine learning.

AI fluctuates into all fields of human activity and stimulates a number of problematic technical, economic, social and legal aspects. With the introduction of full robotics and automation and collaborative robots and other systems, the labour market and society as a whole is changing significantly. We have numerous studies that focus on various aspects of AI. The issue of AI is also being addressed by experts from the perspective of copyright law (Zibner, 2022). The logical consequence is the dynamic progression of AI implementation in the entire education system.

2 Artificial Intelligence in Education

The above implies corresponding changes in the vocational education system at national and international level. It is clear from the above that this is a large-scale project that will have implications for the whole of society and all its components. The emergence of digitalised factories and systems will lead to the revision of many technical professions, and some professions will probably cease to exist (e.g. production line operators, shop cashiers, professional drivers, etc.). Conversely, vocational training and the status of specialised professions and occupations will increase in importance. New interdisciplinary branches of technical and other sciences will also emerge. New specialist jobs will be created (maintenance, repair, operation and supervision of robotic systems, cyber security, etc.).

2.1 Areas of innovation in education

It is evident that as robotics, automation and the introduction of smart factories progresses, innovation processes in technical education will have to become more dynamic in all types of schools. However, innovation in the case of vocational technical education in secondary and higher education will be of strategic importance. The main areas of innovation can be summarized in the following areas (Pecina & Sládek, 2017):

- Innovations in the area of content in the teaching of vocational subjects.
- Innovations in the field of preparation of future teachers of professional subjects.
- Innovations in the field of further education of teachers of vocational subjects.

A key area is the question of the competences of teachers of technical subjects in relation to innovation processes in education. Key competences (i.e., core or transferable) come to the fore. The main areas of these competences are as follows:

- Problem-solving ability, flexibility and adaptability.
- Ability to design innovative solutions, creativity, systems thinking.
- Ability to communicate across disciplines, work in a team.
- Ability to withstand workload and stressful situations.

In the area of innovation in the content of teaching of technical subjects, this involves the introduction of innovative and new educational contents of individual technical sciences. It is evident that these are cross-curricular and interdisciplinary educational contents that result from the relationship between engineering, electrical engineering and computer science. These disciplines have the largest share in the introduction of automated systems into practice.

Teacher training colleges try to respond flexibly to the current situation in the field of further education of teachers of vocational subjects. It is the universities that should be the guarantors and promoters of further teacher education in vocational subjects. From this point of view, the importance of subject didactics in vocational education (didactics of vocational subjects, didactics of practical teaching) is growing, whose discourse is at the borderline between pedagogical sciences (subject didactics) and technical and economic sciences (transformation of selected scientific knowledge into the didactic system of vocational subjects). The contents of such a system are examples and applications in the field of actual knowledge of technical reality. The issue of AI in education is rapidly becoming the focus of many educational courses and training. These courses focus on the following areas and tools (Pecina, 2023; Bilavčíková, 2024):

- Lessons preparation using AI, Chatbot, prompting
- Canva, Huygen, DALL-E
- LearningApps
- OrgPad and ContextMinds.

The above areas and tools are the subject of a further education course from accredited educational institutions of the Ministry of Education, or other educational bodies. Working groups are being set up at higher education institutions to focus on further education and the implementation of AI in the work of academics and the university training of future teachers.

2.2 Key aspects of the use of AI in education and challenges for the future

From our perspective, the key aspects of using AI in education include the following key areas - Machine Learning, Advanced Data Analytics, Natural Language Processing and Robotics in Education. Machine Learning (hereafter ML) is one of the most prominent areas of AI which is the ability of computer systems to automatically learn and improve their performance without explicit programming. In vocational education, ML can identify patterns in data and tailor learning to the needs of students. Advanced data analysis: The amount of data available is growing exponentially, and AI can effectively analyse this data to identify trends, student behaviours, and areas in need of improvement. In this way, vocational training institutions can better adapt to the dynamic needs of the job market. Natural Language Processing (hereafter NLP) is a technology that enables computers to understand and respond to human language. In the context of education, NLP can support interactive communication with students, provide answers to questions, and even analyse the quality of written work. The combination of AI and robotics in education can lead to new forms of interaction in education. Robots can serve as interactive teaching assistants, promoting practical skills and providing stimulation for creative learning. AI can play a key role in supporting the development of students' critical thinking and analytical skills. Interactive simulation programmes and game elements in the classroom can stimulate creativity and logical thinking (Popenici, 2023; Strnadová, 2023). In the specific context of Czech vocational education, we see opportunities for the use of AI especially in connection with the needs of industry and technological progress. The integration of AI can help to create relevant and up-to-date curricula and facilitate the transition of students into the professional practice.

With the advent of AI in education, there are also challenges that require attention. One key area is the ethics. Finding a balance between the use of AI and the protection of students' personal data is a key factor. At the same time, it is essential to address the question of how to ensure that AI is accessible to all students and does not increase existing inequalities in education. Electronic cheating and misuse of AI in the process of pedagogical diagnosis and assessment of students' learning outcomes is also a serious issue. We expect to see further integration of AI into educational processes, improvements in personalised learning and the development of new technologies that will take vocational education to new levels of efficiency and relevance for the future labour market. In vocational education, AI plays a key role in transforming learning and providing new opportunities for personalised and effective learning. Machine learning enables the identification of patterns in data and the tailoring of learning to the needs of students. Advanced data analytics provides the means to better understand student behaviour and optimize learning processes. Natural language processing enables interactive communication with artificial assistants, while robotics brings new forms of interaction to education. AI is a key tool for the transformation of vocational education and its proper use can bring significant benefits to students, educators and society as a whole. Overall, AI in education opens up new possibilities for an effective and personalised learning process and a positive experience. ML and data analytics are enabling improvements in educational processes, while NLP and robotics are bringing new forms of interaction in learning. However, with these rapid advances come ethical and privacy challenges. The future of AI in education looks promising, bringing innovations that can fundamentally impact the way we learn and prepare for the future.

3 Survey on the Use of AI in the Work of Teachers

At present (2024), we have almost non adequate information on the extent and form to which vocational teachers in secondary schools in the Czech Republic use AI in their work. It is a very diverse and large group of teachers involved in teaching technical, economic, business and service educational subjects. The aim of this research study is to define AI in relation to its use in vocational education and to present the main research findings in the field of AI in the work of teachers in vocational education in selected secondary schools in the Czech Republic. With regard to the problem under study, a quantitative methodology was chosen for the survey. A self-constructed questionnaire was used as a research instrument, which was distributed using Google Forms tool. The questionnaire contained a total of 12 items.

The main research questions were set as follows:

1. Are there more teachers using AI or more teachers not using AI in their work?
2. What AI tools do teachers use in their work?
    a. Do teachers make more use of the ChatGPT language model or other language models?
    b. Do teachers use other AI tools?
3. If teachers use AI, for what purpose?

4. If teachers use AI, how often?
5. How do teachers work with *Prompty*?
6. How do teachers rate the contribution of AI in education?

A total of 550 secondary vocational schoolteachers from 51 secondary vocational schools from three regions in the Czech Republic (South Moravian Region, Vysočina Region, Pardubice Region) participated in the research. The data collection took place in the period January 2024–April 2024. All secondary vocational schools that were contacted by the research team are cooperating secondary schools and were approached to participate in the research. This is therefore a deliberate and accessible research sample.
Based on our findings to date and our own experience in this area, we have established the following substantive and statistical hypotheses that relate to the first two research questions:

H-1	There are more teachers of vocational subjects who do not use AI at work than teachers who do.	
	H-1-0	There are no statistically significant differences between the teachers who use AI in their work and the teachers who do not use AI in their work.
	H-1-A	There are statistically significant differences between the teachers who use AI in their work and the teachers who do not use AI in their work.
H-2	Teachers use ChatGPT more than other AI models when working with AI.	
	H-2-0	There are no statistically significant differences between the teachers who use ChatGPT and the teachers who use other AI models in their work.
	H-2-A	There are statistically significant differences between the teachers who use ChatGPT and the teachers who use other AI models in their work.

Table 1: Definition of substantive and statistical hypotheses.

The chi-square test and descriptive statistics tools were used to assess statistical significance. Research questions three to six are descriptive. Statistical significance between the findings was assessed as part of the data analysis.

4 Key Survey Results

In this section, the focus is on summarizing the main research findings that relate to the stated research questions. The first item of the research instrument investigated the extent to which AI is used in the work of vocational subject teachers. Statistical significance test was conducted at the 0.05 level of significance. Table 2 shows the calculation of the value of the test criterion for statistical significance. It was found that out of the sample surveyed, 210 teachers (38%) use AI in their work and 340 teachers (62%) do not use AI. From the values, it is clear that there are statistically significant differences between the data to the detriment of the use of

AI in teacher's work. The observed value of the test criterion was 30.75. The critical value for the established level of significance and one degree of freedom is 3.841.

Use of AI	Observed frequency (P)	Expected frequency (O)	P-O	$(P\text{-}O)^2$		$(P\text{-}O)/O^2$
Teachers use AI	210	275	-65	4225		15.36
Teachers don't use AI	340	275	65	4225		15.36
Calculated value of the test criterion						Σ 30.75

Table 2: Statistical significance test to evaluate the first hypothesis.

As proved above, we rejected the null hypothesis and accepted the alternative hypothesis H-1-A. There are statistically significant differences between the data in favour of less usage of AI in the work of vocational subjects' teachers. However, it should be noted that a large proportion of teachers do not use AI because they do not have enough information about it. However, teachers are interested in its involvement, which was evident from the data collected by the second item of the research tool.
The third item of the research tool investigated which AI tools teachers use. When testing statistical significance under the second established hypothesis, we found out that the vast majority of the respondents use the ChatGPT 3.5 or ChatGPT, version 4 language model.

Used AI language models	Observed frequency (P)	Expected frequency (O)	P-O	$(P\text{-}O)^2$	$(P\text{-}O)/O^2$
ChatGPT 3.5	80	43.3	36.7	1346	36.77
ChatGPT 4	30	43.3	-13.3	176.89	4.08
Other tools	20	43.3	-23.3	542.89	12.54
Calculated value of the test criterion					Σ 53.39

Table 3: Statistical significance testing to evaluate the second hypothesis.

As demonstrated above, for a significance level of 0.05 and three degrees of freedom, the critical value of the test criterion is 7.815. *The observed value of the test criterion is 53.39. Thus, there are statistically very significant differences between the data, and we accept the alternative hypothesis H-2-A*. Clearly, the ChatGPT language model is the most used.

In the third established research question, we investigated the purposes for which AI is used by the teachers. The necessary data was collected by research tool question 5.

Please indicate how you use AI (language model) in your work (multiple answers are possible).	**N**	**%**
When preparing lessons (I generate preparations, presentations, methodological materials, etc.)	81	35
When searching for current field (subject) knowledge	39	17
In the implementation of teaching	72	31
In the preparation and implementation of students' diagnostics and evaluation	38	17
Otherwise	0	0

Table 4: Purpose of using AI in vocational education.

It is clear from the data that the use of AI is very diverse, and the measured values vary. We also present the results of statistical significance test. We were interested in whether there are statistically significant differences between the values.

Purpose of AI	**Observed frequency (P)**	**Expected frequency (O)**	**P-O**	**$(P-O)^2$**	**$(P-O)/O^2$**
In preparation for teaching	81	46	35	1225	26.6
When searching for the latest field knowledge	39	46	-7	49	1.06
In the implementation of teaching	72	46	26	676	14.7
In the preparation and implementation of students' diagnostics and evaluation	38	46	-8	64	1.39
Otherwise	0	46	-46	2116	46
Calculated value of the test criterion					Σ 89.75

Table 5: Statistical significance test for the third research question.

As verified above, there are statistically significant differences between the data at the 0.05 significance level. For four degrees of freedom, the critical value of the test criterion is 9.448. *The observed value of the test criterion is 89.75.* AI is mostly used by teachers in lesson preparation and then in lesson implementation. By a relatively large frequency difference, AI is used in searching for current knowledge in the field and in preparing and implementing diagnosis and assessment of students. The teachers report that they do not use AI for other purposes.

Through other items of the research tool (questionnaire) we investigated how the teachers work with the generated outputs and how they work with *Prompty* (items 6 and 7). The results are presented in Table 6.

If you use AI (language model) to generate lesson preparations, materials for teaching presentations, etc.	**Observed frequency (P)**	**Expected frequency (O)**	**P-O**	**$(P-O)^2$**	**$(P-O)/O^2$**
I copy the text and consider it done. I trust the AI to generate the correct information.	0	57.5	-57.5	3306	57.5
I check the text and verify the completeness and correctness of the result from AI and edit if necessary.	71	57.5	13.5	182.25	3.17
I copy the text and see if everything I wanted to have in there is included. If it's not all there. I'll add it.	88	57.5	30.5	930.25	16.17
I don't prepare my lessons and other documents using AI.	51	57.5	-6.5	42.25	0.73
Calculated value of the test criterion					Σ 77.57

Table 6: How to work with the generated AI outputs for the needs of lesson preparation.

As shown above, even for the results found by this item, there are statistically significant differences between the data at the 0.05 significance level. For three degrees of freedom, the critical value of the test criterion is 7.815. *The observed value of the test criterion is 77.57.* The numbers of responses are significantly different. A positive finding is that the generated results are always checked or supplemented by the teachers. However, a large number of teachers check only the content completeness of the result (88 respondents). Only less than a third of the respondents check and correct the generated results (71 respondents).
Using item 7, we investigated how teachers work with prompts. Table 7 presents the findings for this item.

Select what assignments you give to the AI (language model)	**Observed frequency (P)**	**Expected frequency (O)**	**P-O**	**$(P-O)^2$**	**$(P-O)/O^2$**
I prompt a topic. E.g. I need to create a lesson on "Soups" etc.	72	57.5	14.5	210.25	3.66
I prompt a topic and who to create the material for. E.g. Generate a written preparation (presentation) on the topic	0	57.5	-57.5	3306.25	57.5

"Soups" for second year secondary school students.					
I prompt a topic, for whom it has to create the material and in what scope. E.g. Generate a written preparation (presentation) on the topic "Soups" for second year secondary school students for one lesson and three pages, etc.	109	57.5	51.5	2652.25	46.16
I instruct AI differently. Give an example of how:	29	57.5	-28.5	812.25	14.13
Calculated value of the test criterion					Σ 121.45

Table 7: How to work with prompts.

There are statistically very significant differences between the findings. The largest proportion of the respondents report that they prompt AI not only for the topic, but also for whom the result is generated and the scope of the result, which is an appropriate approach. A total of 109 respondents chose this option, which is more than half of the respondents.
Using item 8 in Table 8, we investigated teachers' perceptions of the credibility and behaviour of AI in generating responses. The intention was to find out whether the teachers know that AI can fabulate.

How do you think AI (language model) behaves when it doesn't know something	**Observed frequency (P)**	**Expected frequency (O)**	**P-O**	**$(P-O)^2$**	**$(P-O)/O^2$**
It apologises for not knowing and refer you to another source.	230	183.3	46.7	2180.89	11.90
It invents fictitious and non-existent information.	248	183.3	64.7	4186.09	22.84
AI knows de facto everything, it doesn't happen that it doesn't know something.	72	183.3	-111.3	12387.69	67.58
Calculated value of the test criterion					Σ 102.32

Table 8: Fabulation in AI work.

Even in the case of questionnaire item 8, there are statistically significant differences between the data at the 0.05 level of significance. The largest number of respondents reported that AI fabulates (248), which means that a large number of teachers have a correct idea about the work of AI. Of course, this is quite relative, as AI is developing very rapidly, and each new

(language) model is more sophisticated and behaves differently from its predecessor. However, we assume that AI always fabulates in certain circumstances.
Through item 9, we investigated how teachers evaluate the contribution of AI in education.

In your opinion, what is (is not) the benefit of using AI in education	**Observed frequency (P)**	**Expected frequency (O)**	**P-O**	**$(P-O)^2$**	**$(P-O)/O^2$**
It helps in the preparation and implementation of teaching. It is a good "personal assistant" and makes the work easier.	340	183.3	156.7	24554.89	133.96
I doubt the benefit of AI in my work as a teacher (educator).	129	183.3	-54.3	2948.49	16.09
I don't see any benefit. It can be used but I can do without it. I can do what it can do and more.	81	183.3	-102.3	10465.29	57.09
Calculated value of the test criterion					Σ 207.14

Table 9: The contribution of AI in education.

As shown in Table 9, there were *statistically significant differences* between the data. A majority of teachers consider the contribution of AI positive. However, according to the data, there is still a very strong group of teachers who question or see no benefit in AI in the teacher's work (81 respondents).
Item number 10 investigated how often teachers use AI in their work. Table 10 illustrates the results.

How often do you use AI in your work	**N**	**%**
Every or almost every day	0	0
About once or twice a week	141	25
Relatively little, about once a month or less	69	13
I don't use AI	340	62

Table 10: Frequency of use of AI in teacher work.

The data shows that if teachers do use AI, the vast majority use it regularly, on a weekly basis. A smaller proportion of teachers use it more rarely (once a month or less). However, it should be mentioned that we do not have information on how much time teachers spend working with AI. Therefore, we can only assess the frequency of use of this phenomenon. Thus, it can be concluded that at the time of the research, AI is being used by teachers in vocational education to a relatively small extent. Open-ended item 11 asked whether the teachers wanted to add anything to the investigated topic. However, due to the range of the paper, we do not list them.

The last item No. 12 asked for socio-demographic data about the respondents.

University education and length of teaching experience of respondents					
Field of education	N	%	*Length of teaching experience*	N	%
Technical	241	44	0-5 years	113	21
Economic	142	26	6-10 years	66	12
Trade and services	167	30	Over 10 years	371	67

Table 11: Education and length of teaching experience of respondents.

The data shows that two thirds of the respondents had more than 10 years of teaching experience. In all cases, these were teachers of vocational subjects with teaching qualifications for teaching vocational subjects.

5 Final Summary

The results of the research indicated that a significant number of teachers participating in vocational subjects do not currently use AI. However, half of this group expressed interest in incorporating AI into their work, suggesting the potential for further training in this area. Our aim is to engage all teachers in vocational education with this subject. A significant challenge lies in targeting the group of teachers who have a negative attitude towards AI. This is demonstrably a backward stance, which needs to be addressed.

Currently, there is a wealth of training opportunities available in digital education and AI in education, both in the Czech Republic and abroad. Research has shown that AI is used in education, but to a relatively limited extent. However, most teachers would be willing to use AI if they had access to adequate information, indicating an opportunity for further promotion and education in this area. Despite this, there remains a relatively large group of teachers who do not perceive AI as beneficial or useful. We believe this is primarily due to a lack of relevant information regarding this phenomenon.

The research also revealed that among language models, ChatGPT is the most commonly used tool, which is logical given its widespread promotion and availability. Moreover, the study found that teachers most frequently use AI for lesson preparation and delivery. Teachers in vocational education typically use AI once or twice a week, with a small percentage working with AI once a month or less.

For lifelong learning, our research provides a clear signal that the vast majority of teachers are either currently engaging in educational development or wish to do so, and they express a desire to incorporate AI into their educational practice.

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To the Roots: Engineering Pedagogy

Exploring Forms of Cooperation and Roles of English and Disciplinary Teachers Applying CDF Approach to Establish International Educational Environment

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Abstract

This study examines the collaborative dynamics and delineated roles of English and disciplinary teachers in implementing the Conceptualisation, Development, and Fluency (CDF) approach to cultivate an internationalised educational environment within higher education. Specifically, it explores how English teachers contribute by fostering academic language proficiency, thereby enabling students to engage with key disciplinary concepts and discourse. Simultaneously, disciplinary teachers prioritise accessibility to specialised knowledge, guiding students in comprehending and applying field-specific language and communicative norms. From a theoretical standpoint, this research evaluates cooperative strategies such as integrated curriculum design, co-teaching models, and interdisciplinary workshops which collectively enhance the integration of language and content instruction. The study presents diverse forms of cooperation, analysing their advantages and challenges within the Slovak higher education landscape with a focus on the local context of the Slovak University of Technology in Bratislava (STU MTF). Furthermore, the contribution critically assesses the practical applicability of CDF framework, offering insights into its potential for establishing inclusive and internationally oriented learning environments.

Keywords: Internationalisation of Higher education, Teacher Cooperation, CDF Approach

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1 Introduction

In today's globalised academic landscape, creating an internationalised educational environment within higher education institutions has become essential for preparing students to succeed in diverse, multicultural contexts. One promising method for fostering this environment is the Conceptualisation, Development, and Fluency (CDF) approach, which emphasizes both language proficiency and disciplinary knowledge as foundations for learning. Implementing this approach requires effective cooperation between English language teachers and disciplinary (subject-specific) teachers, as each brings distinct expertise essential to student development. English teachers focus on enhancing students' academic language skills, enabling them to comprehend and articulate disciplinary concepts accurately, while disciplinary teachers concentrate on guiding students in mastering field-specific content and communication norms. Understanding the forms of collaboration and the roles each type of educator plays in applying the CDF approach is crucial to advancing integrated learning models that support internationalised, inclusive, and accessible education. This investigation thus aims to clarify the collaborative dynamics and practical applications of the CDF framework within higher education to optimize learning outcomes and foster globally relevant competencies.

1.1 Internationalisation of Higher Education

Internationalisation in higher education encompasses a range of strategies aimed at embedding global perspectives, cultural awareness, and cross-border collaboration within universities. This broad concept includes several distinct forms, such as student and staff mobility, international curriculum development, cross-border partnerships, on-campus internationalisation, and internationalisation at home (IaH) each contributing uniquely to the global reach and relevance of educational institutions.

This study primarily focuses on Internationalisation at Home (IaH), given that, within our context, higher education institutions enrol a significantly larger proportion of domestic students compared to international students. To equip students with the skills necessary for a globalised world, it is essential to create an 'artificially internationalised' educational environment, primarily through an English-medium instructional setting.

The methods for establishing English education environments are diverse and vary according to the specific context of each higher education institution. Institutions may implement one or more approaches tailored to their unique educational and linguistic landscapes. Common approaches include English-Medium Instruction (EMI), where courses are delivered entirely in English; Content and Language Integrated Learning (CLIL), which integrates language and content instruction; bilingual or multilingual programs that balance English with the local language; English-focused campus initiatives that promote language use and cultural exchange on campus; and Virtual Exchange and Collaborative Online International Learning

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(COIL), which facilitate cross-cultural interactions and collaborative projects through online platforms.

To establish an English-language educational environment, provide targeted support for students, and facilitate collaboration between English and disciplinary faculty, we have selected the Conceptualisation, Development, and Fluency (CDF) approach as our framework for implementation.

1.2 Conceptualisation Development and Fluency – CDF approach

The Conceptualisation, Development, and Fluency (CDF) approach is a structured framework designed to help students progressively build their academic and language skills within an English-medium or internationalised educational environment. The CDF approach is particularly useful in higher education settings where content learning and language proficiency need to be developed simultaneously. Here’s how each component of CDF can contribute to establishing an English-language education environment:

Conceptualisation

In the CDF approach, conceptualisation focuses on helping students understand and engage with core concepts of their discipline in English. This stage encourages students to form a foundational understanding of key ideas, theories, and vocabulary in their field, often through structured reading, introductory discussions, and guided activities. By introducing disciplinary content in English, students begin to develop both content comprehension and language familiarity simultaneously (Turner & Robson, 2008).

Development

The development phase builds on students’ initial understanding by deepening their engagement with subject-specific content and enhancing their language skills. Here, students are encouraged to participate in more complex discussions, collaborative projects, and analytical tasks in English. This stage often includes interactive learning strategies, such as group work and case studies, which require students to actively use English in ways that align with the professional and academic standards of their discipline (Hyland, 2006)

Fluency

The fluency phase aims to enable students to communicate their ideas and knowledge effectively in English with confidence and accuracy. By this stage, students have developed a level of comfort with both the disciplinary content and language and are encouraged to participate in presentations, debates, and writing projects that require fluency in English. Fluency activities are often designed to simulate real-world professional tasks, preparing students to work in international environments where English is the primary language of communication (Beelen & Jones, 2015).

The CDF approach thus provides a scaffolded structure in which students progressively develop the language proficiency and academic skills required for their fields. By focusing on conceptual understanding, skill development, and fluency, CDF supports an inclusive, English-medium education that benefits both domestic and international students in globalised higher education settings.

2 Teachers in Higher education

The authors will provide a brief overview of English practitioners and disciplinary teachers, focusing on their roles and potential in applying the CDF approach.

2.1 English Teachers

When speaking about English teachers, we should keep in mind that we speak only about those teaching English for Specific Purposes at Slovak non-philological universities. Here we must admit that the number of English teachers at Slovak higher educational institutions has significantly reduced recently, and especially the number of ESP practitioners. This unfavourable process of decrease is still going on despite the plans and visions of the Ministry of Education, Science, Research and Sport of the Slovak Republic which has previously proclaimed the necessity of having a knowledge-based and the English language competent population of graduates. Some universities closed their language centres/departments, e.g. the Technical University of Košice has significantly reduced the number of language teachers, and the rest of practitioners has been allocated at individual faculties, which means they have no further close cooperation and knowledge or experience exchange with other fellow teachers, although – on the other hand, this allocation may improve their insight into the discipline they teach language for. From other institutions with similar situation, we can mention Trnava University, Faculty of Law, or Trenčín University of A. Dubček which has also allotted their language teachers to subject-specific departments and similarly it has been done by the University of St. Cyril and Methodius in Trnava, at its Faculty of Social Sciences, just to mention at least few examples in the country.

Teachers are hardly trying to keep with the latest educational trends. They implement ICT (including the utilisation of artificial intelligence for educational purposes), utilise a communicative approach in teaching, constantly develop integrated language and soft skills, use many practical examples, case studies in teaching as well as have extracurricular activities. The universities (especially the technically oriented ones) also suffer from low interest from the wide public. The number of students is decreasing, however, the last few years the foreign students (from Ukraine or Kazakhstan to mention at least the situation at STU MTF in Trnava) came to Slovak universities and improved such the number of students.

The role of English teachers has shifted significantly in recent years. Not only they are *a) language teachers*, they also b) *must have some background knowledge* in the specific subject they teach English for (medicine, law, informatics, engineering, etc.). These two roles could be enough, however, recently, the ESP teachers have become c) *intermediators* of the internationalisation process as the government requires the universities to provide as many study programmes in English as possible, not mentioning the growing number of Erasmus mobility students.

This situation has proved the fact that the cooperation of ESP practitioners with subject-specific teachers – disciplinary teachers – is inevitable, and should be present throughout the whole academic year and study in the form of mutual help, i.e. the disciplinary teachers should help the English practitioners to grasp the subject matter more in depth, to understand the concept; and vice versa, the English teachers should help the disciplinary ones to better implementation of linguistic elements into their subject. Application of this mutual and constant cooperation would lead to the development of students´ knowledge, experience, and confidence. With such experience and enhancement, the students can fluently and smoothly communicate their ideas and will gain comfort with both disciplinary content and language in real-world professional situations.

2.2 Disciplinary Teachers

Disciplinary teachers are all those teachers teaching a specific subject in a particular scientific discipline. They have deep knowledge of their discipline, also have analytical skills, and are able of practical application of their knowledge. These teachers often follow a structured approach, i.e. a linear and logical progression to convey the curricular topic systematically.

The there are several ways of their possible cooperation with English practitioners which depends on the disciplinary teachers´ English language competence. And here is the situation much better as the survey executed within our institutional project INTERMTF I in 2018 showed – 67.3% of disciplinary teachers (of 209 teachers-respondents) are prepared to start teaching at least part of their lesson in English. The language teachers can provide help and support especially in terms of didactics, i.e. how much and what tools can be used to integrate language into their subject-matter teaching.

The best way of mutual cooperation of disciplinary and English teachers seems to be the Content and Language Integrated Learning (CLIL) and application of CDF approach. The benefits of such learning lie in enhanced and developed student learning as this integrated approach helps them not only grasp the complexity of concepts but also communicate them effectively and fluently. Needless to say, the cooperation is beneficial for both groups of teachers and boosts thus interdisciplinary understanding.

3 Teacher Cooperation Forms

There are several approaches to enhancing the development of an English education environment within universities, including team teaching, collaborative research and project initiatives, specialised English and pedagogical training courses for disciplinary faculty, and the establishment of professional learning communities. The specific form of implementation should be carefully tailored to the context and unique needs of the local university.

3.1 Teacher Cooperation at STU MTF

ESP instructors have undertaken various initiatives in their efforts to identify an appropriate model of collaboration, with the overarching objective of establishing an effective English education environment at STU MTF. They designed and led the international research project CLIL-HET (CLIL-Higher Education Teacher), which aimed to develop a didactic study program for disciplinary teachers and facilitate the exchange of teaching strategies among educators from various countries. The project investigated the needs and concerns of disciplinary teachers within the context of an English education environment. Collaboration in the project centred on subjects and study programs delivered in English for domestic students. The initiative also addressed both disciplinary teachers and students, examining their linguistic preparedness and capacity to establish a simulated international environment.

3.2 Future Cooperation Forms

Recently, the focus on building an international academic environment at STU MTF has shifted toward developing study programs in English specifically for foreign students, rather than for domestic audiences. To achieve optimal collaboration among educators, considerations must extend beyond linguistic and didactic preparedness to include intercultural studies, ensuring a comprehensive approach to fostering an effective international educational setting.

Future forms of collaboration are likely to be grounded in interdisciplinary connections. At STU MTF, the implementation of online courses is being considered as a means of supporting both students and disciplinary teachers. These courses aim to help disciplinary educators standardize the English proficiency levels within their classes while simultaneously offering didactic guidance on how to effectively prepare and deliver their subject content in English.

The development of future cooperation models at STU MTF is significantly influenced by the willingness of disciplinary teachers to engage in additional training, their openness to collaboration, and their readiness to share expertise with colleagues. Equally critical is the university management's commitment to offering incentives and support for teachers actively contributing to the establishment and enhancement of an English education environment, whether for domestic students, international students, or mixed groups.

4 Discussion

In the dynamic landscape of higher education, promoting collaboration between English teachers and subject-specific instructors is essential for equipping students to succeed in a globalised environment. By integrating frameworks such as the CDF (Conceptualisation, Development, and Fluency) approach with methodologies like Content and Language Integrated learning (CLIL), educators can create environments that merge linguistic proficiency with disciplinary expertise, benefiting both domestic and international students.

4.1 Cooperation's Role

Collaboration between English teachers and disciplinary teachers is fundamental to effective internationalised education. English teachers play a vital role in improving students' academic language skills, essential for comprehending and expressing disciplinary content. Disciplinary educators facilitate students' understanding of domain-specific concepts and communication standards. This partnership enables students to acquire confidence and fluency in their fields while also cultivating the language skills essential for professional success (Beelen & Jones, 2015).

4.2 Implementing the CDF Approach

The CDF framework offers a structured approach for integrating content and language learning.

- *Conceptualisation:* This phase introduces essential disciplinary concepts in English, fostering an initial understanding (Turner & Robson, 2008).
- *Development:* During this phase, students engage with progressively complex content using interactive methods such as case studies and collaborative tasks (Hyland, 2006).
- *Fluency:* Focused on practical application, this phase equips students to effectively convey disciplinary knowledge in professional settings.

These stages collectively support an inclusive, English-medium education that prepares students for global opportunities.

4.3 Advantages of CLIL

The CLIL methodology enhances cooperation by seamlessly integrating content and language instruction. This method promotes interdisciplinary comprehension and strengthens both linguistic and subject-specific skills. Students gain a more comprehensive educational experience, enabling them to articulate complex concepts effectively. Simultaneously, subject teachers enhance their teaching methods through linguistic insights provided by English educators (Hurajová, 2018).

4.4 Challenges and Recommendations

Despite its advantages, implementing cooperative models necessitates addressing institutional and logistical challenges. A decline in the number of English practitioners and insufficient institutional support at some Slovak universities impede progress. Addressing these issues requires specific strategies, including:

- Establishing interdisciplinary workshops.
- Cultivating professional communities.
- Hurajová (2019) suggests utilising digital tools like AI to create innovative teaching solutions.

In a period of swift global transformation, higher education must adapt by adopting collaborative methodologies such as the CDF framework and CLIL.

5 Conclusion

The world is rapidly changing, and so is education in higher educational institutions, particularly concerning their internationalisation. This process requires new approaches and a shift in the roles of both English practitioners and disciplinary teachers to effectively prepare a new generation of educated individuals.

Despite potential differences in university education systems at international, national, or local levels, collaboration among all involved stakeholders is essential (Hurajová, 2019). Implementing Content and Language Integrated Learning (CLIL) and the Conceptualisation, Development, and Fluency (CDF) approach can offer numerous benefits. Therefore, integrating these methodologies into curricula and syllabi is advisable.

Strengthening cooperation between English and disciplinary educators enables universities to equip students for success in diverse, multicultural settings. This transition not only enhances educational outcomes but also fosters a generation capable of navigating an increasingly interconnected world.

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To the Roots: Engineering Pedagogy

What Happens when we Flip the Class?

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Abstract

What happens when we flip the classroom? Nothing. The students are still learning, and the teacher is still guiding them. But is the answer really that simple? Essentially, yes. However, the flipped classroom methodology comes with its own nuances, which can influence the overall educational outcomes. To ensure that students achieve outcomes equal to or better than those in traditional classrooms, some adjustments are necessary. In this article, we share our insights and experiences with the flipped classroom approach, offering perspectives from both teachers and students across various subjects.

Keywords: Education, Flipped Classroom, Teaching materials

1 Introduction

What occurs when we implement the flipped classroom model? Basically nothing. Essentially, the process remains unchanged: students continue to learn, and the teacher continues to guide them. Nevertheless, adjustments are likely necessary to ensure that students attain educational outcomes comparable to or exceeding those achieved through traditional teaching methods. So, the answer to the question posed is certainly not that simple.
The concept of flipped classroom is not new in pedagogical practice. Flipped classroom is a teaching method in which students watch educational videos or learning materials before the actual class takes place and then focus on discussions, problem-solving, and practical exercises under the guidance of a teacher in class.
Flipped classroom can be a very effective teaching method when used and implemented correctly. This method can help students with different learning styles to learn more easily

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and quickly because videos and materials can be adapted to the individual needs and pace of the students. Additionally, using the classroom for discussions and teacher – led practical exercises can help students understand and apply the concepts and information they have learned from the materials.

2 Flipped Classroom

The flipped classroom method is a modern teaching method that brings change in the traditional teaching pattern. In traditional teaching, students learn new material in the classroom, listen to lectures from the teacher, and then do assignments, homework, and master the learning material at home. In the flipped classroom this situation is turned inside out. (Baig & Yadegaridehkordi, 2023; Bishop & Verleger, 2013) Students study new materials at home in advance, before class – they watch lectures in the form of online videos or read an article on the topic that they will later learn in class. The lesson then does not cover new topics, but emphasizes practical activities, discussions and problem solving. Students, together with their teacher, review and discuss knowledge and solve examples and problems within groups. (Tang et al., 2023)

This method allows students to have more control over their learning and adapt the pace of learning to their needs. Research has shown that the use of the flipped classroom method has a positive impact on students' studies, as it increases their interest in the subject, improves their motivation and self-confidence, helps develop their critical thinking and thus ultimately leads to an overall improvement in academic results. (Pšenáková at all., 2024)

A flipped classroom can reduce the amount of time spent on lectures, provide hands-on experience, and help students better prepare and motivate themselves for their studies. (Jiang et al., 2022)

Currently, the flipped classroom method is becoming increasingly popular, and several studies indicate its successful use in various areas of education, including higher education.

2.1 Benefits of flipped classroom in higher education

The flipped classroom brings several advantages to higher education that can improve the quality of teaching and learning efficiency. Based on various publications and our own experiences, we will list the following (Galindo-Dominguez, 2021; Mandasari & Wahyudin, 2021; Sointu et al., 2023):

More active involvement of students in work during face-to-face classes. Students come to class with prior knowledge of the topic, allowing them to immediately engage in discussions, exercises, or case studies. This approach leads to greater engagement and active learning rather than passive reception of information. Higher cognitive levels of thinking, such as analysis, synthesis, and application, are activated as students use basic knowledge to solve more complex problems in the classroom.

Flexibility, individual pace of learning. Students can study materials at their own pace, which supports effective time management. Materials such as videos and presentations can be viewed at their own pace and at a time that suits them best. They can return to materials whenever they need to, which is a great advantage for students with different learning styles and different speeds of knowledge acquisition. This approach fosters the development of independent and self-directed learning, which is especially crucial in higher education, where greater student autonomy is expected.

More efficient use of time in classroom. With students having studied the background information in advance, class time can focus on in-depth activities such as discussions, practical exercises, problem solving, or project work. This increases teaching effectiveness and promotes a deeper understanding of the subject content. Teachers can provide direct and specific feedback during class because they can focus on specific questions and problems that students have.

Developing critical thinking and problem solving. Active learning enables the development of critical thinking skills because students talk about the material they have studied, are encouraged to research, analyse, and discuss issues rather than simply memorising facts. They work on practical tasks that often require creative and analytical thinking. Students learn to solve problems and apply theoretical knowledge to real-world situations, which improves their readiness for practical challenges in the profession.

Improving the relationship between teacher and students. Face-to-face classes are focused on interactive activities and discussions, allowing the teacher to work more closely with the students. This approach reduces barriers between students and the teacher, strengthens the relationship and trust between them, promotes openness and improves mutual communication. Teachers can better understand the individual needs of students, their weaknesses and strengths, which allows them to tailor their approach to students according to their specific needs.

More space for immediate feedback. During various classroom activities, teachers can immediately identify areas that students are struggling with and provide immediate feedback. This gives students the opportunity to understand material that they may not have mastered through self-study. This type of direct interaction contributes to better knowledge acquisition and increases students' confidence in learning.

Increasing responsibility for one's own learning—supporting independence. By studying background information in advance, students take greater responsibility for their learning progress, as the flipped classroom encourages independent study prior to the lesson. Such an approach inspires students to recognise the importance of their own initiative and engagement in the learning process. In this way, students become active co-creators of their own learning and develop the ability to independently plan and organise their tasks and time. Students are led to take responsibility for their own learning, thereby developing independence and self-management.

Preparation for the modern job market. The flipped classroom develops skills such as independent learning, critical thinking, teamwork, and communication that are essential in the modern job market. This way of learning teaches students how to prepare for their tasks effectively and responsibly. This approach supports students in acquiring skills important for lifelong learning, which is becoming increasingly important in dynamic professions.

2.2 Disadvantages of the flipped classroom in higher education

Although the flipped classroom method is currently becoming increasingly popular and has many advantages, there are also certain disadvantages that can affect its success. Disadvantages for teachers include:

- *Higher demands on the time needed to prepare teaching materials*. Preparing quality learning materials (such as videos, online quizzes, or interactive exercises) is not only time-consuming, but also requires certain technical skills that not every teacher has. Teachers need to spend more time planning lessons that include in-class activities, which can be challenging with many students.
- *Fewer opportunities for direct control of the study process.* The teacher has limited control over how well and to what extent students have studied the materials before class. If students do not assimilate the information well, classroom activities may be less effective and efficient.

For students, the flipped classroom may be disadvantageous for the following reasons:

- *It places higher demands on self-discipline.* The success of a flipped classroom depends on whether students study the necessary materials before class. If they do not, problems arise with active learning in the classroom. Some students who have trouble planning their time or studying independently may fall behind others.
- *Access to technologies.* There are still students who come from socially disadvantaged families and have limited access to new technologies.
- *Tiredness and exhaustion.* Some students may find the flipped classroom challenging because they must study in their own time. This method can be stressful when used across multiple subjects. Students with demanding personal or work commitments may find it difficult to devote time to independent study outside of class.

Finally, we must also realise that not all subjects are suitable for using the flipped classroom method, and it is also not suitable for all learning styles, e.g. for students who prefer a traditional approach to learning with clear guidance from the teacher.

Although these disadvantages are real, they can be entirely or partially mitigated through appropriate teaching planning, balancing self-study with face-to-face instruction, employing suitable technologies, and supporting students in independent learning. The challenge for teachers is to find an effective solution that encourages the involvement of all students in the learning process and yields the desired outcomes.

2.3 Steps for implementing a flipped classroom method

Based on our experience introducing the flipped classroom method into teaching certain subjects, we have proposed four basic steps that, in our opinion, should be followed when implementing this method in a given subject.

1. *Set clear goals*: Determine what students should know before arriving for an in-person class.
2. *Prepare learning materials in advance:* Video lectures, e-books or articles, presentations that students should study at home.
3. *Focus on interaction in face-to-face classes*: After preparing at home, focus on activities in class such as discussions, presentations, or group projects.
4. *Provide feedback to students*: Provide regular feedback on assignments and project solutions so that students know whether they are doing things correctly, where they are making mistakes, and where they can improve.

The effectiveness of the flipped classroom model in teaching largely depends on the teacher, who, through their activities and approach to students and their work, can properly motivate, guide, and lead students to achieve the same or better study results than in traditional teaching.

In practice, this method is successfully used at many universities and in various fields, such as engineering, medicine, and social sciences.

3 Analysis Results

Several studies have confirmed that the flipped classroom improves academic performance and engagement for both students and teachers. (Paňková, E., at al., 2017; Pšenáková at al., 2024)

As part of the project, we also conducted a smaller survey, some partial results of which we present here.

For data analysis, we used data from the responses of 61 respondents who participated in flipped classroom teaching. In total, we track over 20 variables in the survey, but in our analysis, we have only used 3 so far, namely:

1. *Student's preferred teaching method:* distance learning or face-to-face.
2. *Flipped classroom teaching quality assessment:* using a Likert scale.
3. *Overall quality of the course:* using a Likert scale.

We set the following hypotheses:
H1: Students preferring distance learning will evaluate flipped classroom teaching more positively than students preferring face-to-face teaching.
H2: There is a significant difference in the perception of the overall quality of teaching by students preferring the face-to-face form of study and students preferring the distance form of study.
Based on the answers to the question about the preferred teaching method, we found that most respondents prefer the distance learning form, which was chosen by 47 (77%) students, and only 14 (23%) prefer the face-to-face form.
The quality of teaching using the flipped classroom method was assessed by respondents using a Likert scale, and therefore it is appropriate to check the normality of the underlying distribution of variables using the Shapiro test (tab.1).

Shapiro-Wilk normality test		
Learning Preference	on-site	distant
W	0.75821,	0.48217,
p	0.001589	1.189e-11

Table 1: Normality test.

In both cases, it is confirmed that the result does not correspond to a normal distribution, which is what we expected. To verify hypothesis 1, we therefore used a one-sided Mann-Whitney U test, according to which the W statistic equals 443.5 and p-value = 0.005599.
The test result shows a significant difference in the evaluation of the flipped classroom method between students preferring the distance learning method (1.255319 – average value of the Likert scale answers) and students preferring the face-to-face method (2.142857).
Based on the answers given in Likert scale, we can also draw a conclusion from the average value of the responses, confirmed by the Mann Whitney test, that students who prefer the distance learning form of study evaluate teaching through the flipped classroom more positively than students who prefer face-to-face teaching. Hypothesis H1 was confirmed.
We follow a similar procedure to confirm our second hypothesis (tab. 2). Specifically, we first verify whether our expectations that the data are different from a normal distribution are confirmed.

Shapiro-Wilk normality test		
Learning Preference	on-site	distant
W	0.57641	0.53319
p-value	2.519e-05	5.225e-11

Table 2: Normality test.

The results confirm that this is not a normal distribution, and therefore we used the Mann Whitney U test, according to which W = 357.5, p-value = 0.5467.

The result did not confirm a significant difference in the perception of the overall quality of teaching between students preferring the face-to-face and students preferring the distance form of study. Students preferring the face-to-face form had an average assessment of the quality of the subject of 1.571429 and the group preferring the distance form of 1.361702. In this case, we rejected the hypothesis H2.

4 Conclusion

Based on the partial results of the survey, we were able to conclude that students who prefer distance learning perceive the flipped classroom method more positively than students who prefer face-to-face learning, which is completely understandable, since the flipped classroom method contains elements of distance learning. However, we are satisfied with the result that there is no significant difference in the assessment of the overall quality of teaching, which also confirms that the use of the flipped classroom method in education does not reduce its quality compared to traditional teaching.

The flipped classroom method, while it has its drawbacks, offers many advantages that can improve not only students' academic performance but also their skills needed for their future careers. Nevertheless, it is important to consider the specific conditions and capabilities of the university, department, subjects, and necessary technologies to make its implementation as effective as possible.

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Teaching PLC Programming Using Interdisciplinary Relations

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Abstract

Within the 'Fundamentals of Robotics' course, we developed a teaching aid for programming programmable logic controllers (PLCs), integrating interdisciplinary relationships across various educational areas. This tool aimed not only to teach students how to program PLCs but also to effectively apply knowledge from multiple subjects. We created an automated, low-maintenance freshwater aquarium care system, applying knowledge from engineering, science, and computer science disciplines such as technology, computer science, mathematics, physics, biology, and chemistry in its design and implementation. The paper also focuses on a detailed analysis of the educational standards of the relevant subjects needed in the development of this teaching aid. For primary school students interested in applying STEAM principles with their teachers in engineering subjects, it is necessary to determine the appropriate grade level for incorporating these activities into their education.

Keywords: PLC, Programming, STEAM, Interdisciplinary Relations, Educational Process

1 Introduction

Programmable Logic Controllers (PLCs) are a key component of industrial automation and are widely used to control a variety of industrial processes. In recent decades, the teaching of PLCs has become one of the important components of technical education because, due to the rapid advances in automation technologies, knowledge of their programming is essential for professionals in industrial manufacturing, energy, and other technical disciplines (Brettel et al., 2014). However, the implementation of PLCs in the teaching of programming requires a systematic approach that can effectively link theoretical knowledge with practical applications. This creates room for the use of interdisciplinary relations allowing students to not only understand the principles of PLC programming, but also understand its links to other

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disciplines, thereby enhancing their technical skills and critical thinking abilities. Interdisciplinary relations in the process of education allow the application of knowledge from different areas increasing the chances of better understanding and deeper immersion into the subject. According to Beers (2016), "interdisciplinary relations promote the integration of knowledge, thereby creating a more comprehensive understanding of the content and its connections to real-world problems". It follows that effective teaching of PLC programming can benefit from a cross-curricular approach, as it provides the opportunity to link theory with practical applications not only within technical subjects such as physics or electrical engineering, but also with aspects of mathematics, computer science and logical thinking.

1.1 The importance of PLCs in industrial practice and education

Programmable logic controllers are currently used in a variety of industrial applications, including production line control, process monitoring, and automation of technical devices. The importance of these systems highlights the fact that PLCs are among the key enablers of the transformation of the manufacturing process in the Industrial Revolution 4.0, as they enable increased efficiency and safety of industrial processes (Vogel-Heuser & Hess, 2016). Therefore, it is important for engineering students to understand not only the principles of their operation, but also the basic methods of their programming. Teaching PLC programming involves learning basic logic functions, analysing control processes and implementing them in programmable systems. In this context, the use of interdisciplinary relations is of key importance as it broadens the student's understanding of different aspects of control systems, while linking theoretical knowledge with practical experience.

According to some studies (e.g., Brettel et al., 2014), PLCs can be an effective tool for students to gain hands-on experience because they allow them to interact with real devices, which increases their motivation and interest in studying engineering subjects. This motivation can be further fostered by using an interdisciplinary approach that develops the ability to apply knowledge gained in one subject to solve problems in another. The use of methods such as projects and case studies can strengthen these relationships as students are forced to apply knowledge from different disciplines to solve complex problems.

1.2 Benefits and challenges of an interdisciplinary approach in teaching PLCs

Interdisciplinary approach in teaching engineering subjects such as PLC programming has many advantages including the opportunity to learn how to solve problems through the application of different knowledge while fostering the development of analytical and critical thinking skills. In teaching PLCs, it is important that students understand the basic principles of automation and can apply them in a broader context, thereby increasing their ability to creatively solve engineering problems. This approach allows students to gain a broader perspective on the connection between theory and practice, leading to a better understanding of the practical applications of PLC systems (Vogel-Heuser & Hess, 2016).

However, a challenge in introducing interdisciplinary relations into the teaching of PLCs is often the need for coordination between subjects and their teachers. Different subjects that could be included in the teaching of PLC programming, such as mathematics, physics and computer science, have different methodological approaches, which can lead to problems with content integration. For an effective use of an interdisciplinary approach, teachers' collaboration with each other is essential to plan and coordinate content effectively so that space and opportunities are created for the application of knowledge from one subject in another context (Beers, 2016).

The use of interdisciplinary relations in teaching PLC programming represents a promising approach. It promotes the integration of theoretical knowledge with practical skills, thereby improving students' readiness for professional practice. This method emphasises practical tasks and projects that apply knowledge from various fields. Such an approach leads to a better understanding of the connections between different technical disciplines and increases students' motivation to study them.

1.3 Teaching PLC programming using interdisciplinary relations

Integrating different disciplines to establish natural relationships among them is a key trend in contemporary pedagogy, particularly within engineering and science subjects. This interdisciplinary approach enables students to acquire knowledge and skills that are practically applicable in real life, while also fostering their analytical, creative, and critical thinking abilities. The 'Fundamentals of Robotics' course, which we have integrated into the curriculum, emphasises the development of these skills through the teaching of programmable logic controllers (PLCs). In this context, we have created a specific teaching aid that supports pupils not only in acquiring technical knowledge, but also in linking it to knowledge acquired in various other areas. Our aim was to ensure that students not only learn the principles of PLC programming, but also that they are able to use knowledge from disciplines such as technology, computer science, physics, biology, chemistry or mathematics, thus gaining a more comprehensive view of the issue of automation and its applications.

The result of this effort was the construction of an automated freshwater aquarium care system that we designed to be low maintenance while incorporating various aspects of an interdisciplinary approach. This system allows students to learn the basic principles of automation and PLC programming directly while working with a specific piece of technical equipment, while motivating them to use their knowledge in different areas. The designed teaching aids integrate STEAM (Science, Technology, Engineering, Art, Mathematics) principles that promote the development of technical and critical thinking skills as well as creative problem-solving skills.

In addition to the actual development of the system and the implementation of the interdisciplinary approach, this paper focuses on a detailed analysis of the subject-specific learning standards that are essential to the design of this teaching aid. We will present specific topics and areas that students should master in order to successfully complete the project. In addition, since our ambition is to integrate such teaching aids into the primary school educational process, we will also focus on finding an appropriate grade level in which these activities could be effectively integrated into the classroom. Equipped in this way, students will gain a solid foundation that is essential for their further studies in electrical, mechanical and technical fields, increasing their potential for success in professions where the ability to link different knowledge and apply it in practice is increasingly valued.

2 Analysis of Educational Standards

In this part of the article we deal in detail with the analysis of educational standards of those subjects that are essential in the creation of an educational aid. If teachers of the subject Technology in primary school together with their students would like to create an educational aid and apply STEAM principles in education, it is important to know in which grade it is appropriate to start with this work and which educational standards of each subject are closely related to the educational aid we have designed. In this way, interdisciplinary education is deepened. However, in the primary school, our teaching aid cannot be controlled by a PLC system; instead, it will be managed by a BBC micro: bit microcontroller, which the pupils are already familiar with.

This approach effectively integrates technical and scientific knowledge into the learning process, thereby fostering the development of students' critical thinking and practical skills. The use of the BBC micro: bit microcontroller is ideal for primary schools as it is accessible and easy to use, enabling pupils to acquire basic programming and technical skills at an early age. This way of teaching not only promotes interdisciplinary links between different subjects but also prepares pupils for future challenges in technology and innovation.

Product part	*Implementation of automation (lighting, filtration, power supply, heating, alarm)*
Educational standard for the subject Physics	
Year	*6*
Thematic unit	Investigating the properties of liquids, gases, solids and objects
Year	*7*
Thematic unit	Temperature. Investigation of the transformations of states of matter
	Heat
Year	*8*
Thematic unit	Light
	Force and motion. Work. Energy
Year	*9*

Thematic unit	Magnetic and electrical phenomena. Electric circuit
Educational standard of the subject Computer Science	
Year	*6*
Thematic unit	Communication and cooperation - working with a website
	Algorithmic problem solving - problem analysis
	Algorithmic problem solving - language for writing solutions
	Algorithmic problem solving - using a sequence of commands
	Algorithmic problem solving - using cycles
	Algorithmic problem solving - interpreting the solution notation
	Algorithmic problem solving - finding, correcting errors
	Software and hardware - working with files and folders
	Software and hardware - working in the operating system
	Software and hardware - working on a computer network and the Internet
Year	*8*
Thematic unit	Representations and tools - working with graphics
	Communication and collaboration - web search
	Algorithmic problem solving - problem analysis
	Algorithmic problem solving - a language for writing solutions
	Algorithmic problem solving - using sequences of commands
	Algorithmic problem solving - using cycles
	Algorithmic problem solving - using branching
	Algorithmic problem solving - using variables
	Algorithmic problem solving - using interaction tools
	Algorithmic problem solving - interpreting the solution notation
	Algorithmic problem solving - finding and correcting errors
	Software and hardware - working with files and folders
	Software and hardware - working in the operating system
	Software and hardware - working on a computer network and the Internet
Educational standard of the subject Technology	
Year	*5*
Thematic unit	Man and technology
	Man and production in practice
	Useful and gift items
Year	*6*
Thematic unit	Graphic communication in technology
	Electricity, electrical circuits
	Simple machines and mechanisms
Year	*7*

Thematic unit	Graphic communication in technology
	Technical materials and their working processes
Year	*8*
Thematic unit	Household electrical appliances
	Technical electronics
	Technical creation
Year	*9*
Thematic unit	Residential installations
	Creative activity

Table 1: Educational standards for the implementation of automation.

Summary of performance standards:

1) Physics:

a) Describing and verifying characteristics of substances and solids: Students learn about the characteristics of substances such as density, strength, shape, mass, and more. They investigate these experimentally and verify theoretical knowledge.
b) Measurement of physical quantities: Students learn to measure various physical quantities such as length, mass, time, temperature and electrical resistance.
c) Investigating the state transitions of substances: Students are introduced to state transitions (melting, solidification, boiling, condensation) and their effect on substances.
d) Heat and Light Propagation: Students learn about conduction, convection, and radiation of heat. They also explore the propagation of light and its characteristics.
e) Mechanical Work and Energy: Students explore the concepts of work, energy, and power. They distinguish between different forms of energy and its transformation.
f) Electrical and Magnetic Phenomena: Students learn about electric circuits, magnetic fields, electromagnetic waves and their applications.

2) Computer Science:

a) Algorithmic problem solving: Students learn to create algorithms to solve problems. It includes logical thinking, sequence of steps and programming.
b) Working with websites, software and hardware: Students are introduced to the use of computers, operating systems, applications and peripherals.
c) Working on a computer network and the Internet: Students learn about networks, protocols, security, and communication on the Internet.
d) Working with graphics: Students deal with creating and editing graphics as well as creating web pages.

3) Technology:

a) Man and technology (year 5): Observe the rules of health and safety, hygiene and behaviour.
b) Man and Production in Practice (year 5): Diagram of the body structure of plants and animals, comparison of body parts of moss and flowering plant, observation of the

external body structure of invertebrates. Describe the process of making a simple product. To present the design and making of a simple product from natural materials available in the region.

c) Utility and gift items (year 5): Make a sketch of a simple product, select technical materials and tools for making the product, design a work procedure for making the product, make the designed product, present the results of their work.
d) Graphic communication in technology (year 6): Determine from a technical drawing the dimensions of a depicted object, draw a representation of a simple object in one projection, assign dimensions to a depicted simple object, develop a project to compare different types of representations.
e) Electricity, electrical circuits (6th grade): Connect a simple electrical circuit on a building block, to describe the main principles of first aid procedure in case of electric shock, to connect separately other electrical circuits on an electrical building block according to the diagram.
f) Simple machines and mechanisms (year 6): Give examples of the use of simple machines, mechanisms and gears in practice, to compare some types of gears in mechanical toys.
g) Graphic Communication in Technology (year 7): Identify individual projections on a technical drawing, fill in a missing projection of an object on a technical drawing, draw a simple technical drawing of a product in three projections, explain the difference between a technical drawing and technical documentation, project the shape, dimensions, material and work procedure for a simple product of their own.
h) Technical materials and their working procedures (year 7): Design a technological procedure for making own product, implement selected working procedures of manual machining on products according to a technical drawing.
i) Household electrical appliances (year 8): Describe the principles of operation of selected electrical appliances, master the rules of use of selected electrical appliances in the home, calculate the electricity consumption of selected household appliances using the energy label.
j) Technical electronics (year 8): Connect a diode in the permeable and impermeable direction, to state the methods of controlling electrical appliances and devices in the home, to describe the principle of transmission of telecommunication signals.
k) Technical creation (year 8): Create technical documentation for own simple product in electronic form, design own product, implement on own product working procedures of manual machining of materials with the use of electrical circuits, develop a project of own simple combined product.
l) Residential installations (year 9): Explain the causes of possible faults in electrical installations and the resulting dangers to humans, list the most common plumbing and drainage faults.

m) Creative activity (year 9): Design a technological procedure for making a product, make a product using other working procedures, justify the need to use other working procedures of manual processing of selected materials in making a product, apply a simple electrical circuit on their own product, make their own more complex combined product according to their proposed project.

Summary of content standards:

1) Physics:

a) Characteristics of liquids and gases: Incompressibility, fluidity, divisibility, compressibility, and expandability.
b) Measurement and Experiments: Measurement of volume of liquids, mass of solids, temperature, and temperature time course.
c) Heat and Temperature: Heat propagation by conduction, convection, radiation, thermal conductivity, thermal conductors and insulators.
d) Light and Energy: Conversion of light to heat, sources of light, direct propagation of light, reflection and refraction of light.

2) Computer Science:

a) Algorithmic problem solving: Analysing a problem, using a language to write the solution, working with sequences of commands, cycles, branching and variables.
b) Software and Hardware: Working with files and folders, operating system, working on a computer network and the Internet.
c) Communication and collaboration: Searching for information on the web, working with graphics, and digitising graphical information.

3) Technology:

a) Man and technology (year 5): School rules, working regulations in the school workshop.
b) Man and production in practice (year 5): Product, origin of the product: idea – production process – product, design of a product to make life more pleasant for man
c) Utility and gift objects (year 5): raw material, material, semi-finished product, gift and utility object idea, design, sketch, dimensions, tools and instruments, work process.
d) Graphic communication in technology (year 6): Representation in technology, design, sketch, technical sketch, pictogram, technical drawing, dimension, chalking, types of lines, scale, representation of objects on one projection – scale, reading a simple technical drawing.
e) Electricity, electrical circuits (year 6): Electricity, production – energy conversion, sources, uses, circuits, elements and schematic markings, diagrams of electrical circuits, effects of electric current, first aid for electric shock.
f) Electrical energy, electrical circuits (year 6): Simple machines, mechanisms, gears – types and principles, uses (mechanical toys, mechanical devices and equipment in the home and in practice).

g) Graphic communication in technology (year 7): Representation of solids on three projections, technical documentation of the product, design, technical drawing of the own simple product.
h) Technical materials and their working processes (year 7): Technical materials - metals, wood, plastics, ceramic materials, glass, rubber, textiles, composite materials, properties and uses of wood working processes: cutting, splitting, drilling, gluing, joining with screws, joining wood by plating, surface treatment metal working processes: cutting, filing, drilling, riveting, bending plastics machining work processes: drilling, gluing, bending, forming, bolting, independent work, product by combination of materials
i) Electrical appliances in the home (year 8): Electrical appliances in the home, types of electrical appliances, principle of operation of electrical appliances, rules of safe use and operation, household economy, energy label (energy class) of electrical appliances, electricity consumption.
j) Technical electronics (year 8): Diode, transistor, integrated circuit, microchip, logic circuits, sensors and control elements, signal transmission, telecommunication technology.
k) Technical creation (year 8): Design, production technology, design and creation of technical documentation, design, PC, drawing programs.
l) Residential installations (year 9): Electrical wiring, high current, low current, basic elements of residential (house) installations, electrical installation materials, electricity consumption in the home, plumbing and drainage, basic elements and their function, regulation of consumption in the home, heating and air conditioning in the home, types of heating and heating, forms of energy, inspection and maintenance of residential installations.
m) Creative activities (year 9): Practical activities aimed at the manufacture of designed products, combined working themes, other available working methods in the field of woodworking, metalworking, plastics and electrical engineering, design and technical drawing of own more complex combined product, design.

Product part	*Care and observation*
Educational standard for the subject Biology	
Year	*5*
Thematic unit	Communities of organisms
	Nature and life
Year	*6*
Thematic unit	Living organisms and their structure
Year	*7*
Thematic unit	Vertebrate body structure and function
Year	*8*
Thematic unit	Basic life processes of organisms
	Heredity and variability of organisms

	Environment of organisms and humans
Year	*9*
Thematic unit	Inanimate nature and its exploration
Educational standard for the subject Chemistry	
Year	*7*
Thematic unit	Substances and their properties
	Transformations of substances
Year	*8*
Thematic unit	Important chemical elements and compounds
Year	*9*
Thematic unit	Thematic unit Carbon compounds

Table 2: Educational standards for care and observation.

Summary of performance standards:

1) Biology:

a) Communities of Organisms (year 5): Distinguish communities by organisms, construct food chains, and classify organisms into different communities.
b) Nature and Life (year 5): Distinguish between animate and inanimate parts of nature by example, decide which information to obtain by observation and which by experiment, choose a suitable tool for observing a particular natural phenomenon, observe natural phenomena with a microscope, magnifying glass.
c) Living organisms and their structure (year 6): Diagram the body structure of plants and animals, compare the body parts of moss and flowering plants, and observe the external body structure of invertebrates.
d) Structure and functions of the vertebrate body (year 7): Distinguish between the terms organ and organ system, explain the importance of organ systems for vertebrate life, justify the differences in the organs of the digestive system depending on food, compare external and internal fertilization, analyse the differences in the development of fish, amphibians, reptiles, birds, and mammals, plan and carry out behavioural observations of vertebrates.
e) Environment of organisms and humans (year 8): Identify how humans interfere positively and negatively with environmental components, monitor air, water, and soil pollution around school and home.
f) Inanimate nature and its cognition (year 9): Explain the dependence of organisms on inanimate nature and the influence of organisms on inanimate nature using examples, identify differences between minerals and rocks by observation.

2) Chemistry:

g) Substances and their characteristics (year 7): Systematic observation of properties of substances, distinguishing between mixtures and chemically pure substances, importance of water to life.
h) Transformations of Substances (year 7): Distinguishing reactants and products in chemical reactions, simple experiments on chemical combining and decomposition.
i) Important chemical elements and compounds (year 8): Orientation in the periodic table of elements (hereafter referred to as PTE), assess the impact of selected oxides, hydroxides, acids and salts on the environment, orientation in the pH scale, determine the pH of a solution using an indicator.
j) Carbon compounds (year 9): Differentiate between inorganic and organic substances, perform simple experiments to distinguish and identify inorganic and organic substances, characterise the importance of plastics, synthetic fibres, detergents and cleaning products.

Summary of content standards:
1) Biology:
a) Communities of organisms: distribution of communities, food chains, adaptation of organisms to the environment.
b) Nature and Life: Nature, animate and inanimate parts of nature, organisms, observation, experiment magnifying glass, microscope, telescope, microscopic slide, slide, cover slip, tweezers, preparation needle.
c) Living organisms and their structure: Structure of plants and animals, categorization of invertebrates, observation and presentation of results.
d) Structure and functions of the vertebrate body: Vertebrates, organ, organ system, reproduction and development of vertebrates, external fertilization, internal fertilization, development of the individual outside the body of the female, in the body of the female.
e) Basic life processes of organisms: Cell structure, nutrition, respiration, reproduction, and life cycle.
f) Environment of organisms and man: Environment, components of the human environment, ecology, environmental science, conditions of life.
g) Inanimate nature and its exploration: Inanimate and animate nature, minerals, ores, minerals.

2) Chemistry:
a) Substances and their characteristics: Observation of the properties of substances, distinguishing between mixtures and chemically pure substances, and the importance of water.
b) Transformations of substances: Chemical reactions, law of conservation of mass, chemical aggregation and decomposition.

c) Important chemical elements and compounds: Description of the Periodic table of elements (hereafter referred to as PTE), properties of substances and their relation to PTE, hydrogen, oxygen (ozone) iron, alkali metals (sodium, potassium).
d) Carbon compounds: Observation of the properties of organic substances: heating behaviour, solubility in water and organic solvents, flammability, composition of organic substances (most important elements of organic compounds), influence of substances on chemical processes in living organisms (vitamins, pharmaceuticals, poisons, drugs).

3 Educational Aid - Freshwater Aquarium

Building an educational aid such as an automated freshwater aquarium care system required several steps that included planning, design, selection of appropriate components, programming and testing. This process allowed not only the students but also the teachers to create a functional and sustainable system that enriched learning with practical skills. First, the basic objectives of the project and the requirements for the aquarium's functions had to be defined, such as controlling lighting, water temperature, oxygen supply, and monitoring pH and water level. It was useful to determine which functions would be controlled automatically and which would require manual adjustment, and what values (e.g. temperature range, ideal pH value) would be optimal for the chosen fish and plant species in the aquarium.

Based on the specifications, the necessary components had to be selected. The basis was a programmable logic controller (PLC), which made it possible to control the individual functions. Various sensors and actuators had to be connected to the PLC, such as a temperature sensor to monitor the water temperature, a filtration to clean the water and a heater to heat the water. The components were connected to the PLC and programmed to operate automatically or according to set intervals. Once the components were selected, it was necessary to design a basic electrical circuit that ensured that all components were properly connected and powered. This step involved working with voltage regulators and protection elements to ensure safe and reliable operation. Pupils created a circuit diagram and gained a basic understanding of wiring electrical components. They then needed to program the PLC to control the entire system in an automated manner. As part of the programming, the pupils created a sequence of steps that were regularly performed (e.g. switching the lights on during the day and off at night).

The PLC could also be programmed based on sensor data. The programming process allowed pupils to apply logical thinking and taught them the basics of automation processes. After programming, it was necessary to test the system and verify its correct functionality. In this step, it was checked that the PLC responded correctly to sensor changes and that the actuators functioned as required. Pupils identified faults and made the necessary calibrations – for example, setting the correct thresholds for switching the lighting or the temperature heater.

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To complete the project successfully, it was important that the pupils produced documentation of the whole process. This included a detailed description of the individual components, a circuit diagram, a description of the program and the calibration procedure. Finally, the pupils presented the resulting system to others, which contributed to the development of their communication skills and ability to present technical solutions. The teaching aid thus constructed not only taught the pupils technical and scientific knowledge, but also developed practical skills in automation, teamwork, problem solving and project management.

Figure 1: Educational aid freshwater aquarium and control unit.

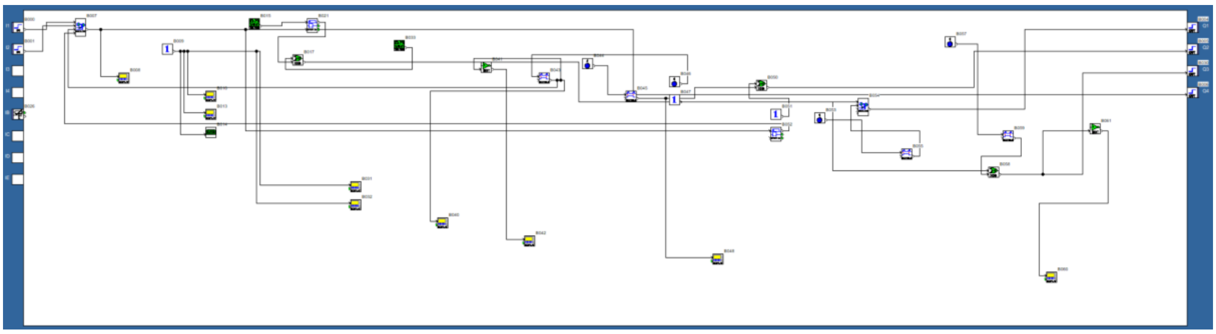

Figure 2: Control unit program.

The figure 4 shows a printout from the project documentation, where the program for the PLC is developed in detail. Individual diagrams, block diagrams and logical sequences that describe management processes are clearly visible in the foreground. The document contains a detailed description of the functions of each step, the inputs and outputs of the system, and the interconnection of logical operations.

4 Conclusion

The use of interdisciplinary relations in the teaching of PLC programming represents a promising approach that can promote the integration of theoretical knowledge with practical skills and thus improve students' readiness for professional practice. This approach emphasises the use of practical tasks and projects that allow the application of knowledge from different fields, leading to a better understanding of the links between various technical disciplines and increasing students' motivation to study technical subjects.

The integration of knowledge from different disciplines, such as technology, computer science, physics, biology, and chemistry, enables students to better understand complex technical problems and apply theoretical knowledge in practical situations. The creation of an automated freshwater aquarium care system demonstrates how theoretical concepts can be linked to practical applications, enhancing student motivation and engagement. This approach also promotes teamwork and project management, which are key skills for future professional practice.

Effective teaching of PLC programming can benefit from an interdisciplinary approach as it provides the opportunity to link theory with practical applications not only within technical subjects but also with aspects of mathematics, computer science and logical thinking.

The use of interdisciplinary relations in the teaching of PLC programming represents a promising approach that can promote the integration of theoretical knowledge with practical skills and thus improve students' readiness for professional practice. This approach emphasises the use of practical tasks and projects that allow the application of knowledge from different fields, leading to a better understanding of the links between the different technical disciplines and increasing students' motivation to study technical disciplines. Based on the results obtained, we recommend continuing to integrate interdisciplinary methods into technical education to ensure comprehensive preparation of students for the challenges of modern industry and technology.

Acknowledgements

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Vocational Education and its Perspectives

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Abstract

Vocational education has long held a fundamental and significant position within the Czech educational environment. However, in recent decades, it has faced challenges due to the variability of graduates' applicability in the labour market and rapid technological advancements. In the Czech Republic, a substantial majority of students pursue secondary education after completing primary school. It is reported that up to 80% of pupils undergo vocational education and less than 20% undergo general education programme. Approximately 6% of the population has not progressed beyond primary education, typically due to not completing secondary education and thus, the majority of secondary vocational education graduates then enter the labour market directly.

The employment rate of vocational graduates aged 20-34 is around 80%, which is above the EU average, even though most graduates obtain a qualification recognised in the labour market. Aligning vocational training with labour market demands and addressing the workforce's age composition presents significant challenges. The Ministry of Education, Youth, and Sports of the Czech Republic has proposed strategies to mitigate these issues, emphasizing enhanced collaboration between the education sector and industry, as well as the integration of dual system elements into vocational education. These initiatives are outlined in the 'Strategy for the Education Policy of the Czech Republic up to 2030+'.

Another option being considered is a later selection of professions and postponing early specialisation by creating a common foundation for related fields of education. This approach is being implemented through the ongoing revision of vocational education framework programmes and the innovation of the sectoral system. This paper examines these developments and offers reflections on the anticipated changes in vocational education within the Czech Republic.

Keywords: Vocational Education, Statistics, Typology of Vocational Education, Comparison of Vocational Education Systems

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1 Introduction into the System of Vocational Education in the Czech Republic

In cultural societies, schools are considered a crucial transition from family to society. This transition ensures the fulfilment of one of society's fundamental functions: education (Jůva, 2001). However, in each country, this transition is conceptualised differently due to the long-term development of the society, political system, and the formation of the educational system as stated by Čepelová (2020).

Vocational education is not only part of the education system, but also an important element of the economic and social development of any country. Vocational education is defined as any professional training of workers during their lifetime (Průcha, Walterová, Mareš, 2009). Adamec (2021) describes vocational education as an integral component of the education system, emphasising its significant role in secondary education, particularly at the higher secondary level, which in the Czech Republic corresponds to the secondary school level. This level encompasses two primary domains: vocational and general education. Collectively, these domains provide a comprehensive framework for the development of students' knowledge, skills, and attitudes. Consequently, vocational education can be characterised as a systematic sequence of steps designed to prepare students for specific professional tasks. These competencies are essential for individuals in performing the professional activities they have chosen, aligning with the field of study they have completed. Another objective of vocational education is to provide a general framework for habitual resocialisation, facilitating the gradual integration of each adolescent into the adult world (Hrmo & Krpálková-Krelová, 2010). Vocational education is divided into various segments based on the specifics of the vocational focus. Part of this process includes assisting individuals in finding employment, considering further educational opportunities or daily life requirements (Arbizu, et al. 2008).

In the Czech Republic, vocational education is initiated at ISCED 32, which is rated as upper secondary education, which usually starts after the completion of compulsory primary level of education. However, the vocational education system in the Czech Republic is rather fragmented after this completion. At the age of 15, primary school leavers can choose between general education programmes (four-year programme: Grammar school) and so-called 'vocational education' programmes. These are, however, of two types: vocational secondary education and lyceum, which is on the borderline between general education, i.e. grammar school, and vocational education; programmes of post-secondary education; and shortened programmes (see Figure 1):

- Three-year vocational training programmes ISCED 353 – this end with a final examination leading to a vocational certificate - level 3 of the European Qualifications Framework (EQF) and enable graduates to enter the labour market directly and to pursue occupations requiring mainly practical skills (bricklayer, hairdresser, etc.). The

[2] International Standard Classification of Education (ISCED, mezinárodní standardní klasifikace vzdělávání) je klasifikace vzdělávání schválená UNESCO v roce 1976. (http://www.uis.unesco.org/Library/Documents/isced97-en.pdf http://www.uis.unesco.org/Education/Documents/isced-2011-en.pdf)

apprenticeship certificate also enables individuals to obtain a trade licence and operate a business. Graduates of these programmes can pursue two-year further education programmes (ISCED 354, EQF level 4) and sit the matriculation examination, which will allow them to study at universities or higher vocational schools.

– The four-year vocational training programmes ISCED 354 and the lycée programmes ISCED 344 culminate in the baccalaureate examination, corresponding to level 4 of the European Qualifications Framework (EQF). These qualifications enable graduates to pursue tertiary education or enter mid-level positions in sectors such as technical, commercial, service, or health. Lycée programmes, which include up to 70% general education subjects, primarily prepare graduates for university studies.

Initial vocational training programmes with lower requirements in general education and vocational theory are primarily designed for candidates with special educational needs. These programmes, which can last one, two, or three years, culminate in a diploma or final examination certificate, corresponding to level 2 of the European Qualifications Framework (EQF).

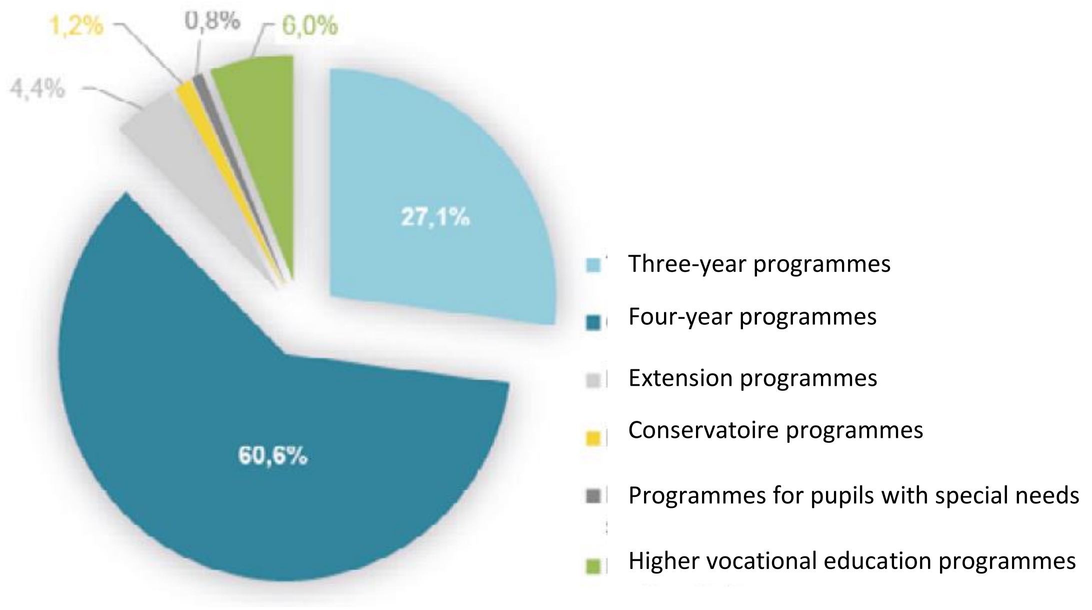

Figure 1: Pupil ratio by type of vocational education in the school year 2021/2022. (https://statis.msmt.cz/rocenka/rocenka.asp)

Initial vocational training programmes are offered by public and state schools, which provide programmes free of charge, as well as by private and religious schools, which may charge tuition fees. Depending on the type of disability, secondary schools may also provide programmes for students with special educational needs.

Graduates with a school-leaving certificate can then apply to study at the tertiary level of their choice, with the lowest level of tertiary education being the so-called vocational colleges, where studies lead to the degree of Diploma Specialist (DiS). Studies at these schools have the approximate character of university studies. Further vocational training can be provided:

a) within the formal education system (there is no age or other formal restriction for adults),
b) as part of active employment policy (so-called retraining),
c) through corporate training - this may be either compulsory training as provided for by law, or unregulated training in accordance with company policy,
d) through open market training providers responding to the specific needs of individuals.

In addition to initial vocational training programmes, secondary schools also offer programmes aimed at employed candidates (varying form and length of distance learning), combining shorter full-time school-based training with tutorials and various methods of online distance learning.

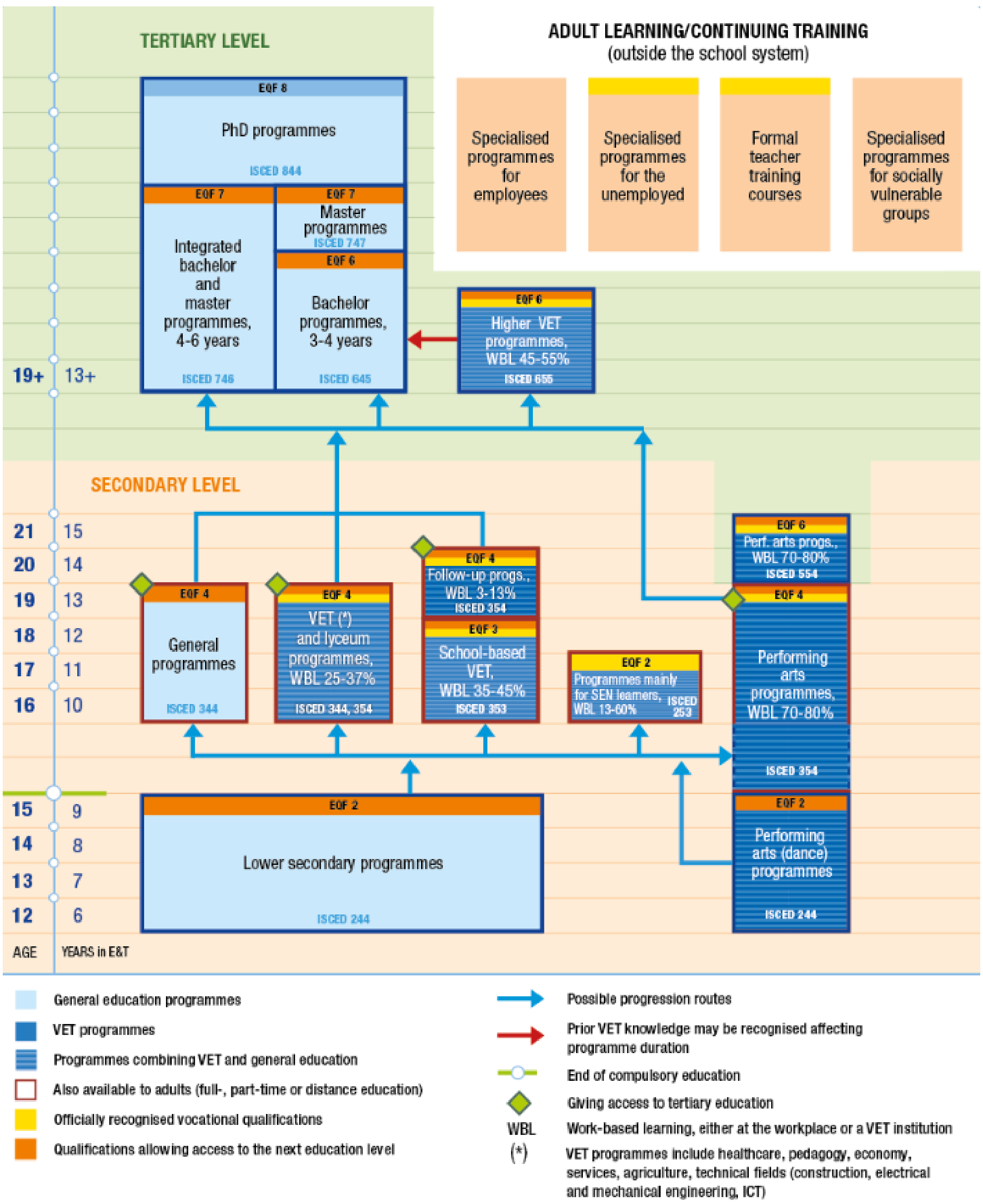

Figure 2: Vocational training in the Czech education system. (Cedefop and ReferNet Czechia, 2022)

The National Qualifications Framework (NQF) facilitates the verification and recognition of prior learning, enabling individuals to obtain qualifications typically awarded through initial vocational training without the necessity of completing a formal training programme.

2 Selected Foreign Vocational Education Systems

If we examine the evaluation of foreign systems of secondary vocational education, we find that the German and Swiss systems are most often cited as the best or most effective. The primary reason for this assertion is the existence of the so-called dual model in apprenticeship training (Tureková, Hrmo, Marková, Kordosová, 2021). However, despite its sophistication, the German system is hardly transferable to other educational systems. This is primarily due to differences in national cultures, which is, incidentally, a challenge faced by all education systems globally. Indeed, attempts to transfer various models (e.g. Swedish, Finnish) to the Czech Republic in the 1990s confirmed this rule of non-transferability and led to the subsequent development of framework educational programmes (Kleskeň & Podpiera, 2010). Below, typical examples of the implementation of secondary vocational education in selected countries are provided:

The Swedish model integrates vocational and general education in one type of upper secondary school, while giving equal importance to both types of education (Ježková et al., 2011). In Sweden, the principal of a single school has been applied since the early 1970s. This means that all Swedish youth aged 7-16 are educated in a nine-year primary school (grundskola), which has a unified curriculum (content and objectives of general education). After leaving primary school, almost all pupils go on to one type of secondary school, which is the grammar school (gymnasieskola). This is an institution that provides either general or vocational education over three years, i.e. usually for pupils aged 16-19. Pupils entering a grammar school choose one of the national curricula on offer, which are differentiated according to the prospective orientation of the students. These programmes are either academically oriented, i.e. preparing students for later university studies, or vocational education and training programmes.
In addition to the predominant vocational stream in grammar schools, a smaller proportion of young people are integrated into apprenticeships (lärlingsutbildning). This is vocational training in which at least 50 % takes place in the workplace (in vocational training at grammar school, the proportion is only 15 %). Apprenticeships involve a tripartite contract between the pupil, the employer and the school. Apprentices study the same compulsory subjects as pupils in grammar school and have an instructor at the workplace. Importantly, in addition to entering the labour market, apprenticeship graduates have the option of continuing their

education in one- and two-year vocational colleges with a vocational focus or, under certain conditions, applying for admission to tertiary institutions.

The German and Swiss models of vocational education differ significantly from those of many other European countries. This is mainly due to the fact that, while in most of these countries there is a uniform education for all young people at primary school level, usually up to the age of 15-16, in the German model the principle of distributing pupils already after the first stage of primary education, i.e. at the age of ten, is embedded, and at the age of 15-16 all pupils (with the exception of pupils in multi-year grammar schools) can start one of the initial vocational education pathways at upper secondary school level (Hippach-Scheinder & Huismann, 2016). The variation in vocational schools is also very diverse. The main types of vocational secondary schools are:

- A vocational (apprenticeship) school (Berufsschule) implements dual vocational training (duale Berufsausbildung) of usually three years.
- The basic vocational training year (Berufsgrundbildungsjahr) is a compensatory one-year education for pupils who have not completed their main school or have completed it with poor grades. The year serves to enable pupils to start an apprenticeship.
- Vocational training schools (Berufsfachschule) prepare for a vocation in 1-3 years and provide vocational qualifications accordingly. On completion of this school, pupils can take an exam (Fachschulreife) and continue their education at a vocational college or vocational school.
- Vocational/vocational grammar school (Berufliches Gymnasium/Fachgymnasium). These schools provide both general and vocational education with a focus on business, economics, technical, IT, food and agricultural professions. Students take the baccalaureate and have access to universities.
- Vocational training schools (Berufsaufbauschule) are vocational schools with one to three years, mainly for young people who are already employed but have not completed secondary education. They can be attended by pupils who have already completed an apprenticeship or several years of work experience.
- Vocational upper secondary school (Fachoberschule) These vocational schools are at upper secondary level and give access to vocational colleges. The studies combine vocational theoretical training with workplace experience.
- A vocational school (Berufsoberschule) is a type of vocational school for students who have already completed a vocational apprenticeship or have five years of professional experience. It offers a certificate in various fields of study leading to a university degree, with the requirement of a foreign language examination.

One of the strengths of German vocational training, which places it at the top of international rankings, is the 'duals system'. In this country, it is seen only as a way of apprenticeship, but its possibilities are wider. Different forms of the dual system operate in vocational training in countries such as Austria, Switzerland, Denmark, Hungary, the Netherlands and partly also in the Czech Republic, the Slovak Republic and Poland. The purpose of dual training is to ensure that apprentices acquire as effectively as possible the practical skills required for a particular profession. The training takes place in such a way that about 40% of the time is the theoretical part at school. School attendance is usually two days a week. In the practical training (about 60 % of the time) at the workplace, apprentices are already trained by instructors (masters) in the special skills of each profession.

The American model has no uniform education system in the USA as in Europe. School education varies from state to state in the federation. Nevertheless, certain common educational features can be defined (Prucha, 2017). The beginning of compulsory schooling is at the age of six in primary school (elementary school), in which students are educated during eight or six years and then enter secondary school with four years (high school). This education is usually completed by the age of seventeen. Graduates can earn a GED (high school diploma), which is required for entry into higher education, including vocational education. High school provides a general education, although through electives students may receive orientation in some vocational areas. After graduating from high school, most students enter one of the colleges or, less frequently, an apprenticeship. Colleges are of several types, the most common being two-year colleges, known as junior colleges, which provide post-secondary non-tertiary education (at ISCED level 4), either general or vocationally oriented. Another type is four-year colleges, some of which are at ISCED 5 and ISCED 6 level. Graduates receive an Associate Degree, and exceptionally some of these colleges award a Bachelor's Degree.
In the USA, apprenticeships are usually started after high school, i.e. at the age of 17-18, but a large proportion of apprentices are older students aged 20 and above. Depending on the level of expertise, the apprenticeship lasts between 1-5 years. The dual training model is widespread in the US, with American apprentices completing the majority of their training on-the-job in businesses and other workplaces and a smaller proportion in school.

3 Factors Influencing Vocational Education

Historically, vocational education has been developed in response to the needs of the labour market and the economy. With the development of industry and subsequently information technology, it has undergone and is undergoing many transformations. In the Czech Republic, as in many other countries, vocational education is key to preparing a workforce capable of adapting to the changing demands of the labour market.
The economic and social development of any country is largely determined by the level of skills of its workforce. In this context, vocational training has a crucial role to play in providing skills and competences that are relevant to the rapidly changing needs of the labour market. The ability of education systems to meet the demands of particular occupations depends on the influence of several factors such as demographics, economic indicators and highest

educational attainment (Petnuchova, et al., 2012). The most important external factors include:

- demographics,
- economic and labour market indicators (economic structure, employment, etc.),
- highest educational attainment.

For instance, research by the World Economic Forum (2020) predicts that up to 85 million jobs could be replaced by 2025 because of the transition to a new economic structure. This global trend is expected to impact the Czech labour market significantly. The integration of technologies such as robotics and automation necessitate that vocational education systems produce graduates capable of adapting to these changes. This requirement places high demands on the flexibility and adaptability of curricula.

The main challenge for education policy is, of course, the demographic evolution of the population. This concerns both pupils and teachers (the average age of teachers in secondary schools is 49.4 years3). One of the ideas reflected in the Czech Republic's Education Policy Strategy 2030+4 is the introduction of elements of the dual system in vocational education, the promotion of cooperation between education and the world of work, an emphasis on improving vertical permeability within the vocational education system and strengthening the link between formal and non-formal education.

The economy and the labour market are currently undergoing dynamic developments that are changing the needs of the labour market in relation to job seekers, including recent secondary school graduates. The Czech education system should respond to these trends in an appropriate way and prepare pupils for the changing work environment. This thesis has been pursued in many variations for decades, but only partial steps have been taken, mainly due to the transformation of the framework education programmes in force in the Czech Republic. An example of this is the thesis of the so-called 'emerging fourth industrial revolution, which brings changes related primarily to digitisation and the introduction of new technologies'. This thesis is undoubtedly valid and logical in the context of the rapid development of technology, yet it does not make any significant progress in the secondary education system. This is not only the case in the Czech Republic, as the context is global. The world economy is in a constant process of transformation under the weight of globalisation, technological and other socio-political influences. The high heterogeneity in education between countries creates, among other things, the overall sectoral distribution of a country's industry, as well as, for instance, the ability to telework (Brussevich et al. 2020). The effects on the workers themselves are also uneven, as some jobs adapt much more quickly and easily to the new conditions of Industry 4.0 (but also vice versa). Many industries, such as catering, hotels, agriculture, retail, transport and logistics, have limited opportunities to transition working from home and find it more challenging to adapt to the new industrial landscape (Echtelt 2021).

[3] https://www.npi.cz/images/EU_projekty/ReferNet/Spotlight_on_VET_Czechia_2022/Prehled_odborneho_vzdelavani_v_Ceske_republice.pdf
[4] https://msmt.gov.cz/vzdelavani/skolstvi-v-cr/strategie-2030

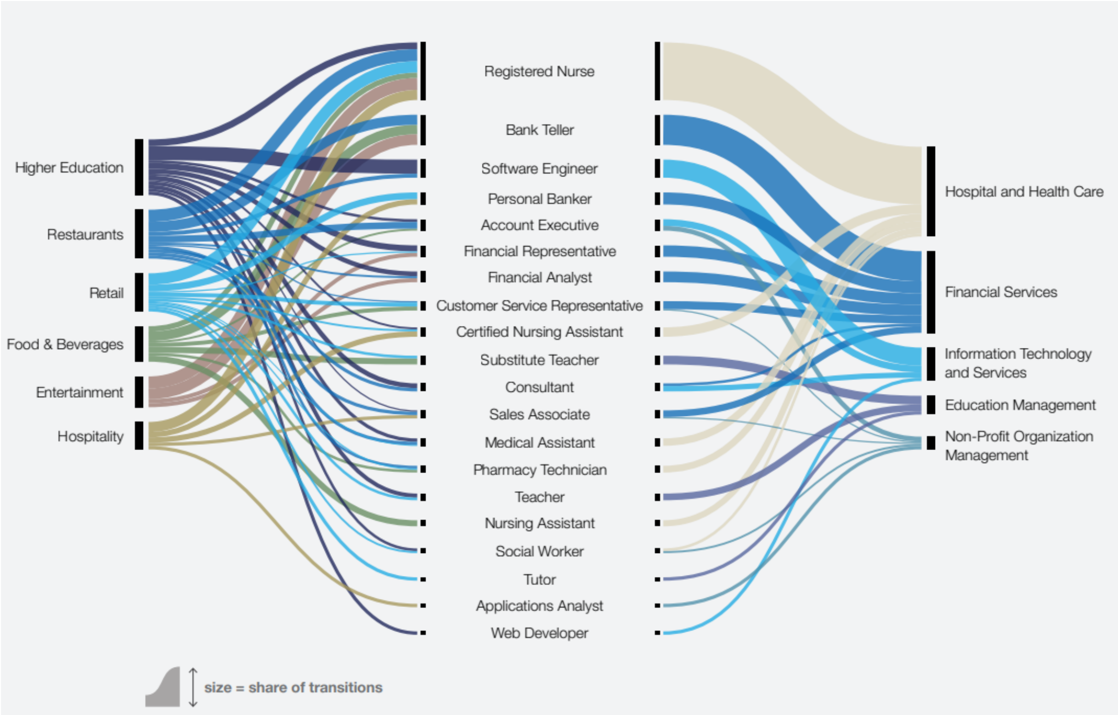

Figure 3: In-focus transitions for affected young workers.
(https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf)

The connotations around the impacts of automation sound rather negative and are mainly associated with job losses and mass redundancies. However, from a different perspective, automation and robotics can help to address the demographic ageing issues faced by most developed countries. The adoption of new technologies can sustain economic growth with a potentially lower labour force. This implies that a lack of jobs may not be the main problem, but too few people of economically active age are (Andres and Hrmo, 2020). This is supported by Abeliansky and Prettner [2017] who offer this explanation and present this trend as a reason why countries experiencing population aging tend to adopt more robotization of processes.

Data from these surveys show that companies expect to restructure jobs in response to new technologies. The main drivers of this revolution are the overall transformation of values and needs (55%) and the introduction of automation accompanied by a reduction in the workforce (43%) (World Economic Forum, 2020). The figure below shows in more detail the newly emerging jobs and, in turn, the jobs at risk or displaced jobs, i.e. employees who will need to be relocated to other positions as part of the new distribution of work between humans, machines and algorithms (Figure 3).

4 Vocational Education and Didactics

In preparing secondary vocational schoolteachers, vocational education didactics are fundamental components of their pedagogical training. These didactics are central to the development of effective teaching strategies tailored to vocational contexts. Regrettably, this area often receives less emphasis in higher education compared to didactics for lower-level schools. Consequently, many subject-specific didactics remain stagnant, lacking the evolution necessary to establish a robust scientific foundation (Pecina, 2017). In this context, it is therefore possible to perceive the necessity to evaluate their current state in the context of all subject didactics and to indicate their further possible development regarding the transformation of the requirements of today's society, i.e. the change of the paradigm of vocational education due to the digitalisation of industry, commerce and services.

Field didactics are relatively young interdisciplinary disciplines in relation to didactics and pedagogy in general, applying just those general pedagogical and didactic knowledge to the teaching of specific fields (subjects) in vocational education. In the conditions of the Czech Republic, a certain systematic development of these sciences can be traced from the second half of the twentieth century.

The basis of subject didactics is formed by the relevant scientific disciplines, which are transformed into the curriculum, into the preparation of teachers of vocational subjects within the framework of these didactics. According to Pecina (2017), didactics in vocational education can be divided into the following groups according to the focus and specifics of the respective individual disciplines:

- Didactics of technical subjects.
- Didactics of economic subjects.
- Didactics of vocational subjects in commerce and services.
- Didactics of other subjects (disciplines) which cannot be clearly classified in the previous groups (agricultural subjects, medical subjects, police training subjects...etc.).

From the above it can be concluded that this is a rather very broad field due to the large number of disciplines. At present, there are almost three hundred of them, divided according to area, length of training and completion into the categories J, E, H, M, L0, conservatoires, post-secondary studies5. Despite the large number of subjects, certain common elements can be traced in some of them, which make it possible to develop common areas of teaching in each subject. Pecina and Marinic (2021) list these elements in the following summary:

- Teaching in materials and technologies, equipment of workplaces and facilities for teaching needs.
- Significant combination of theory and practice, great importance of students' professional practice and cooperation with the labour market, companies and establishments of the given fields.
- Preparation for future careers, courses with an apprenticeship certificate or a school-leaving certificate.
- The focus of the teaching technology in selected teaching methods and forms, specific material means of teaching (interpretation, demonstrative methods, instruction,

[5] https://www.infoabsolvent.cz/Obory/1?NastavKraj=True#filtrForm

teaching in specialised classrooms, teaching day, production means of the given fields, great importance of project teaching, teaching occupational safety,etc.).

– Specific diagnostics and assessment (in addition to the usual methods, these are set and check papers, assessment of final and graduation papers).
– The rapid development of the various disciplines and the resulting need to update educational strategies, projects, documents, teaching texts and textbooks.
– The focus is shifting to continuing and lifelong learning for both teachers and graduates of these disciplines.

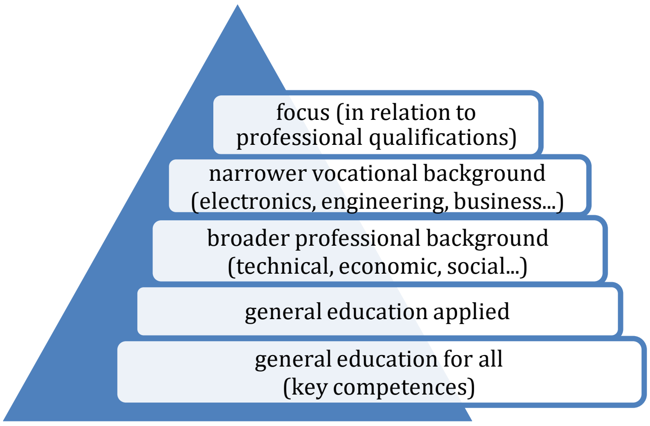

Figure 4 Competency pyramid[6].

Some of the above points can certainly be disputed, but in the reality of the labour market, the idea of interconnectedness of vocational training fields seems much more realistic today than it was a few years ago. The less than 300 courses mentioned also mean that pupils studying in them have only a limited opportunity to adjust their educational path. The narrow focus of the fields of study significantly limits their employment in the labour market, but also the prerequisites for retraining (Zimmermann, K. F., at al., 2013). The ineffectiveness of this system is furthermore underlined by the fact that a larger proportion of graduates do not end up working in their original field of study7. From this perspective, the argument that the fields should have a broader vocational basis based on the principle of the competence pyramid (see Figure 4) appears to be correct, as it is only on the higher levels that students build the knowledge, skills and competences needed for work activities. It can thus be concluded that the reduction of disciplines in the form of removing overlaps, often very narrow specialisations and reflecting on interdisciplinary links is a necessary part of the reform.

In fact, the Czech Education Policy Strategy 2030+ and the recommendations of experts from the European Centre for the Development of Vocational Training (Cedefop) show that the main objective of vocational education does not appear to be preparation for a narrow

[6] https://www.pzpk.cz/aktuality/odborne-vzdelani-cekaji-zasadni-zmeny/ or https://www.mpsv.cz/documents/20142/372813/K4.0_Blok_II._01_N%C3%A1stroje+New+Skills+Monitor+a+Kompeten%C4%8Dn%C3%AD+pyramidy.pdf/c63b5e18-5926-567c-2cff-4f1c49fd862a

[7] https://www.pedagogicke.info/2024/04/ve-vystudovanem-oboru-zustava-jen.html or https://infoabsolvent.cz/Temata/ClanekAbsolventi/4-3-09 or https://hn.cz/c1-65751270-vetsina-lidi-nepracuje-v-oboru-ktery-vystudovali-do-velke-miry-je-to-dano-i-vyvojem-pracovniho-trhu

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profession, but much broader preparation for flexible participation of the graduate in society and the labour market. The reform that is underway in the Czech Republic at the time of writing aims to create a functional and permeable sectoral system that will equip graduates with the competences for long-term employability in the labour market with further vocational and non-vocational training.

5 Conclusion

The establishment of subject didactics in vocational education has been debated for many decades, even though the fact that it is a scientific field with its own genius loci in vocational education, within both basic and applied research. Unfortunately, this area is marginalised in terms of resources, incentives and research subsidies from relevant institutions. Consequently, there is a lack of research findings, which hampers the dissemination of results through monographs and international platforms such as professional journals and scientific conferences. This ongoing neglect continues to undermine the significance of this scientific field.

The challenge to change approaches involves modernising vocational schools through the transition to digital technologies, innovation, and the application of new teaching and assessment methods. Unfortunately, this reform trend is not supported by sufficient analytical evidence and relies more on the practical conclusions and experiences of experts who are only marginally active in this field.

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To the Roots: Engineering Pedagogy

Project-Based Learning as Innovation in the Subject of Didactics of Vocational Training

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Abstract

The paper proposes Project-Based Learning as an innovation in the subject of Didactics of Vocational Training within the Teacher Education study programme. The impetus for this innovation stems from Masaryk University in Brno's call to make teaching more interactive, alongside the European Union's efforts to promote holistic education at universities. The paper outlines the benefits of project-based learning, presenting examples of good practice from both the Czech Republic and abroad, with particular emphasis on teacher education.
The proposal for this innovation is based on the results of a survey that identified the changes students deem desirable in the current teaching concept. Drawing from theoretical knowledge and the survey findings, a new concept of project-based learning is introduced. The existing syllabus for the subject has been transformed into a major project, which involves detailed preparation for a teaching unit. This project will be divided into sub-parts that align with the individual phases of teaching in vocational education.

Keywords: Innovation, Project-Based Learning, Vocational Training Teacher Education

1 Introduction

Teachers at Masaryk University in Brno are encouraged to develop and innovate methods and forms of teaching in existing subjects of bachelor's and master's degree programmes. The introduction of simulation, project-based and inquiry-based teaching that will be sustainable and long-term is supported. Innovation in teaching aims to develop interactivity and/or create space for the introduction of distance elements into teaching.

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The need for excellent and relevant university education is highlighted by the European Commission (2022) in its Strategy for Universities. Universities are challenged by the European Commission (2022) to holistic education and promote future skills such as critical thinking, problem-solving, creativity and entrepreneurial skills. The OECD (2018) distinguishes three types of skills that are essential for future education: 1) cognitive and metacognitive (critical and creative thinking, learning and self-regulation), 2) social and emotional (empathy, self-effective, responsibility and cooperation), 3) practical and physical (use of new information and communication technologies).

Project-based learning (PBL) is an educational strategy that helps students succeed in the 21st century. It focuses not only on educational content but also on the education and development of skills needed in the future. A good project is better able than traditional teaching to equip students not only with basic knowledge of the field but also with the skills for their successful lives (Larmer et al., 2015). The application of projects in teaching develops students' personalities at all levels, i.e. cognitive, social, emotional, motivational and volitional (Kratochvílová, 2016). In the course of working on their projects, students develop research skills, use existing knowledge and at the same time collect new ones, use new technologies, collaborate, solve problems, communicate and present their results (Bell, 2010). Projects by Larmer et al. (2015) give students many more opportunities to acquire 21st-century skills, including critical thinking and analytical reasoning, the ability to analyse and solve complex problems, the ability to communicate effectively orally and in writing, the ability to apply knowledge and skills to real-world environments, the ability to find, organise, evaluate information from multiple sources, the ability to innovate and be creative, Teamwork and cooperation skills, time management, independent inference, presentation skills, etc.

1.1 Project-based learning

According to the pedagogical dictionary, project-based teaching (PBL) is teaching based on a project method, in which students are led to work independently on certain topics (projects) and gain experience through practical activities and experimentation (Průcha, Walterová, Mareš, 2013). PBL is student-driven and supported by teachers who supervise its progress. Students solve real challenges, propose solutions, organize research, apply existing and gather new knowledge, skills, develop cooperation and communication skills (Bell, 2010).

Larmer et al. (2015) wrote in their book proven project elements and teaching procedures that should be included in a well-prepared project and called it Gold Standard PBL, see Figure 1. The Gold Standard PBL diagram describes the project elements for its successful and effective application in teaching simply and concisely. The authors of the PBL Gold Standard based their work on the original ideas of the founders of PBL, Kilpatrick and Dewey, and on the ideas of PBL professional educators. PBL is a systematic, organized activity that aims at a specific goal – to equip students with key knowledge, understanding of the field and at the same time 21st-century skills (skills of success). To successfully meet this goal, the following is required:

- solving a challenging problem or question,
- research solution of the problem – targeted research, investigation of the problem/question using a method that would be used in the adult world,
- authenticity, engaging, interesting for students,
- student voice and choice – opportunities for students to be involved in decision-making,
- reflection – looking for opportunities for improvement,
- providing constructive criticism and evaluation to improve individual and collective work,
- presentation of tangible results in front of an audience. (Larmer et al., 2015; Allen, 2015).

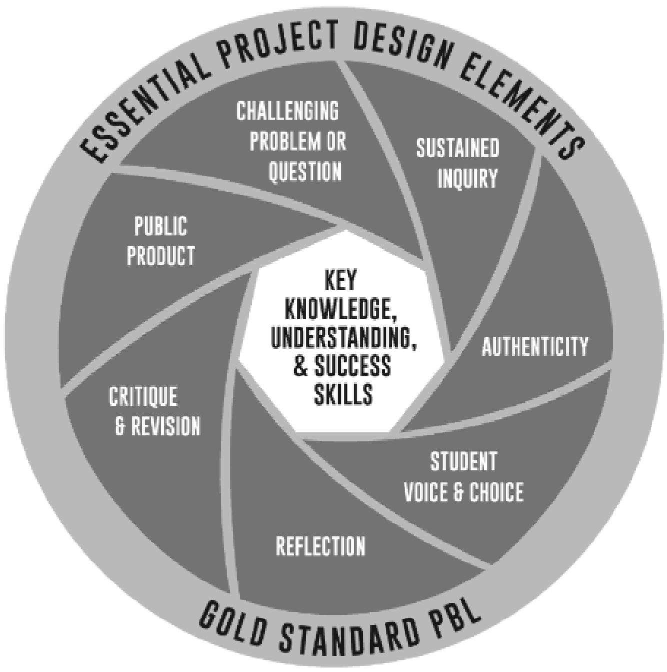

Figure 1: Gold Standard PBL (Larmer et al., 2015).

1.2 Project-based learning in University Education

PBL is nothing new in the world of education. Teaching based on the project method was promoted as early as the first half of the 20th century in the USA by representatives of pragmatic pedagogy J. Dewey and W. H. Kilpatrick. Since then, PBL has been implemented at various intensities at all levels of education in almost all education systems of the world. Universities are no exception. Projects are most often implemented at technically oriented schools, but also, for example, at faculties of education, as we mention in Chapter 1.3.

Successfully introduced PBL in bachelor's and especially master's studies at the Faculty of Transportation Sciences at the Czech Technical University in Prague is described by Votruba (2019). At the Faculty of Transportation Sciences, PBL has been introduced since the school year 1995/96 and the total number of hours of projects has increased from 40 hours per academic year to 65 hours per academic year 2000/2001 (Votruba, 2019). Votruba (2019) evaluates the experience with PBL significantly positively, based on the positive reception of the projects by students, teachers and cooperating entities. According to Votruba (2019), the dominant influence on the introduction of PBL is the support of the project leader (teacher) and the support of the relevant department, the longevity of the project (there is no 'self-learning' effect in short-term projects), the adequate number of students (2-5 students), the management of the project by an internal teacher and the introduction of multidisciplinary projects.

An example from abroad of the implementation of PBL in higher education is the Department of Mechanical Engineering at the University of India. Students in 17 groups of 4-5 students designed and then created a prototype of the product for one semester. The main advantages of the implemented PBL were perceived as follows: the possibility of students influencing the project result and the learning process, updating the knowledge of the topic in question, improving communication skills, data collection and analysis skills and presentation skills. The involvement of students in PBL was excellent, as was the achievement of the required technical and soft skills for the 21st century. (Pawar et al., 2020)

The next experience with project-based learning from Bartels and Stolz (2024) from the University of Applied Sciences Cologne confirms the positive impact of projects on learning outcomes and the improvement of soft skills, provided that certain prerequisites for the successful implementation of projects in teaching are ensured.

1.3 Project-based learning in Teacher Education

PBL in teacher education has two main objectives. The first objective is to activate students in teaching and to use all the benefits of PBL to engage students and positively motivate them to lifelong learning. The second objective is to try to make students understand and try to participate in PBL. If we want future teachers to implement projects in their own future teaching, they must first understand them.

Teachers prepare students, a new generation of citizens, for a future life in which they will be confronted with many complex problems. Such problems often do not have an easy solution and will all require sophisticated cooperation, varying expertise, creativity and perseverance. PBL provides opportunities for students to practice working together on valuable, meaningful and complex tasks. The transformation of traditional teaching towards PBL is desirable, but it will not be possible without adequate teacher education. A change in the way future generations teach is only possible in a situation of successful and high-quality teacher education. (Grossman et al., 2019)

Since the school year 1996/1997, theoretical and practical preparation for PBL has been part of the undergraduate training of teachers of the 1st level of primary school at the Faculty of Education at Masaryk University in Brno (FoE MUNI). Preparation for PBL is systematic and regularly adjusted, and its aim is: "*To equip students at primary school teaching at the 1st level of primary school with such competencies that they can design, implement and reflect on a project in practice.*". The innovative concept of the transformation of teacher education consists in the implementation of a so-called pedagogical project, which integrates the theoretical knowledge of the student ('I know ') with the experience gained in practice ('I can ') and with the use of reflection ('I know why '). In this case, the pedagogical project even partially replaces the unsatisfactory form of the state final examinations and is an important written basis for the successful completion of the state final examination. (Kratochvílová, 2016)
To demonstrate foreign experience with PBL in teacher education, we present the results of a study from Saudi Arabia. Alrajeh (2020) investigated at the University of Saudi Arabia the value that academics place on the use of PBL in preparing student teachers for K-12 teachers. In the study, Alrajeh (2020) concluded that academics have positive attitudes towards PBL and think they use PBL in their current teaching practices, but how they have explained their implementation of PBL in the classroom has not lived up to the essential characteristics of PBL. Academics have often confused problem-based learning with project-based learning. The results of the study resulted in recommendations for faculty members to improve a comprehensive understanding of PBL and subsequent successful implementation of PBL in teacher education programs. Overall, PBL is seen as a useful learning strategy and a major part of the learning process to help students develop their skills. (Alrajeh, 2020)

2 Methodology

2.1 Research Questions and Problem

Before the change of the concept of the traditional method of teaching to PBL in the subject Didactics of Vocational Training, we were interested in what change in the current concept of teaching is desirable on the part of students of vocational training. We asked the following initial research questions:

- What kind of teaching suits students in lectures?
- What methods and forms already applied in lectures would students recommend using in lectures in the future?
- What methods and forms of teaching are essential for future teachers in their teaching practice?

These questions led us to formulate a basic research problem:

- How do students perceive the current teaching strategy of the subject Didactics of Vocational Training?

From our point of view, student's perception of the current teaching strategy means finding out whether students prefer traditional education based on the transmission of knowledge or whether they would be interested in a more activating way of teaching based on the transformation of existing knowledge. Given that even in the current form of teaching, there have already been efforts on the part of the teacher to incorporate some activating elements into the lessons, we ask students which of them they are most interested in. Furthermore, we find out which topics of lectures (methods and forms of teaching) are best applicable to students' future teaching practice. The quantitatively oriented survey aimed to gain insight into the current teaching strategy in the subject of Didactics of Vocational Training.

2.2 Research Sample

The survey sample was chosen intentionally and consisted of full-time and part-time students of the subject Didactics of Vocational Training. This course is taught regularly in the spring semester in the 2nd year, and 3rd semester in the study program Teacher Education in Vocational Training and as part of the supplementary pedagogical studies at FoE MUNI in Brno. 21 students out of a total of 40 students enrolled in this course in the monitored period 2024 of the spring semester participated in the survey. This corresponds to a return of 53%.

2.3 Research Method

To answer the main and minor research questions, a quantitative survey was conducted among students at the end of the semester. Students were asked to anonymously fill out a questionnaire that contained 3 basic questions. For two questions, a 5-point Likert scale was used, which allows us to detect finer differences in students' perceptions, compared to simple yes and no answers. A value of 5 on the scale means I like it the most, and a value of 1 on the scale means I like it the least. In one case, multiple-choice questions were used. The online tool Google Forms was used to distribute the questionnaires and Microsoft Excel software to evaluate the results.

3 Results

In this part of the paper, we present the results of three items of the questionnaire survey, which determine students' perception of the current state of teaching:

1. comparison of students' interest in traditional and activating elements of teaching,
2. students' perception of the activities implemented in teaching so far,
3. methods and forms best applicable to educational practice from the student's point of view.

3.1 Traditional versus activating elements of teaching

It turned out that students prefer to learn in the traditional way. The students were most satisfied with the emphasis on information and the transfer of ready-made knowledge (transmission) with an emphasis on their applicability in practice. They were least interested in independent scientific research and finding out knowledge. From these results shown in Figure 2, we conclude that it is much easier for students to study the materials processed by the teacher, take the exam and get a grade than to take responsibility for their learning, look for their sources of information, analyse them, critically evaluate them and use them to create their result/product.

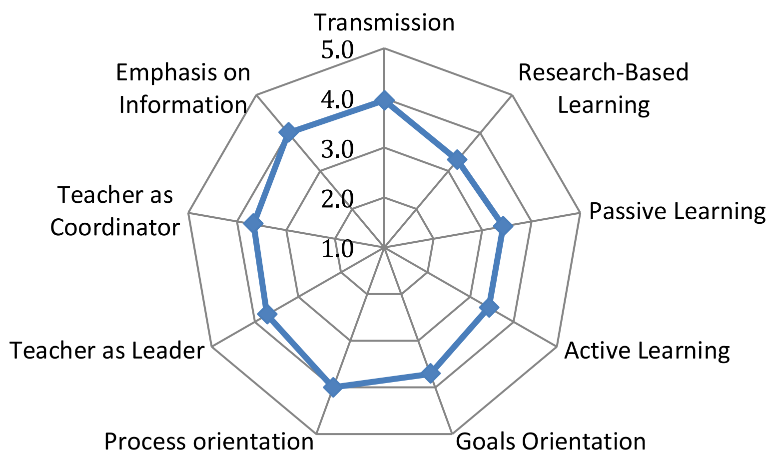

Figure 2: Comparison of traditional and activating teaching.

3.2 Activities implemented thus far

Among the teaching activities implemented thus far (see Figure 3), students have shown the most interest and enjoyment in working with online applications designed for reviewing and practising the curriculum. These include games, question-and-answer card selections, random question wheels, crosswords, sudoku, quizzes, and similar tools. Furthermore, students have expressed interest in engaging with artificial intelligence (AI), specifically the generative AI chatbot tool, OpenAI's ChatGPT. The students also perceived positively the analysis of good practice examples. Examples of role-playing, excursions, problem tasks and group work were discussed in the lectures. In its current form, students were not interested in the creation of mind maps, visualisation of curriculum by a concept diagram and independent work with text such as the study of pedagogical documents issued by the European Union and the Ministry of Education, Youth and Sports of the Czech Republic.

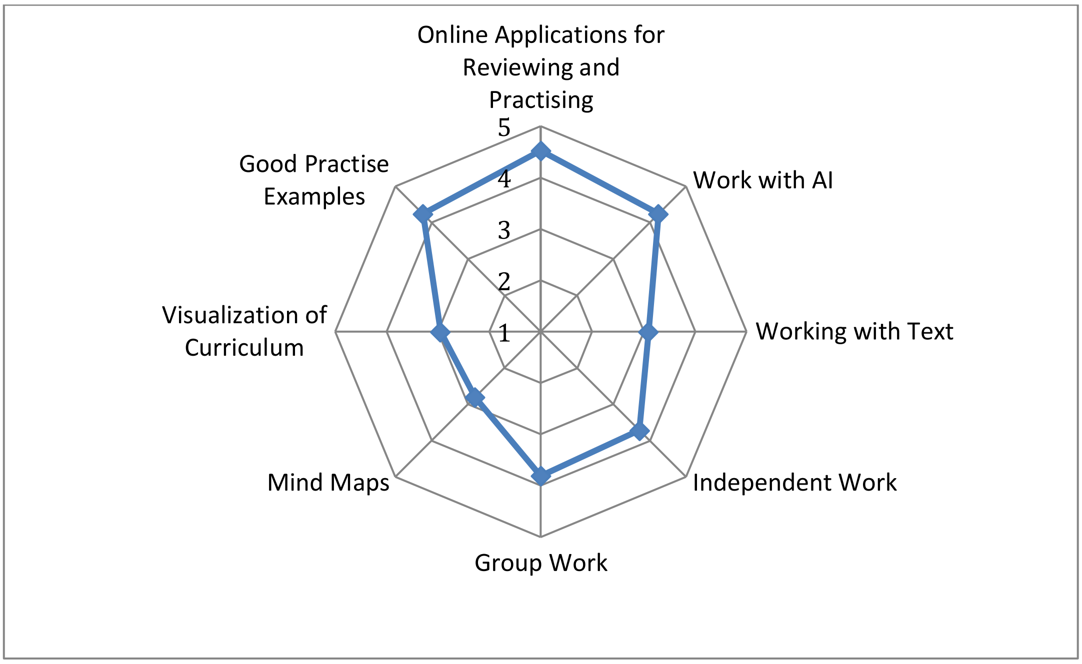

Figure 3: Current learning activities and their popularity.

3.3 Application potential of teaching

The methods and forms of teaching in which students see the greatest potential for future use in their own teaching practice are instruction, practical exercises, problem learning and group and cooperative learning as can be seen in Figure 4. From the students' point of view, the greatest emphasis should be placed on these methods and forms in the future.

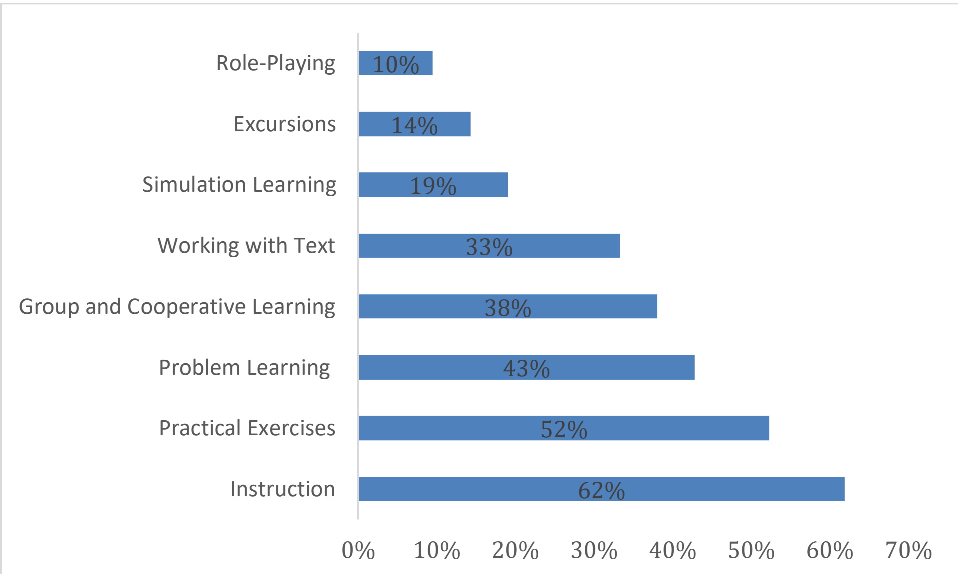

Figure 4: Methods and forms of teaching important for future teaching practice.

4 Proposal of PBL in Didactics of Vocational Training

The aim of the innovation of the subject Didactics of Vocational Training is the application of PBL in teaching. In PBL, students should be encouraged to work independently on certain topics (projects). In our case, students will work on one main project, which will consist of smaller sub-parts, while each sub-part of the project will have its theoretical and practical level of processing.

The main project will be detailed preparation for a teaching unit in vocational training. The sub-parts of the project are detailed phases of teaching, i.e.: introduction, communication of educational goals, motivation, exposure, fixation, evaluation and reflection. These phases correspond to the topics of the lectures (syllabus) of the subject of Didactics of Vocational Training. The breakdown of the main project into its sub-parts, including the division into theoretical and practical parts and the schedule of teaching, is shown in Table 1.

Main project	**Theoretical part**	**Practical part**
Detailed preparation for one teaching unit *1st – 2nd week, 4 hours*	Project assignment including evaluation criteria. Introduction to Didactics of Vocational Training. Principles of creating detailed preparation for the teaching unit in vocational training.	Brainstorming (individual/pair) to find a suitable topic of detailed preparation in the field of study. Presentation of selected topics and approval by the teacher.
Subprojects	**Theoretical part**	**Practical part**
Didactic principles *Week 3, 2 hours*	Identification of didactic principles with a close link to the effectiveness and quality of vocational training.	Definition of own didactic rules based on identified didactic principles, which students will implement in their teaching within one teaching unit.
Learning objectives *Week 4 – 5, 4 hours*	Familiarization of students with the hierarchy of goals for vocational training. Division of goals into cognitive, sensorimotor and affective areas. Learning the rules for correctly defining goals.	Students will create a list of specific goals for all 3 areas of student development, which will define the content and depth of their own teaching for one teaching unit.
Curriculum content *6th – 7th week, 4 hours*	Explanation of the process of selecting the content of the curriculum (reflection and analysis of teaching materials). Explanation of different systems and teaching procedures. Explanation of the 3 phases of learning in vocational training.	Students will create a visualization of the theoretical part of the teaching content for one teaching unit using a concept diagram. They choose a specific system of teaching. They think about specific practical activities acquired by students. They phase the acquisition of the curriculum into 3 stages.

Teaching methods, organisational forms and material resources *Week 8 – 9, 4 hours*	Introduction of basic methods, forms and material means with a close link to vocational training.	Students will choose their strategies for the appropriate mediation of didactically transformed curriculum content to their students within one teaching unit. This means that they choose suitable specific methods, forms and material aids for students to master the curriculum, including the method of evaluating results and feedback for students.
Presentation of complete detailed preparation for the teaching unit *10th – 11th week, 4 hours*	Review of the project assignment and evaluation criteria.	Presentation of comprehensive detailed preparation for the teaching unit, which will be created by the synthesis of continuously implemented sub-projects. Evaluation of students' project work. Peer review of students' detailed preparations. Evaluation of detailed preparations by the teacher.
Evaluation and reflection *Week 12, 2 hours*		Evaluation of the course of project-based learning by the teacher and students. Concluding binding and reflection.

Table 1: Design of the main project and its parts.

5 Discussion

In our view, the ideal implementation of Project-Based Learning (PBL) in the Didactics of Vocational Training should also encompass an implementation phase. During this stage, students would apply their project—detailed preparation for the teaching unit—in real teaching contexts. Compulsory internships for students in teaching fields could serve this purpose. This would involve a more demanding form of the initial phase of the project, requiring the harmonisation of the chosen topic for detailed preparation with the ongoing teaching of the specific class in which the students will undertake their practice. This would ensure the maximum applicability of PBL, as students would implement their prepared teaching with a real class at a specific secondary vocational school. Students could then supplement their project with class characteristics, documentation of their lesson preparation, materials they created for students, and photographic documentation.
Project-based learning would end with reflection (including self-reflection) on actual teaching. Students could be invited to self-reflect by answering questions such as:

- How did you manage to implement real teaching based on detailed preparation?
- Evaluate the fulfilment of the set learning objectives at individual levels (cognitive, sensorimotor and affective).
- Describe whether other goals that were not planned were met.
- Were there any changes during the real teaching compared to the preparation? If so, please describe which ones.
- How do you evaluate the choice of teaching methods and forms of teaching?
- The next time you prepare for class, what would you change?
- Can you formulate any interesting thing that surprised you during the implementation of the lessons?
- From your point of view, which key competencies and their sub-components were developed by the project?

This is how the project-based teaching described by Kratochvílová (2016) was practically completed. In our case, at least in the first year of innovation, the application of the projects to real teaching will not be implemented. If project-based learning proves successful, we will consider linking more subjects and increasing the number of hours; this could create space for trying PBL in real education.

6 Conclusion

The results of this paper can be summarised in several points. Firstly, the main advantages of Project-Based Learning (PBL) were highlighted, including the introduction of domestic and foreign examples of good practice. Secondly, the students' perception of the current strategy for teaching the subject 'Didactics of Vocational Training' was presented. The survey showed that students are more comfortable with traditional education based on the transmission of knowledge. Among the teaching activities implemented thus far, students were most interested in online applications suitable for reviewing and practising the curriculum, working with artificial intelligence, and analysing examples of applications and good practices from real-world scenarios. The methods and forms of teaching that should be the most emphasized in the future from the student's point of view are instruction, exercises, problem teaching and group and cooperative teaching.

Thirdly, the concept of Project-Based Learning (PBL) for the subject 'Didactics of Vocational Training' was outlined. The main project was defined and divided into several sub-parts, each corresponding to topics in the syllabus of this subject.

Lastly, the potential expansion of PBL to other subjects within the Teacher Education in Vocational Training study programme and supplementary pedagogical studies at the Faculty of Education, Masaryk University in Brno, was discussed.

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ICT Literacy of Teachers and Students in the Context of Students' Critical Thinking

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Abstract

In contemporary education, information literacy is a key competence for both students and teachers. Digital skills can be enhanced and mastered through continuous professional development. Teachers' ICT skills also influence the quality of the educational process. They have more opportunities, options, and competencies to implement modern educational approaches, such as applying active learning methods. Active learning methods significantly aid in developing students' critical thinking. By fostering critical thinking, students become socially, economically, and politically capable individuals who can discern and evaluate the information presented by the mass media.

Keywords: Information Literacy, Critical Thinking, Activating Methods, Mass Media

1 ICT Literacy

In Slovakia, the information literacy in schools is primarily addressed by the Ministry of Education, Research, Development and Youth of the Slovak Republic, the National Institute of Education and Youth (NIVAM), various scientific and research institutions, such as colleges and universities.

The digitisation of education is facilitated, among other means, by financial support from European projects. However, it is questionable to what extent the acquired technologies are utilised in practice. The concept of literacy, as one of the basic competencies of a modern person, is closely related to this issue.

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In this context, literacy, as a primary competence, can be understood from different perspectives: on the one hand, the ICT or digital literacy of the population in general; and on the other, the ICT literacy of specific groups, such as students and their parents.
Hrmo et al. (2003) state that the term competence has many definitions which often overlap. Having a certain competence means that in a certain situation we are able to navigate appropriately, react appropriately and thus activate a suitable operation, to adopt a beneficial attitude (Hrmo et al., 2003).
Blaško (2013) perceives teaching strategies in the context of the development of key competences, and characterises them as common methodological procedures, i.e. methods and forms, activities, possibilities, rules in teaching at the school level or at the subject level, but also beyond them. He stated that they are common to all teachers and schools, and that by them the school targets, systematically forms and develops all key competences of students (Blaško, 2013).
According to Brown (2017), digital literacy is now, in an increasingly digitised society and knowledge economy, essential for successful life, education and work (Brown, 2017).

1.1 Teacher's digital literacy

According to Vránová et al. (2016), the teacher's digital competences include professional involvement in work communication with both colleagues and students, professional cooperation, and continuous professional development. One of the key skills of effective educators is the ability to know and work with digital resources, which they use to create and modify digital teaching materials. When using digital resources, it is essential to respect copyright, protection, and sharing protocols. Furthermore, technologies can improve the quality of teaching in various ways. The implementation of technology into teaching is related to the introduction of new procedures and methods. A digitally competent teacher must be able to manage and lead all students, support student collaboration, and foster independent learning. It is important for the teacher to be able to create assessment strategies, analyse learning outcomes, obtain feedback, and plan through digital assessment tools. The benefit of digital technologies is their potential to support students, build access, inclusion, differentiation, individualisation, and activate students to learn (Vránová et al., 2016).
According to Turek (2010, p. 192), a person with abilities, motivation, knowledge, skills, and attitudes to do what is required to be done in the relevant field is usually considered to be a competent person in a certain area (Turek, 2010, p. 192).
Therefore, teachers should actively educate themselves and work on their own self-development in order to motivate students and at the same time, to be able to mediate current information to them, support their critical thinking and creativity in learning, and even outside of school.
Bodoríková et al. (Hattie, 2003; Barber and Mourshed, 2007) state that:

> "Efforts to improve the quality of education is accompanied by the effort to improve the quality of the teachers´ work, which fundamentally influences the quality of education. This is also evidenced by some research which show that the quality of teachers has a greater impact on the educational outcomes of students, such as the quality of the curriculum or the material and technical equipment of schools." (Hattie, 2003; Barber and Mourshed, 2007 In: Bodoríková et al., 2023)

1.2 Student's digital literacy

According to Sak (2007), if we want to maintain competitiveness in Europe and even in the world, it is not enough to educate digitally literate users of digital technologies. It is essential to equip students with knowledge and skills in the field of informatics. The phenomenon of today's time is informational thinking, and this perspective is precisely information and the way in which digital technologies work (Sak, 2007).
Digital literacy is closely linked to the effect of multimedia, or even opinion-forming mass media on the development of the student's personality.
Buckingham (2007, p. 43) states that: "In most regions of the world, the media is an inescapable fact of the contemporary world. In most industrialized countries, children spend more time with media of various kinds than they do at school or with their family or friends" (Buckingham, 2007, p. 43).
The digital literacy of students, media and their influence are currently receiving increased attention. Young generation is often the most endangered group of people, which is most exposed to the threats of media content, hoaxes, misinformation and the like, which threaten their critical thinking.
According to Strenáčiková (2020, p. 350): "Although a lot of money and energy was invested in the digitisation of education, neither teachers nor students were prepared for a situation where the entire education will be implemented only in virtual mode" (Strenáčiková, 2020, p. 350).

2 Activating Methods Influencing Students' Critical Thinking

2.1 Critical thinking

Ruisel (2004) defines critical thinking as a process that minimises the influence of prejudices and biases through the rational evaluation of evidence, produces conclusions that follow from this evidence, considers alternative explanations.

Facione (2011) claims that without critical thinking, an individual in today's democratic society is threatened economically and politically (Facione, 2011).

Today, society feels the most pressing need to pay increased attention to the critical thinking skills development. These days, when people are exposed to the enormous pressure of all kinds of information from the opinion-forming mass media, we feel the need to think critically. Young adolescents are the most vulnerable group that is most exposed to the influence of mass media (TV, radio and especially the Internet), from where they get a lot of different information. These mass media have a significant influence on most young people, trying to influence their judgement. Without critical thinking, the influence is often successful.

Strenáčiková (2015, p. 280) states that:

> "Valuable information must be selected from information noise and waste. Although every individual is constantly exposed to the continuous (and sometimes misleading) influence of the mass media, commercial TV stations and magazines with articles without factual informative value, the young generation is most at risk, since young people are also overwhelmed by the enormous numbers of information from the Internet." (Strenáčiková, 2015, p. 280)

In schools, teachers have the opportunity to discuss and explain to their students what misinformation, hoaxes, and the like are, but many times, it is only in theory. A much more valuable competency that teachers can impart to their students is the ability to learn to think critically. The ability to think critically is practical and useful at any age and in any area of life. Critical thinking can be trained and supported in the educational process in several different ways. These methods have a common label: activating methods. There are several activating methods that have the potential to support students' critical thinking and that can make the learning process special and attract or activate students. The teacher only has to choose which activity suits the students' needs and expectations the best, and which one would capture their attention and lead them to active enthusiastic learning.

Bodoríková et al. (2023, p. 153 – 154) state that:

> "Topics regarding the students' critical thinking still raise a lot of questions in teachers, gradually lead them to a changed view of teaching, enable them to see the teaching process in broader contexts, to understand the essence of educational situations, and to find ways to solve them." (Bodoríková et al, 2023, 153-154)

2.2 Brainstorming

This teaching method was described by Alex Osborne in 1953 as a method of encouraging groups to creative thinking.

The key principle and advantage of brainstorming is to produce a large number of different proposals for solutions to an appropriately formulated problem in a short time. This method is especially suitable for solving specific problems that require original ideas created in a short time. Maňák and Švec (2003) recommend working in smaller groups, with approximately 5-8 group members. The optimal time for brainstorming is 30 to 45 minutes, during which no criticism of any of the proposed solutions is allowed. The actual assessment of ideas falls to the next stage of the process. Furthermore, they also state that supporting the complete freedom of ideas is a matter of course. Every proposal or idea must be registered, and this creates the possibility of inspiration from ideas that have already been exposed (Maňák, Švec, 2003).

Brainstorming requires maximum relaxation. It cannot be expected that the answer to every question will be found with the help of brainstorming, but it certainly helps the development of creativity, creative and critical thinking. The brainstorming has undergone some development. Over time, several other variants developed from this activating method, such as brainwriting, brain sketching, or the 6-3-5 method.

2.3 Mind maps

Mind maps graphically display concepts from a certain area and the relationships between them. Müller (2013) states that mind mapping is a method that allows you to manage waves of information, process them and give them an easily understandable structure. Mind mapping can help us improve our overview, show clear connections, relationships and potential problems. It also allows us to express our thoughts and contributes to their full awareness (Müller, 2013).

Mind maps mainly focus on the linear recording of main thoughts and ideas, and thus imitate the real functioning of the brain, which is divided into two hemispheres responsible for coordinating various activities of the human body.

According to Belák (2022), it is necessary to familiarise students with mind maps first, similarly to other newly used methods. That is why he considers it important to explain to students the benefits of creating and using mind maps in the classes (Belák, 2022).

2.4 Project method

W. H. Kilpatrick is considered to be the author of the project method. He developed the problem-based method created by his teacher J. Dewey into the currently known method of project teaching.

Zormanová (2012) states that in this method, students are led to independent work on certain projects. These projects are usually perceived as complex tasks or problems that are connected to the reality of life. A characteristic feature of project-based teaching is the aim.

The given aim is represented by a certain output, possibly a product, or a practical solution to a problem. Projects are often based on interdisciplinary relationships (Zormanová, 2012). Turek (2010) includes project method among modern concepts of the teaching process (Turek, 2010).

3 Conclusion

Bodoríková et al. (2023, p. 10) state:

> "Today we know that only scientific knowledge is not enough for practical life, therefore effective teaching includes the development of skills associated with critical thinking, such as the processing of ideas based on their meanings, the ability to identify key ideas and assumptions in arguments, recognise important contexts, interpret data correctly, reevaluate different arguments, ability to draw logical conclusions from available information, distinguish facts and assumptions, create hypotheses, evaluate the reliability of evidence, effectively make decisions or solve problem tasks." (Bodoríková et al., 2023, p. 10)

As stated by Grecmanová, Urbanovská, Novotný (2000, p. 13):

> "Critical thinking is primarily active and independent thinking, conditioned by the following abilities: understanding information and its thorough examination, comparing an idea with other opinions and statements, seeing facts in context, using all levels of thinking processes, taking a stand and being responsible for it." (Grecmanová, Urbanovská, Novotný, 2000, p. 13)

The school provides a sufficient environment and space for students to develop their own ideas and thinking processes under the supervision and guidance of their teacher. The teacher's creativity in introducing activating methods significantly contributes to the development of students' critical thinking. Incorporating digital technologies into the planning and implementation of these activities adds value, as it supports and develops the ICT literacy of both teachers and students. Consequently, students can become mature, critically thinking individuals who are not entirely subject to the information flow of the mass media but are able to discern and select information that is real, true, and genuinely useful to them.

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Innovations in the Education of Future Teachers: Integration of Digital Didactic Tools in the Training of Primary Education Teachers

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Abstract

The aim of this paper is to analyse the current state and possibilities of integrating digital didactic tools—such as software applications with gamification elements, robotic and coding kits, and didactic toys based on STEM/STEAM principles—into the undergraduate training of primary education teachers. The study assesses the effectiveness of these tools in the educational process by analysing qualitative and quantitative results from domestic and international studies conducted within a European context. The research includes an analysis of data from various faculties of education that are progressively introducing digital technologies into curricula designed to prepare future teachers. Both domestic and foreign studies have demonstrated significant improvements in the cognitive and motivational abilities of primary education students when utilising tools with elements of gamification and AR/VR technologies. Based on the results obtained, this article proposes several recommendations for the effective implementation of digital didactic tools in teacher preparation. The conclusion underscores that the technological and digital readiness of future teachers is crucial for successfully meeting the demands of modern education and ensuring quality education for the next generation.

Keywords: Pre-service Teacher Training, Digital Didactic Resources, Pedagogical Innovation

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1 Introduction

Currently, education at all levels of schooling is in a period of intense innovation, responding to rapid technological advances and the changing needs of society (Buckingham, 2020). Especially in the field of primary education, new approaches to integrate digital didactic tools into the educational process are gradually emerging. For faculties of education in Slovakia, this means not only adapting curricula to modern requirements, but also effectively preparing future teachers to work with digital tools that support the development of children's cognitive and practical skills at an early school age. In this way, new conditions are created for the development of children's digital competences and technological thinking, contributing to their better preparedness for the needs of the current labour market and life in the digital era. Literature on this topic highlights specific resources such as software applications with gamification elements, robotic and coding kits, and didactic toys based on STEM/STEAM principles (Asad et al. 2021; Alrashedi et al., 2024). These tools help develop algorithmic and critical thinking, creative problem solving, and promote active participation of students in the learning process. The studies (Pridavková et al., 2023; Peykova, Garov, 2021) suggest that incorporating digital technologies and gamification into the learning process not only increases students' motivation but also contributes to improved academic performance and deeper understanding of the curriculum. In the foreign context, the implementation of these tools in schools and in teacher training has already been shown to yield positive results, but in the Slovak environment, this is an area that requires deeper analysis and adaptation to the specific conditions of our schools and teacher training.

This paper analyses the current state of integrating digital didactic tools into the undergraduate training of primary education teachers in Slovakia. We aim to address the following question: *How can the use of modern digital tools enhance the effectiveness of future teachers' education, and what is the potential of these technologies in teacher training?* Exploring this question may significantly influence the current approach to teacher education in Slovakia or confirm that modern technologies and didactic approaches can be effectively incorporated into the existing framework, thereby contributing to its further improvement. If these tools are successfully implemented, we can anticipate increased motivation and performance among students in STEM areas, which will also strengthen teachers' competencies and readiness to meet the demands of the digital era.

2 Theoretical Background

Integrating digital tools into teacher training fundamentally reshapes education to meet the needs of a digital society. Technologies like gamified apps, robotics kits, and augmented reality (AR) offer significant benefits for developing students’ cognitive and practical skills (Black et al., 2006; Buckingham, 2020). These tools enable educators to adapt learning experiences to various student needs.

One of the most prominent approaches is gamification, which integrates game elements such as rewards and competitions to increase student motivation and engagement in the learning process (Sylvester, 2024). The research on gamification in education highlights its considerable benefits for teachers, as it allows them to experiment with various pedagogical methods and assess their impact on student motivation and academic performance. According to the study titled *Latent factors on the design and adoption of gamified systems for education* (Doe, Smith, 2023), effective gamification design integrates educational, curricular, and technological principles that are crucial for fostering an engaging learning environment. The study emphasises that well-designed gamified applications significantly enhance student motivation, leading to increased engagement and potentially improved academic outcomes. This aligns with the broader understanding that gamification, when aligned with educational objectives and thoughtfully implemented, can serve as a powerful tool to enhance educational processes and outcomes.

Robotics and programming are other important components of modern education. Based on a study *The Significance of Training Student-Teacher Lecturers in Pedagogical Robotic and Coding Skills* by Mokonyane-Motha and De Jager (2023), it was found that teachers who were trained in robotics building blocks and coding not only showed higher readiness for technology instruction but also improved students' ability to master complex problems. Preparing future teachers to work with these tools promotes the development of algorithmic thinking and critical skills. These results are consistent with other research, such as the study by Jaipal-Jamani and Angeli (2017), which found that preservice teachers' self-efficacy and their understanding of science concepts significantly improved when they were trained in robotics and programming. This training also enhanced their computational thinking, further emphasizing the importance of integrating these technologies into teacher education programs.

Another important technological approach is the use of augmented reality (AR) in the educational process. In a study conducted in Slovakia, Pridavková and colleagues (2023) showed that the use of AR in mathematics education increases not only interest in the subject, but also understanding of complex concepts. Student teachers who had the opportunity to work with AR technology during their undergraduate education showed greater motivation and creativity in solving mathematical problems. In this way, AR technology creates an environment for interactive learning, which has a profound effect on students' ability to better retain and understand the material.

The literature also suggests that pre-service teacher education should include training in the use of STEM/STEAM toys and other didactic tools aimed at developing critical and spatial thinking skills. The study by Shukshina et al. (2021) suggests that STEM and STEAM frameworks can significantly foster problem-solving skills, critical thinking, and creativity among students by incorporating practical, interdisciplinary approaches that connect scientific theory with real-world applications.

The importance of integrating digital tools into pre-service teacher training is therefore indisputable. Digital technologies offer a way to keep up with modern educational challenges and allow teachers to better prepare their students for the complex issues of today's world (Alrashedi et al., 2024; Black et al. 2006). The findings from these studies clearly indicate that effectively incorporating digital tools and methodologies into the preparation of future teachers can significantly impact their ability to lead classrooms in technologically challenging environments and effectively educate the next generation.

3 Current State of Knowledge

The study *Technology-Enhanced Education through VR-Making and Metaverse-Linking to Foster Teacher Readiness and Sustainable Learning* by Lee and Hwang (2022) investigates how pre-service English teachers can develop and implement technology-enhanced learning environments using Virtual Reality (VR) and integrate these experiences into metaverse platforms. This research equips future educators with the skills necessary to create engaging, adaptive, and sustainable educational settings. By employing a mixed-methods approach, the study gathers data through pre- and post-intervention surveys and reflective papers written by participants. Surveys are quantitatively analysed for statistically significant changes, while reflective papers provide qualitative insights via sentiment analysis and text mining. Results indicate significant enhancements in technological readiness, critical thinking, creativity, collaboration, and communication skills – the 4Cs of 21st-century skills. The findings highlight the pedagogical advantages of VR in creating interactive, engaging environments that support long-term knowledge retention and essential competencies.

An OECD report (2020) analyses the impact of the COVID-19 pandemic on education, with an emphasis on the technological readiness of schools and teachers in European countries. The aim was to identify the level of readiness for digital tools and to explore the need for further teacher training in digital skills. Methods included the use of data from several national surveys, questionnaires and interviews with school administrators and teachers. These methods provided insight into how schools were responding to distance education and what their technological capacity was. The results showed that approximately 65 % of schools in Europe showed increased preparedness to use digital technologies during the pandemic. Nevertheless, a large proportion of teachers felt the need for further training to help them use these technologies more effectively. The report's conclusion underlines that the pandemic has revealed significant gaps in teachers' digital training and highlighted the need for more intensive technology training during their undergraduate studies.

The study by García-Valcárcel and Tejedor (2009) examined the integration of information and communication technologies (ICT) into university teaching within the framework of the European Higher Education Area. The research aimed to explore how ICT tools are utilised in higher education, the competencies teachers need to effectively use these technologies, and the challenges they face. The study used a descriptive methodology, gathering data through interviews with university lecturers from various disciplines at the University of Salamanca. The findings highlighted that most educators recognize the potential of ICT to enhance teaching and learning processes. However, the study also revealed significant barriers, such as insufficient technical infrastructure, lack of time, and limited training in pedagogical applications of ICT. Teachers emphasized the need for training that combines technical skills with methodological guidance to create meaningful learning experiences. The research underscored the importance of equipping educators with the knowledge to design and implement technology-supported learning environments, fostering collaboration and innovation.

In her study *Formation of ICT Competency of Future Teachers* Rahimova (2024) addresses the critical integration of Information and Communication Technology (ICT) into the training of future educators. Recognizing the growing demand for digital literacy in modern education, Rahimova focuses on enhancing the ICT competencies of teacher candidates. The objective is clear: to prepare future teachers to effectively navigate and utilise technology in their professional practices, ensuring they can meet the challenges of the information society. Rahimova employs a comprehensive analytical approach, examining the impact of various ICT tools and resources within educational settings. She evaluates how these technologies influence both the educational process and the development of professional competencies among students and educators. Her methodology involves not only the review of existing literature but also the analysis of pedagogical outcomes when ICT is integrated into teaching strategies. The results of the study underline the significance of ICT in education. Rahimova finds that embedding ICT tools in teacher training enhances the dynamism and relevance of the teaching process, aligning it more closely with contemporary educational needs. The study concludes that a strong ICT competency is essential for future teachers, as it directly affects their ability to foster an engaging and effective learning environment.

The study *Developing technological pedagogical content knowledge skills during teaching practicum* by Jaeni and Ghufron (2024) delves into how Indonesian pre-service teachers develop their technological pedagogical content knowledge (TPACK) skills during their teaching practicums. It seeks to explore the specific activities and strategies these future educators employ to enhance their TPACK competencies, as well as the challenges they encounter and how they overcome them. This inquiry is crucial for improving teacher training programs and ensuring educators are well-equipped to integrate technology into their teaching. Using a qualitative narrative inquiry approach, the research gathers insights from interviews with five pre-service teachers from diverse educational backgrounds. The analysis of these interviews helps to map out the strategies used by these individuals to develop their TPACK, such as observing veteran teachers, participating in educational workshops, studying relevant literature, and actively applying TPACK frameworks in their practicum activities. Despite their efforts, these pre-service teachers face several challenges, including limited access to resources, low confidence in using technology, and inadequate time for reflective practice. To navigate these obstacles, they employ various adaptive strategies like collaborating with peers, engaging in reflective teaching, and setting clear, achievable goals for their practicum sessions. This study's findings highlight the importance of structured support and practical strategies in teacher training programs, suggesting that such elements are vital for preparing future teachers to effectively use digital tools in their educational practices.

The article *Teaching and learning natural sciences using augmented reality in preschool and primary education: A literature review* by Lampropoulos (2024) critically examines the impact of augmented reality (AR) tools on natural sciences education in preschool and primary settings. Lampropoulos aimed to gather and synthesize evidence on the effectiveness of AR in enhancing the understanding of scientific disciplines like Astronomy, Biology, Chemistry, Earth Sciences, and Physics among young learners. Employing a literature review methodology, he analysed 63 studies selected from various academic databases, focusing on those that specifically addressed the use of AR in early education. The results from this comprehensive review clearly demonstrated that AR tools not only boost student engagement and motivation but also lead to improved learning outcomes. Students exposed to AR showed better comprehension and retention of complex scientific concepts compared to peers taught through traditional methods. The study also highlighted that AR fosters an interactive and collaborative learning environment, which is crucial in making abstract scientific content more tangible and relatable to young students. By incorporating AR into teacher training programs, educators can be better prepared to leverage these technologies to enhance science education, making them invaluable tools for both teaching and learning in contemporary educational settings.

The 2017 study by Manning, Garvis, Fleming, and Wong titled *The Relationship Between Teacher Qualification and the Quality of the Early Childhood Education and Care Environment* delves into how teacher qualifications impact the quality of early childhood education and care (ECEC). Their research compiles and analyses empirical data from 1980 to 2014, using the Campbell Systematic Review methodology to critically evaluate the influence of educators' academic and professional credentials on the learning environments they provide. Essential to this analysis are metrics from the Early Childhood Environment Rating Scale, which assess the quality of ECEC through various dimensions, including program structure, activities, language development, and reasoning skills. The results underscore a clear and substantial link: higher teacher qualifications are strongly associated with better quality in ECEC settings. This finding highlights the indispensable role of well-qualified educators in elevating educational outcomes for young children. The implications of this study are significant, advocating for the integration of more advanced training and qualifications within teacher education programs. This is particularly crucial for equipping future educators with the competencies necessary to not only utilise digital tools effectively but also to create enriching and high-quality educational environments for early learners.

Jen Scott Curwood's study *Teachers as Learners: What makes technology-focused professional development effective?* delves into how digital tools are incorporated into professional development for English teachers, specifically examining how these practices affect their adoption of technology and teaching methods. The goal is to identify key elements that contribute to the success of professional development focused on technology integration and to explore effective implementation strategies. Methodologically, this research adopts a qualitative case study approach, involving English teachers and library media specialists from two high schools over a year. The process included observing and recording meetings of professional learning communities, conducting interviews, and analysing these interactions to gain insights into how digital tools are weaved into teaching practices. The findings reveal that successful technology integration hinges on creating and maintaining collaborative learning environments where teachers are actively using digital tools. Professional development programs that provide direct, hands-on experiences with technology, coupled with regular opportunities for reflection on teaching practices and ongoing support through peer dialogue, significantly boost teachers' readiness and enthusiasm to incorporate digital tools into their curriculum. This study underscores the importance of well-structured professional development in equipping future educators with the skills and confidence to seamlessly integrate technology into their teaching strategies.

The study Shukshina et al. (2021) focuses on identifying ways to integrate STEM and STEAM approaches into teacher education in Russia with the aim of modernizing their pedagogical skills and effectively utilizing digital didactic tools. The goal of the research is to explore opportunities to improve educational strategies so that future teachers can teach complex concepts in an attractive and interactive manner while also promoting creativity and critical thinking in students. The work proposes methodological innovations, including the inclusion of courses focused on the effective use of digital technologies in primary education. This modernization of curricula aims to equip future teachers with the skills needed to address current educational challenges and ensure that students acquire the skills necessary for the 21st century. In summary, the research emphasizes the need to update teacher education to include digital tools and STEM and STEAM approaches, focusing on preparing educators for a technology-driven and innovative educational environment.

The study *Teacher Perceptions of Barriers and Benefits in K–12 Technology Usage* by Carver (2016) focused on analysing the barriers and benefits of technology use in U.S. K–12 schools. The main goal was to determine what barriers prevent teachers from using technology effectively and what benefits it brings to their teaching. The research included surveys and interviews of teachers in a variety of schools, which provided both qualitative and quantitative data on teachers' experiences with technology. The researcher analysed this data to identify the major barriers and benefits that technology integration brings to K–12 education. The results showed that less than half of the teachers felt prepared to use technology effectively in the classroom. Major barriers included lack of technology training during pre-service education and limited access to technology in schools. However, teachers with sufficient technology skills reported higher student engagement and better teaching dynamics when using technology. In conclusion, Carver (2016) recommends increasing teachers' technology preparation during their undergraduate studies so that they have a better ability to integrate technology into their teaching to maximize the benefits that modern technology brings to the classroom.

The study *Virtual Reality as a Pedagogical Tool to Enhance Experiential Learning* conducted by Muhammad Mujtaba Asad and colleagues (2021) explores the potential of virtual reality (VR) to transform experiential learning in educational settings. Aiming to evaluate the impact of VR on enhancing student engagement and understanding, the research utilises a systematic literature review methodology, analysing twenty-six peer-reviewed articles from various educational disciplines. The results indicate that VR significantly boosts student motivation and engagement, offering dynamic learning environments where theoretical knowledge can be applied in practical, simulated scenarios. This capability of VR to facilitate complex learning experiences, which are otherwise unfeasible in traditional classrooms, underscores its potential as a transformative educational tool. Integrating the insights it becomes evident that VR technology can play a crucial role in modernizing teacher education. By incorporating VR into teacher training programs, we can better equip future educators with the skills and understanding necessary to implement engaging and effective learning experiences using digital tools. Such an approach not only enhances the educational process but also prepares teachers to effectively utilise emerging technologies to foster a more interactive and immersive learning environment.

The study by Alrashedi et al. (2024) focuses on the role of gamified platforms in the training of future primary education teachers, specifically examining how these digital didactic tools enhance trainee engagement and motivation. The researchers adopted a quantitative methodology to measure the impact of gamification by conducting pre- and post-intervention assessments. Their findings highlight a significant increase in motivation and engagement among teacher trainees, who reported a greater interest in teaching and a stronger willingness to incorporate digital tools into their future teaching practices. The results suggest that gamified platforms can effectively create an innovative and interactive learning environment, essential for the evolving field of primary education. Conclusively, the integration of gamification in teacher training programs is seen as crucial in developing highly effective and motivated educators, preparing them to meet contemporary educational challenges and to foster an engaging learning environment for their future students.

The research titled *Educational Robotics for Elementary Students: Teaching's Opportunity* by Tira Nur Fitria (2024) focuses on the innovative integration of educational robotics into the curriculum for training primary education teachers. The study's objective is to evaluate the potential of educational robotics to enhance teaching methods, particularly in fostering computational reasoning and problem-solving skills among students. Employing a library research methodology, the study synthesizes data from a range of scholarly articles, journals, and books related to the application of robotics in educational settings. The findings suggest that educational robotics not only enhances creativity and technological proficiency but also promotes collaborative skills and supports personalized learning experiences, especially for students with special needs. However, challenges such as the need for specialized teacher training and the integration of robotics into existing curricula are also identified. This research highlights the importance of incorporating advanced digital tools like educational robotics in teacher education programs to equip future educators with the necessary skills for the digital era.

The study *Digital Storytelling Skills of Teacher Education Students* (Cariño et al., 2024) explored the digital storytelling competencies of pre-service teachers at a Catholic university in the Philippines. The research aimed to assess the current level of these skills and propose strategies for improvement. Using a quantitative descriptive approach, the study evaluated third-year teacher education students through oral tests and analysed their proficiency in areas such as grammar, vocabulary, discourse, and technical skills. The findings revealed that most participants demonstrated a need for significant improvement in digital storytelling. The study also highlighted that there were no substantial differences in skill levels across different fields of specialization or academic majors. To address these gaps, the researchers proposed an intervention called *Project CLASS*, focusing on improving storytelling through guided listening and short storytelling sessions using digital tools. The study concluded that pre-service teachers require targeted support to enhance their digital storytelling abilities, which are crucial for modern educational practices in the digital age.

One of the relevant studies carried out in Slovakia, which focuses on the integration of digital didactic tools into the undergraduate preparation of primary education teachers, is the work of Pridavková and colleagues (2023) entitled *Analysis of students' work in the context of the inclusion of augmented reality technology in mathematics education*. The aim of this study was to investigate the impact of the implementation of augmented reality (AR) technology at the undergraduate level in mathematics education and to analyse student work before and after the introduction of AR technology. The research was conducted on a sample of 50 primary education teaching students who were divided into experimental and control groups. The experimental group used augmented reality during mathematics teaching, while the control group worked with traditional methods. The researchers collected data through analysis of student papers and questionnaires that assessed students' experiences and attitudes towards the use of AR in the teaching process. The results of the study showed that students from the experimental group showed a higher level of understanding of mathematical concepts and greater motivation to learn compared to the control group. Student work also indicated more creative approaches and deeper understanding of the curriculum, indicating the positive impact of AR on learning. Pridavková and colleagues (2023) concluded that incorporating augmented reality technology into pre-service teacher training can positively influence teachers' didactic skills and readiness to implement modern technologies in the educational process. The study provides valuable insights into the effectiveness of AR in the preparation of future teachers in Slovakia and suggests the potential of this technology in improving the quality of education in primary schools.

3.1 Results of analyses of domestic and foreign studies

The analysis of the results of domestic and international studies suggests that the integration of digital didactic tools is essential for the quality undergraduate preparation of future teachers. Overall, three key areas of findings can be distinguished: the development of teachers' digital skills, motivation and engagement through gamification and VR, and the use of digital technologies in STEM education.

The first area – developing teachers' digital skills – includes the results of international studies that highlight the importance of technology-oriented professional development. Research by Curwood (2011) and a study by Carver (2016) show that technology-focused professional development is essential for future teachers because it enhances their ability to use technology effectively in the teaching process. For example, the TPACK model, tested in Indonesian (Jeani, Ghufron, 2024), has proven to increase teachers' confidence and readiness to work with digital tools. On the other hand, Slovak research (Pridavková et al., 2023) suggests that access to advanced technologies such as AR applications is limited, which hinders prospective teachers from gaining the necessary practical experience.

The second area – motivation and engagement through gamification and VR – is one of the key points of the international studies. Research by Alrashedi et al., (2024) and Asad and colleagues (2021) has shown that VR and gamified platforms can significantly increase prospective teachers' motivation and engagement in the teaching process. While gamification promotes interaction with content and creates a stimulating environment for learning, VR provides a safe environment for students to practice didactic skills and increase their confidence. However, there is still a lack of these technologies in pedagogical training in Slovakia, indicating gaps in access to innovative, practical methods that are more common abroad.

The third area – the use of digital technologies in STEM education – is particularly relevant in the context of developing the technical skills of future teachers. STEM-focused research, such as studies by Shukshina et al. (2021) and Peykova with Garov (2021), has shown that teacher preparation in programming and robotics can significantly improve teachers' ability to motivate students to solve complex problems and foster their technical thinking. However, this type of education is not yet sufficiently developed in Slovakia, suggesting the need to strengthen STEM training in faculties of education.

4 Conclusion and Recommendations

Based on the analysis of domestic and international studies, it appears that digital didactic tools have a significant potential to improve the quality of the preparation of future teachers.

Foreign research highlights those technologies such as virtual reality (VR), augmented reality (AR), gamified platforms, and specific professional development models such as TPACK are not only crucial for developing teachers' professional and technical skills, but also for increasing students' motivation to engage more actively in teaching (Alrashedi et al., 2024; Jeani, Ghufron, 2024). However, domestic research suggests that Slovak faculties of education face challenges related to limited access to these technologies, leading to lower preparedness of future teachers compared to their foreign counterparts (Pridavková et al., 2023).

The results of the analysis point to three main areas: the development of teachers' digital skills, motivation and engagement fostered through gamification and VR, and the use of digital technologies in STEM education. The first key area is digital skills development, which, as the international literature highlights, significantly supports continuous professional development. For example, research by Curwood (2011) confirms that professional development focused on digital competencies enhances teachers' ability to use technology effectively in teaching, which is essential for the quality of education. The TPACK model proved to be an effective tool in the Indonesian context for enhancing teachers' confidence and readiness to work with digital tools. The TPACK model (Technological Pedagogical Content Knowledge) provides teachers with a comprehensive framework that integrates technological, pedagogical, and content knowledge necessary for effective teaching using modern technologies (Jeani, Ghufron, 2024). However, Slovak research by Pridavková et al. (2023) points out that limited access to technology such as AR significantly reduces students' practical experience, which limits their readiness to teach in technologically challenging environments.

The second key area is motivation and engagement, which are supported by the use of gamification and VR. International studies show that VR and gamified platforms significantly increase student motivation and engagement in the learning process (Alrashedi et al., 2024; Asad et al. 2021). Gamification promotes interaction with learning content, while VR enables a safe environment for practicing didactic skills. However, technologies of this type are not widely available in pedagogical training in Slovakia, indicating a gap in the possibilities for practical application of these approaches.

The third area focuses on the use of digital technologies in STEM education, which is particularly crucial for developing the technical skills of future teachers. STEM-focused research, such as the work of Shukshina et al. (2021) and Peykova with Garov (2021), highlights that technologically prepared teachers in areas such as programming and robotics are better able to motivate their students and promote complex problem solving. These areas are less developed in the Slovak education system, suggesting the need to expand STEM training in pre-service teacher education.

The current approach to teaching digital competencies in foreign universities offers several advantages, including increased motivation, technical skills and confidence of future teachers. Interactive elements such as VR, gamification and AR provide opportunities to practice didactic skills and gain a deeper understanding of the learning content. Models such as TPACK provide education faculty with a practical framework that integrates technological, pedagogical, and content knowledge, greatly enhancing the preparedness of future teachers. In Slovakia, however, the current approach faces constraints in access to technology and funding, which reduces the opportunities for future teachers to use modern digital tools in their practice.

The gaps identified suggest the need for greater investment in access to digital tools as well as systematic education in STEM, programming and robotics. Recommendations for further research include expanding domestic research on the long-term impact of digital didactic tools, particularly on the motivation and critical thinking of future teachers. Further research could focus on the effectiveness of implementing VR and AR in teacher preparation to understand their real benefits and potential challenges in practice.

Specific measures are proposed to improve the effectiveness and accessibility of teacher education in Slovakia. The first step should be to strengthen the technological infrastructure in faculties of education, thereby increasing future teachers' access to VR, AR and digital platforms. Furthermore, it is recommended to integrate STEM training and courses focused on programming and robotics into the teacher training curriculum, providing teachers with basic technical skills and an understanding of STEM education methods that promote analytical thinking. Introducing gamified elements into didactics and pedagogy teaching would also help to increase student teachers' motivation and improve their classroom management and teaching interaction skills. Finally, the focus should be on expanding professional development opportunities with an emphasis on digital skills, which would enable teachers to acquire up-to-date technical knowledge continuously and effectively.

The above measures can significantly improve the preparedness of future teachers for the demands of the modern learning environment and enable them to make better use of digital tools in primary education. Targeted investments in technological infrastructure and professional development could thus improve the overall quality of education in Slovakia.

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To the Roots: Engineering Pedagogy

Using Retrieval-based Voice Conversion in Educational Video Materials

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Abstract

The rapid and unforeseen rise of artificial intelligence (AI) raises numerous questions regarding its applicability across various fields. Consequently, it is essential to consider its impact on education. This study primarily examines the utilisation of AI within the context of the flipped classroom teaching model, with a particular focus on the audio components of educational video materials. For instance, AI can facilitate replacing a speaker's voice with that of another individual or translating it into a different language while nearly maintaining the original speaker's voice. The application of Retrieval-Based Voice Conversion (RVC) models can significantly aid this process.

Keywords: Artificial Intelligence, Retrieval-Based Voice Conversion, Educational Video Materials, Flipped Classroom

1 Introduction

Artificial Intelligence (AI), as an emerging phenomenon in modern technology, is increasingly permeating various areas of life, including almost all branches of industry and the field of education. While this development is perceived positively, there are also numerous concerns regarding the use of AI. This article contributes to clarifying the principles of AI through special algorithms in text processing, presents the RVC (Retrieval-based Voice Conversion) technology for processing natural speech and outlines the research methodology for processing teaching

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materials for the needs of flipped classroom educational technology. In our article, we therefore consider AI as a tool for possible improvement of voice reproduction in the preparation of educational video materials.

2 Flipped Classroom Method

We present the Flipped classroom method as an innovative method of education, although according to Lage, Platt and Treglia, it is not a new recent method, as shown by the definition from 2000: *"New learning technologies it possible for events such as lectures, which have traditionally taken place inside the classroom, to occur outside the classroom to and events which possibly occurred outside the classroom to occur inside the classroom under the guidance of the instructor."* (Lage, Platt and Treglia, 2000, p. 41).
Research showed that the use of the flipped classroom method has a positive impact on students' learning, as it increases their interest in the subject, improves their motivation and confidence, helps in developing their critical thinking, and thus ultimately leads to an overall improvement in their academic performance (Pšenáková at al., 2024).
The right use of the flipped classroom method has many advantages, the most important is individual tempo of learning, flexibility, more efficient use of class time, and development of critical thinking.
Outside the classroom, students prepare for the lesson from a variety of resources, such as instructional video materials, learning texts, have space for online discussion, etc.
We will only cover educational video materials. But the truth is, the flipped classroom method to be effective, we cannot rely on video materials alone, but on a combination of different resources. If we only provided students with videos for preparation, it might carry several disadvantages, such as: *"poor interaction, poor collaboration, low video quality, lower concentration, technical problems"* (Bui, 2021, p. 275).

3 AI in Education

Collecting large volumes of data in databases enables knowledge extraction. This knowledge can be extracted using artificial intelligence algorithms. Extracted knowledge can be used for concentrated support of education. We can analyse the knowledge stored in big data using machine learning and use artificial intelligence solutions to support activities and decision-making processes in education or to convert natural speech into desired patterns.
The teacher has limited control over how well and to what extent the students have studied the materials before the lesson. If students do not absorb information well, classroom activities can be less effective and ineffective. Therefore, when it comes to the educational process, AI can support learning outside the classroom with the help of prepared educational materials.

3.1 Incidence of Algorithms

AI represents the potential, that can search connections between existing knowledge and enables search for relative and relevant connections from available sources. From the point of view of knowledge management is important for us to provide relevant and adequate details for the needs of a given subject or field. The goal is to gain knowledge through searching from various sources based on artificial intelligence algorithms. Therefore, artificial intelligence, based on algorithms, search information based on required variables, identifies existing patterns from available sources and offers them as complete files.

Many new research articles are published every day, in which different artificial intelligence techniques (e.g., neural networks, fuzzy logic, clustering algorithms, and evolving computing) are applied to various tasks and applications related to opinion mining. (Serrano-Guerrero et al., 2021, p. 1). We present some known AI algorithms, e.g. Artificial neural networks, Support vector machine, Fuzzy logic, Genetic algorithm, Tree-based assembles, Hybrid and ensemble procedures, Deep learning, Bayesian networks, etc. (Nguyen et al., 2023, pp. 4–10).

For the needs of our study, we focus on clarifying the processes for creating natural language with algorithms supporting NLP (Natural Language Processing). Various TTS (Text to Speech) models are known. In our paper, we deal with the RVC (Retrieval-based Voice Conversion) model and try to outline the perspective of text-to-speech research for the needs of creating educational materials in the conditions of university education and supporting flipped classroom educational technology.

For this reason, we are investigating the best ways to provide students with quality delivery of the curriculum using professional voice modulation with respect to voice timbre, emphasizing important parts and essential data, facts or information. The research methodology will be based on training artificial speech, embedding and analysing scenes and testing speech samples on prepared scenes in the form of processed natural language (NLP).

The goal of the models is to perform binary classification of the speech, learning whether the audio is speech spoken naturally by a human being, or has been tampered with by retrieval-based voice conversion. The models trained are: Extreme Gradient Boosting (XGBoost), Random Forests, Quadratic and Linear Discriminant analyses, Ridge Regression (linear regression with L2 regularisation), Gaussian and Bernoulli Naive Bayes, K-Nearest Neighbours, Support Vector Machines, Stochastic Gradient Descent, and Gaussian Process. The study showed that Convolutional Neural Networks and Long-Short-Term-Memory neural networks could score around 97-99% accuracy when dealing with recognition. (Bird–Lotfi, 2023, P. 2).

3.1.1 Artificial Neural Networks

In this section, for the sake of illustration, we mention only some AI algorithms that are used in the application of speech models. A recurrent neural network (RNN) is any network whose neurons send feedback signals to each other (Grossberg, 2013, p. 1888). Recurrent neural networks have been commonly used in earlier work to model contextual information in dialogues.

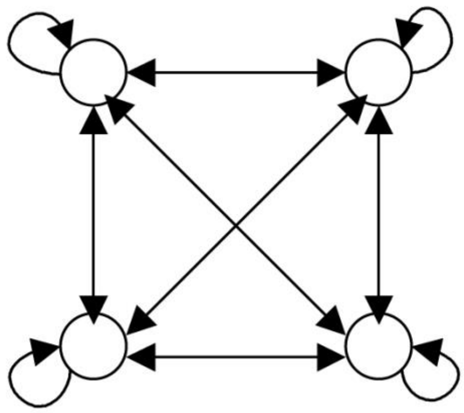

Figure 1: An example of a fully connected recurrent neural network (Medsker–Jain, 2001, P. 14).

Graphs are a kind of data structure which models a set of objects (nodes) and their relationships (edges). Graph neural networks are deep learning-based methods that operate on graph domain. (Jie et al., 2020, P. 57).

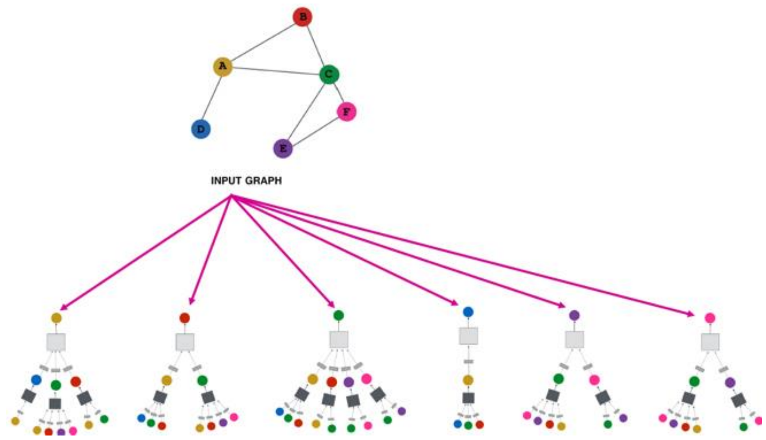

Figure 2: Each node of the Graph has its own neural network architecture (Taneja, 2024, P. 1).

Sparse volumetric data are ubiquitous in many fields including scientific computing and visualization, medical imaging, industrial design, rocket science, computer graphics, visual effects, robotics, and more recently machine learning applications. Neural networks, on the other hand, can be designed to discover such hidden features and can infer values without reconstructing the entire data set. (Kim et al., 2024, P. 2).

3.1.2 Support Vector Machine

The main motivation of Support Vector Machine is to separate several classes in the training set with a surface that maximizes the margin between them. Figure 3 shows the support vectors separate data set of two classes.

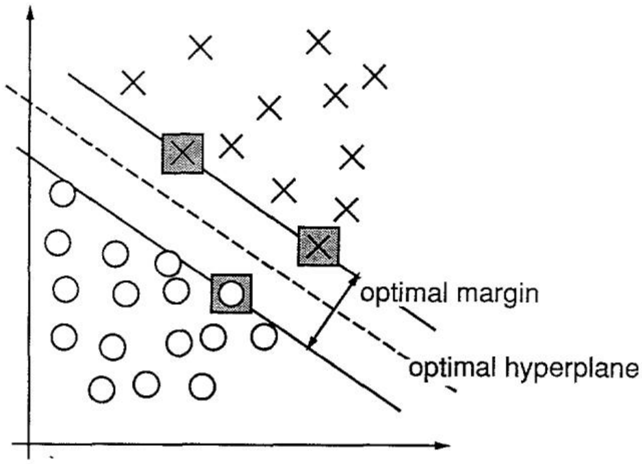

Figure 3: An example of a separable problem in a 2-dimensional space (Cortes et al., 1995, P. 5).

3.1.3 Genetic Algorithms

Genetic algorithms imitate the Darwinian theory of survival of the fittest in nature. Basic elements of genetic algorithms are chromosome representation, fitness selection and biologically inspired manipulations.

Genetic algorithm is an artificial intelligence search method that uses the process of evolution and natural selection theory and is under the umbrella of evolutionary computing algorithm. It is an efficient tool for solving optimization problems. (Hassanat, 2019, P. 1).

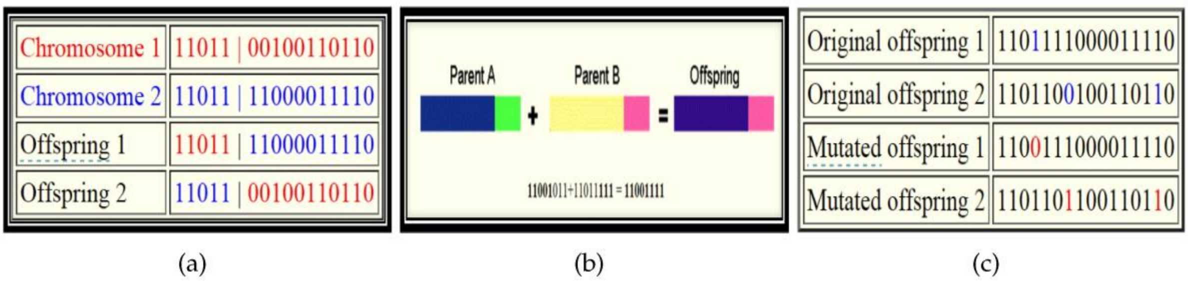

Figure 5: Examples of (a) crossover, (b) one-point crossover, (c) mutation operator in genetic algorithms (Hassanat, 2019, P. 4).

3.1.4 Tree-based Machine Learning

Tree-based machine learning methods are built by recursively partitioning a sample using different features at node from the dataset. Classification and regression trees are effectively used for predictions. According to Wei-Yin Loh classification and regression trees are machine learning methods for constructing prediction models from data. (Wei-Yin Loh, 2011, P. 1).

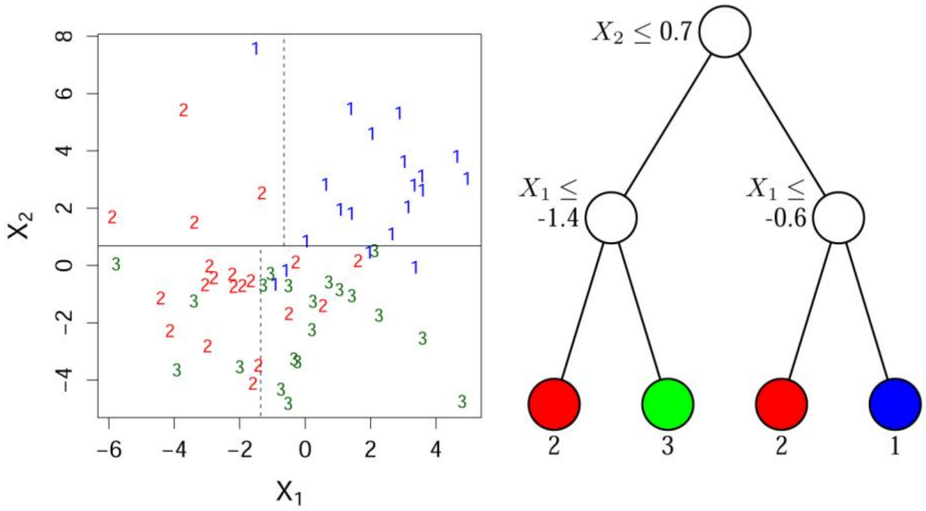

Figure 6: Decision classification and regression tree model with classes. (Wei-Yin Loh, 2011, P. 2).

3.1.5 Deep Learning

In machine learning and data science, high-dimensional data processing is a challenging task for both researchers and application developers. Thus, dimensionality reduction, which is an unsupervised learning technique, is important because it leads to better human interpretations, lower computational costs, and avoids overfitting and redundancy by simplifying models. (Sarker, 2021, P. 5).

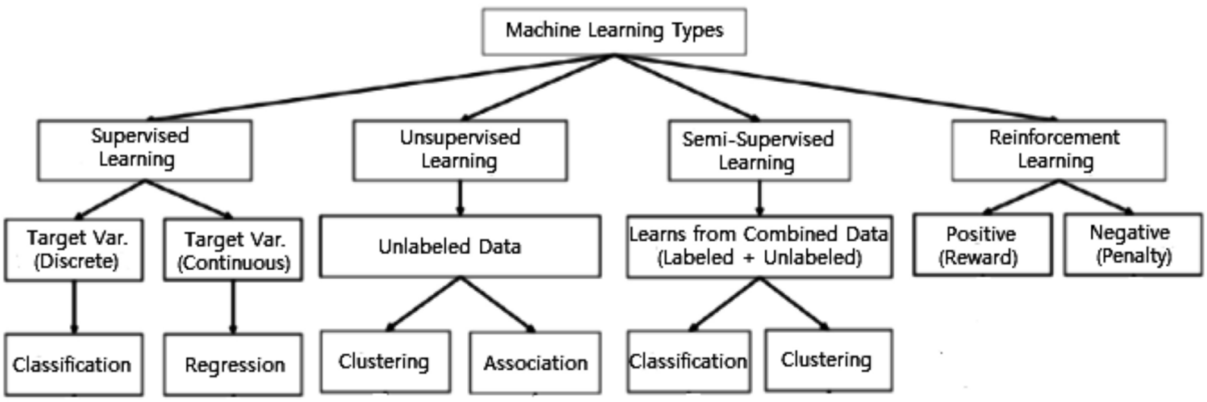

Figure 4: Various types of machine learning techniques. (Sarker, 2021, P. 4).

3.1.6 Bayesian Networks

Bayesian networks are based on the probability of dependent and independent variables. When determining the Bayesian rule, we start from the conditional probability of the phenomenon A, which is dependent on the phenomenon B, that is, the probability of the phenomenon A is equal to the joint probability of the values a, b divided by the probability of the value b.

$$P(a \mid b) = P(a, b)/P(b)$$

P is probability
a – values of A
b – values of B
From the mentioned relationship, we derive the Bayesian rule:

$$P(b \mid a) = P(a \mid b) * P(b) \;/\; P(a)$$

The Bayesian models represent a well-studied and effective way to describe and reason about problems that include uncertainty. (Kukačka, 2010, P. 30).

3.2 AI Generated Voice in Education

3.2.1 Retrieval-based Voice Conversion

RVC is characterized as an area of deep sound processing technology that offers solutions for correct prosody, pronunciation from graphemes, appropriate intonation with stress and overall control of speech style.

Figure 5: Diagram of educational video material processing. Own elaboration.

The RVC technology is based on the process of training and creating a speech model, in which we train the system on the unique voice of an individual and thus create our own model. Next, from the process of inference, i.e. the application of the model created in this way, where we try to apply such a unified model for educational materials and create educational video materials for the method of education, in our case for the flipped classroom method.
Speech processing with RVC technology can also prepare a model for a multilingual education system. We will provide the educational materials prepared in this way to the community of students in real teaching for sound verification. Figure 5 shows a scheme for preparing video material by modifying an audio recording.
RVC has the following characteristics: even on relatively poor graphics cards can be fast training; Training with a small amount of data can also get better results (it is recommended to collect at least 10 minutes of low-noise speech data). The timbre can be changed by model fusion. RVC also cannot intelligently select the number of rounds with the highest similarity to the training sound source in the process of model training, so it needs to manually customize the number of training rounds and provide multiple model results for manual screening (Zhongxi Ren, 2024, p. 468).

3.2.2 Using of RVC in Educational Video Materials

RVC tools provide processes which we consider from point of view of preparation educational video materials for using in flipped classroom method.
Text to speech: speech is generated from the text you have written. The voice can remain original if we have an RVC model from the original speaker, or we can use a different RVC model, for example a voice that is distinctive, interesting for the listeners.
Let's imagine a situation where we teach groups in the national language, but at the same time we teach a group in English for the same subject. For both groups we want to make the video teaching material available, this feature is usable as a dubbing based on the written text. We are limited by the visual content of the video, for example the content presented in Slovak language. However, there are some video materials that are universal in terms of visual content, e.g. explanation of a mathematical example etc.
On the other hand, not every creator of learning video materials likes his own voice, he can change it to a more interesting, more distinctive, i.e. more 'ideal' one. In foreign languages, it is advisable to use the voice of a native speaker.
Speech to speech: Transforming original speech to speech with a different voice. This function can be used to replace the teacher's original voice in video teaching materials, for example, the one that we consider more interesting, and which can help attract students' attention. We can use speech to speech tool in cases like TTS. The quality of the converted voice is greatly affected by the quality of the original voice, in addition, noise should also be removed from the original.
Voice Cloning: This is the process of making a clone voice based on a sample voice of an individual person (approx. 10 minutes is enough). In this case we consider clone voice as an

RVC model. This model can then be used for both TTS and STS. The quality of the model depends on the quality of the sample.

Various RVC technologies are not perfect yet, but they are getting better. There are many websites that offer such services, free for trial. The Applio project (https://applio.org/) offers these tools for free, and we use them for our purpose. Using the Applio and installation of it requires advanced knowledge in computer science. There are various trained RVC models available on the Internet, created by the community of users. Training of RVC model, which is based on deep learning, is hardware intensive. For training, a high-quality graphics card is required to perform the computations (for testing, we used the following hardware configuration: Intel Core i5-10400, DDR4 16GB RAM, GIGABYTE GeForce RTX 3070 GAMING OC 8G rev. 2.0). Setting some parameters in bulk can affect the result when using these tools.

Of course, RVC technology also carries dangers if it is used by people for illegal, criminal purposes. Public figures have various video recordings and radio recordings available to them, their voice can be cloned (training the RVC model). This model then can be used in videos, which will be a completely different speech, but identical voice - video with deepfake voice. Attackers can also use voice spoofing when making phone calls. New tools are also needed to counter these unusual methods of spoofing. For example, the possibility of protection has also been discussed by Zhao et al. (2022), Jordan and Lotfi (2023).

4 Conclusion

AI-generated voice technology has significant potential across various sectors, including healthcare, services, and education. In the context of the flipped classroom teaching model, video learning materials play a crucial role. These materials should engage the listener not only through content but also by employing an appropriate speaker's voice. The aforementioned applications of AI in voice generation can assist in enhancing educational videos. As AI technology continues to develop, it is anticipated to become more refined in the future. This study aims to investigate the effects of modifying the original voice to improve video learning materials for use in the flipped classroom method.

In this paper, we introduce the flipped classroom model as an innovative teaching method that incorporates educational video materials. We highlight that Artificial Intelligence (AI) employs deep learning algorithms to process human sensory information. Additionally, we present Retrieval-Based Voice Conversion (RVC) technology, which processes natural AI-generated speech, as a tool for preparing educational video materials within the flipped classroom framework.

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To the Roots: Engineering Pedagogy

The Teacher and their Contribution to the Educational Process

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Abstract

Education accompanies us throughout our lives. Acquiring new knowledge, skills, and experience is not confined to a few years of formal study; it is a lifelong endeavour. We continually strive to improve, enhance our efficiency, gain deeper insights, explore new ideas, and broaden our experiences. Family and friends support us in achieving our goals, guiding our personal growth and development. Schools play a crucial role in equipping individuals with the knowledge and skills necessary for success in both professional and societal contexts. Teachers hold a fundamental position in this process. Without them, how would society nurture educated individuals and skilled professionals? Who would lay the foundation of knowledge required for effective participation in the labour market? The teaching profession is both demanding and invaluable. A teacher's role extends beyond imparting knowledge; they also inspire, motivate, and guide students towards their future aspirations. Teacher shows the right path and tries to be a co-creator of the students' future. That is why they deserve recognition for their dedicated work.

Keywords: Teacher, School, Curriculum, Education, Motivation

1 Introduction

School plays a fundamental role in an individual's life, serving as a crucial source of knowledge and skills. It shapes a person's development, introduces essential characteristics, and fosters human relationships. An integral component of the school is the teacher, whose work has a

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profound impact on pupils' growth. A teacher's role extends beyond the transmission of knowledge; it encompasses a range of responsibilities essential to their profession.
Pupils mature into adults who embody the values they have acquired at school, which they, in turn, pass on to future generations. A teacher not only educates but also nurtures and guides. They support their pupils, inspire them, and cultivate a positive attitude towards education, nature, society, work, and family.

2 The Teacher in the Educational Process

The teacher is the most essential component of the school system. Furthermore, the teacher's role is difficult to replace, as they do not merely perceive a pupil as one among many in a classroom but rather recognise everyone's unique qualities. Each pupil is unique and achieves better results in something else. Someone is better at mathematics, someone is more open to technical subjects, someone is better at foreign languages. There are also those who are talented at sports or have a better relationship towards art. It is not certain that every pupil will be exceptional in something within school activities. Although education, based on its focus, offers several areas that can be interesting for pupils, but not a single school has the capacity to satisfy all the needs of pupils. It often happens that a pupil finishes high school or university studies in a certain field and finds a job in a completely different field.
There can be several reasons:
- the pupil graduated from the school recommended by his parents,
- the financial difficulty of attending another, more distant school,
- unemployment, changes in labour market needs,
- the difficulty of getting a job in your dream profession,
- change of the graduate's interest in the given work activity,
- the influence of family, acquaintances, and friends,
- attractive salary conditions and other factors.

The fact that a school graduate finds employment outside of their current school focus does not have to be the school's or parents' fault. When choosing a secondary school, many children have no idea what they want to be. They have certain information about individual schools and departments, but they may not have an accurate picture of what the given school will provide them during their years of study. Of course, pupils generally have a sense of what to expect in their studies. However, it is not uncommon for them to be surprised by the breadth of topics covered in certain subjects or to question the relevance of particular subjects in their curriculum. Schools, however, recognise the value of all subjects and the topics they encompass. They strive to establish a logical sequence between subjects and topics, ensuring they are interconnected in a meaningful way. As pupils progress through their education, they will encounter a wide range of subject matter, equipping them with essential knowledge and helping them understand the importance of completing each subject. A significant part of this process depends on the teacher—their personality, empathy, professionalism, expertise, and overall approach to both their responsibilities and their pupils. Teaching should not be regarded merely as a job to be carried out according to prescribed requirements; rather, it is a vocation that demands dedication and a genuine commitment to students' development. Teaching is also about feedback, whether the teacher's effort is also reflected in the pupils' knowledge, whether the pupils understand the essence of the subject matter and can continue to work with it, apply it and develop professionally and personally.

Hrmo et al. (2005, p. 8) states: "the teacher's personality is one of the most important factors in the teaching process, which decisively affects its quality and the quality of its results. Therefore, the teacher must be properly prepared for this activity."

Turek (2014) points out that if a teacher is to fulfil his tasks to the required degree and be effective in his work, he must thoroughly master the field in which he teaches. In addition, he must also have high-quality pedagogical training and high general culture. The teacher's personal and character traits are also important. A teacher should be patient, responsible, fair, creative, honest, etc.

Průcha (2002) writes that the pedagogical competence of a teacher does not lie only in what he learned during his studies or other training, but also in how the person is personally equipped to carry out teaching activities.

It is therefore essential that a teacher is not only an expert in their subject area but also possesses a range of additional qualities that enable them to effectively impart knowledge and experience. Equally important is the ability to spark interest in the subject matter, teach in an engaging and stimulating manner, and motivate pupils to actively participate in their learning. The success achieved by the teacher with the pupils also depends on the teaching style. Zormanová (2014) describes the teacher's teaching style as the teacher's individual approach to teaching.

3 Pupils' Motivation

The teaching style itself can depend on many factors. These are, for example: personality characteristics of the teacher, his previous experience, teaching subject (theoretical or practical), topic of the lesson, structure of pupils, etc. However, it is important that teachers, with their approach, create such conditions and climate in the classroom that the pupils develop a positive relationship with the subject. It is crucial how a teacher delivers the subject matter, responds to pupils' questions, and motivates even those who may have been passive at the start of the lesson. Therefore, understanding the needs of pupils is essential to ensuring effective teaching and engagement.

Petty (2013, p. 39-40) indicated the issue of teaching according to a certain template. When pupils learn the subject according to a certain template, sometimes they do not understand it and therefore forget it. With such learning, they will not know how to proceed in

unpredictable circumstances and situations. Even if they have learned everything correctly, they will lose confidence because learning without understanding is insufficient.
Petty also writes about how compulsory the teaching is. He emphasises that we, as teachers, leave a lasting impact on our pupils through our work. By providing quality education, we enable them to attain qualifications they might not have achieved otherwise. These qualifications can serve as a foundation for further education, allowing pupils to pursue even higher levels of academic and professional achievement. Even in this case, our merit will be visible. Our work will impact their careers and lives. Thanks to us, they will be a happier and more productive part of society.

Therefore, it is important how the teacher approaches the pupils, what teaching methods he applies, how he reacts to different situations during the lesson, how he motivates, how he evaluates, and so on.
Pupil motivation is an integral part of a teacher's work and without it, the desired objective of the lesson shall not be achieved. Motivation arouses pupils' interest in the subject and a higher level of cooperation is achieved. They can be motivated in many ways:

1 – Evaluation of pupils with a grade – The teacher must be objective in the evaluation. The evaluation criteria must be set in advance, and the pupil must have a clear understanding of what is expected of them. In assessments, it is important to distinguish whether they are required to provide an exact answer, such as a definition, or whether they are allowed to express their understanding in their own words. Furthermore, it should be clarified whether pupils must memorise the subject matter verbatim or if they can draw on their creativity, experience, and vocabulary to formulate their responses. The teacher must also correctly set the time needed to test the pupils.
There are inherent differences among pupils in writing, thinking, and responding to questions; therefore, it is essential to consider several important factors. After receiving a grade, pupils must understand the objective reasons behind their evaluation, whether positive or negative. When they comprehend the areas in which their performance was weaker, they are more likely to seek ways to improve, provided they receive sufficient motivation and support.

2 – Praise of pupils – Praise from the teacher has an important function, too. Praise can be given at any time when the teacher sees the space afterwards. After the praise, the pupil gains new strength to continue working, to be even better, more efficient, more diligent and to achieve more. If the pupil feels positive energy from the teacher and sees that the teacher appreciates his efforts, the work of the pupil will be much better and more effective. Praise can also be given at the beginning of solving a task, when the pupil has found the right way to proceed. When a pupil makes a mistake, it is very important for the teacher to praise what is right and point out what is wrong. When offering 'criticism' for incorrect procedures, it is

important not to cross a certain threshold, as doing so could significantly diminish the pupil's motivation.

3 – Didactic technique and didactic means – Nowadays, the diversity of didactic aids is increasingly developing, which can better illustrate the essence of the subject matter and increase the effectiveness of the teaching activity. Every teacher should try to use a wide range of didactic techniques and resources. Learning only from books is becoming less and less effective. Of course, this also depends on the specific subject and topic of the lesson, but in professional subjects the use of information and communication technology is a great benefit. Computers, various software, projectors, interactive whiteboard, product models, production activity simulations, Internet, professional presentations, and videos, etc. they increase pupils' interest in the subject and reduce the monotony of teaching.

4 – Teacher's rhetoric – Communicativeness, clear explanation of new subject matter, appropriate wording of sentences, tone of voice, variety of expressions used, wide vocabulary, enumeration of practical examples, repetition, appropriate enjoyment of praise and criticism, etc. they create a certain image of the teacher in the eyes of the pupils. When the pupil perceives the teacher as an important source of new information and can receive, understand, and subsequently apply that information, the basic goal of the lesson is fulfilled. In this case, it is very important that the teacher chooses appropriate rhetoric and focuses not only on pupils who are more open to receiving new information, but also to find a way to those who are not so open to this. Pupils should also be involved in the communication, so that their communicativeness and effort to present and explain their opinions, attitudes and arguments are also manifested.

4 Educational Process

With the help of the teacher's dedication, perseverance and patience, the pupils will get the necessary education.
Petlák (2016, p. 35-36) describes education as a process in which a pupil acquires certain knowledge and activities, creates knowledge and skills, and develops various abilities. In addition to acquiring knowledge, education also provides various other functions that work simultaneously, complement, and support each other. These functions include preparing an individual for a certain profession, for inclusion in society, creating a starting point for further education, developing psychological cognitive processes, but also the educational side.
When we talk about education, we usually think of school and organised, systematic education in school conditions. However, self-education also plays an important role, which is also confirmed by educators and psychologists. They state that an adult acquires most of his knowledge and skills through self-education and life experiences.

However, this does not mean that the role of school education is not important. On the contrary, the task of the school is to teach and prepare a person for self-education.

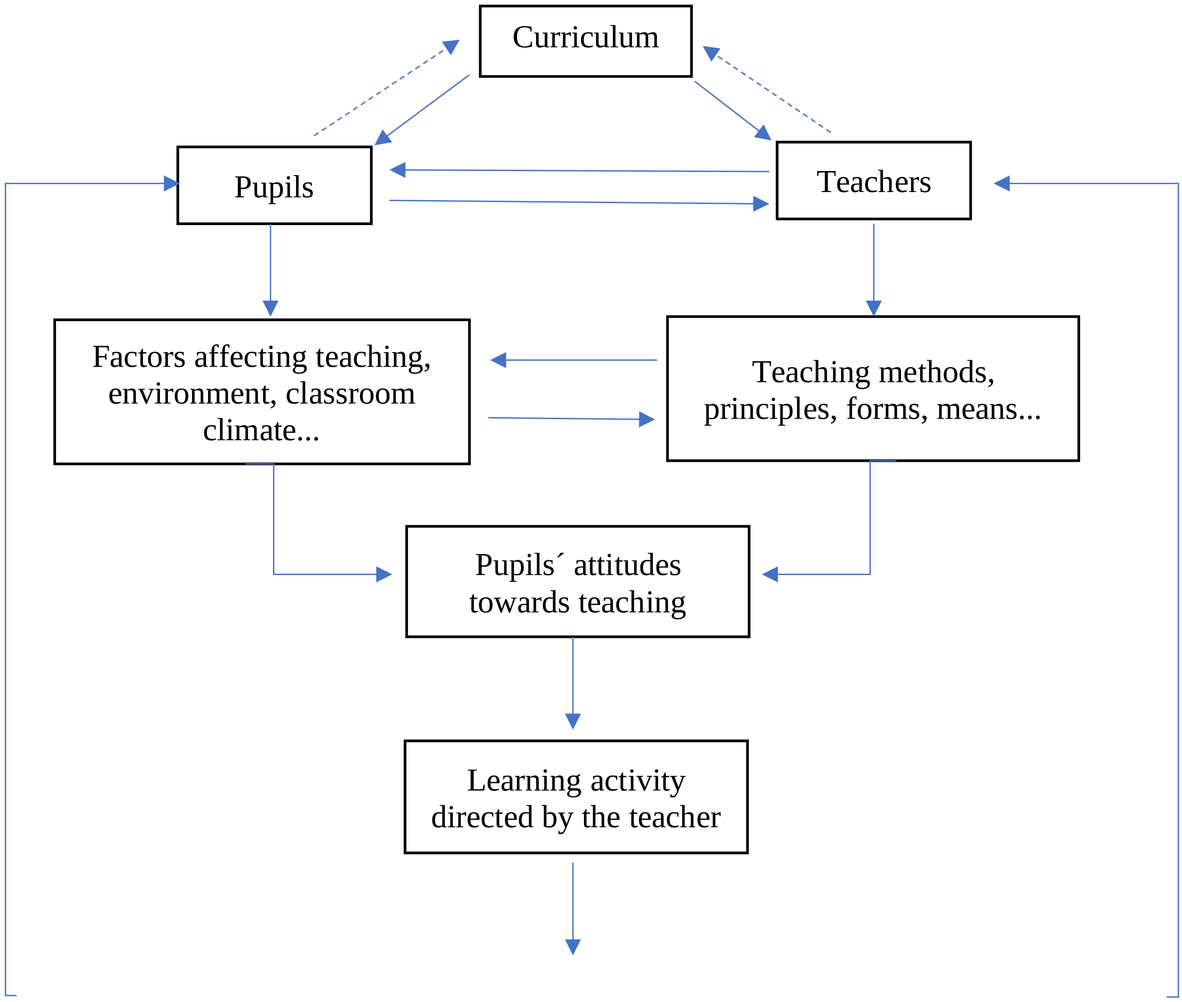

Figure 1: Petlák (2016, p. 67).

People who do not know the work of a teacher in detail think that a teacher only teaches, and results come easily. It is not true. A teacher has a few other tasks that may not be directly related to teaching. A certain group of pupils is created in each class. The difficulty of a teacher's work also lies in the connection between education and upbringing. Pupils are diverse, they come from different families with different moral values, they have different perceptions of their duties, they are brought up differently, they come from better or worse financial backgrounds and their ability to absorb new knowledge also varies.

The teacher must create an environment in the classroom that allows everyone to feel like a valued member of the collective. Each pupil has intrinsic value and can contribute to the group through their attitude and actions, becoming an asset to the entire class. In getting to know their pupils, the teacher recognises both their potential benefits to the collective and the possible challenges they may present. Risks mean the pupil's ability to guide his classmates in the wrong direction, which does not benefit the teachers, pupils, and the school. Pupils who are carriers of qualities and positive impulses should be role models for others. When an ideal environment is created in the classroom and the pupils can follow certain rules of social values regarding work in the classroom, the teacher has a ready space for imparting as much knowledge as possible.

5 The Personality of the Class Teacher

The classroom teacher has a crucial role, as they not only carry out the core teaching responsibilities (educating pupils) but also fulfil several other important duties. They serve as the communication hub between pupils, other teachers, school management, and parents. The teacher collects and processes information from various sources, assessing its accuracy, objectivity, and relevance. When necessary, they respond and act in the best interests of all parties, striving to address issues in a timely, flexible, and efficient manner. The class teacher also encounters a situation when the parent-child relationship does not work perfectly and must also be partially a psychologist. Not all parents devote enough time to their children, mainly for work reasons, and the class teacher, as well as other teachers, should help and eliminate these deficiencies.

For the teacher to be able to perform their work perfectly and to keep up with new requirements, rules, and standards of teaching, he must also be educated. The teacher learns throughout his working life, in addition through various trainings, courses, but also thanks to experience from various situations during classes, school events, etc. The teacher draws new knowledge from various possible sources, updates their knowledge and thus is always ready to fulfil their work duties. It does not only draw information that is part of the curriculum. It also needs a lot of other no less important information, for example for working with pedagogical documentation.

Turek (2014, p. 187-188) describes pedagogical documents as materials that determine the activities of schools, teachers, pupils, and school management. These can be school laws, lesson plans and curricula, school regulations, class books and reports, but also various protocols and many others.

Depending on the specific types of pedagogical documents, the teacher must work with them, create, or study them and observe their content. The teacher must have an overview of what he must administer, how he should proceed, what he must respect so that his work meets the required level.

Turek (2014, p. 194-195) outlined a certain issue about the teacher's work with the curriculum and preparation for teaching. The preparation for teaching itself is often limited only to the description of the subject matter to be covered during the lesson. Many teachers understand their work and duties in such a way that their task is to explain or practice the subject matter based on the curriculum and then test the pupils to see if they have mastered the subject matter to the required extent. It should be emphasised that the role of the teacher is more than just explaining the subject matter and testing. Pupils must understand, remember, and apply the material, and this must also be the goal of the teacher. It is not enough to simply teach pupils; that alone is insufficient. They need to be guided and nurtured in their learning. In addition, it is crucial to simultaneously develop their cognitive and creative abilities, while also shaping their attitudes, value systems, and their ability to communicate and cooperate effectively. To manage all of this, the teacher must have a clear understanding of the curriculum's scope, knowing exactly what content the pupils should master and understand in each lesson. Choosing the right teaching methods, teaching aids and didactic techniques is also important. In all of this, the fact that there are weaker and better pupils, pupils with different styles and pace of learning must also be considered in the class.

Of course, every teacher is unique. Each has their own approach to the structure of their lessons, the scope of the subject matter, and the allocation of time for activities such as revision, testing, covering content, and discussion. These approaches are shaped not only by what they learned during their professional training but also by their experience. Experience is a key factor in shaping a teacher’s attitude towards the teaching process, and it is through experience that a teacher becomes more effective and skilled. A lot also depends on the technical security of the school, because someone would like to improve the quality of teaching with the help of modern technology, when the technical possibilities of the school are limited. The structure of pupils (their diligence, creativity, manual dexterity, willingness to cooperate, social and family background, mental and psychological background...) can influence the teacher's decisions about the course of the lesson, the scope of the subject matter, the approach to the class and to individuals. Sometimes the teacher has a rather difficult task of choosing such a procedure for taking over and repeating the subject matter or testing pupils so that every pupil understands the essence and goal of this procedure, so that they can accept the teacher himself and so that no pupil feels disadvantaged.

6 Principles of Teaching

When we talk about the effectiveness of teaching, we must not forget about teaching principles. As Petlák (2016, p. 112-119) stated, it is not about the rules, nor about the so-called standards, as teaching is very complex, and the teacher must also adapt to the pupils. Therefore, we can understand teaching principles as "the most general or basic requirements that, in accordance with the goals of the educational process and its basic laws, determine its character".

These policies are as follows:

a. The principle of awareness and activity – pupils should approach the learning activity consciously and be active in the lessons to acquire the necessary knowledge and skills through their own active activity.
b. The principle of visuality – the pupil should acquire new knowledge and skills with the help of a certain sensory perception of objects.
c. The principle of adequacy – the curriculum, its content, scope, but also the methods, forms and means of the teaching process should be appropriate to the pupils' abilities.
d. The principle of durability – pupils should not only listen to the teacher as he explains the subject matter, because it is important to understand and remember the subject matter itself, so that the new knowledge is retained in the memory and thus usable in the activity.
e. The principle of systematicity – the didactic system of the curriculum should be logically organized, also regarding the age characteristics of the pupils, so that the pupils learn it under the guidance of the teacher.

Following these principles creates a solid foundation for effective teaching, which is a priority for every school and every teacher.

7 Conclusion

The world is always changing. New technologies are coming, science and technology are developing, people have new priorities, and social values are partly changing. Both schools and teachers must keep up with these changes to prepare pupils as best as possible for the changing world. Educating people must be a priority for the state, because an educated person is the bearer not only of knowledge, but also of precious human values. Therefore, it is very important that teachers have the best possible conditions for their profession, because their work is irreplaceable.

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Formal Education at Secondary Vocational Schools

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Abstract

The article explores the relationship between theory and practice within the school environment. To a certain extent, schools can create an environment that resembles the real working conditions in companies within a given subject area. For instance, this could apply to a vocational subject focused on production and business. Such a subject can function effectively if the necessary quality conditions for running a business are established. It is essential to ensure access to appropriate work equipment, techniques, and technology, as well as qualified staff and suitable working conditions. Each work environment, job position, and function are influenced by specific factors, which should be incorporated into the curriculum of this subject. The article examines the practical implementation of a classroom model designed to integrate theoretical knowledge with production and business activities. The study employs a questionnaire-based approach to assess students' satisfaction with this teaching method, particularly in the context of dual education. The outcomes of this process are then evaluated.

Keywords: Production, Technology, Enterprise, Business, Economy, Education

1 Introduction

Schools and other educational institutions are constantly educating new graduates, who are trying to gain an enforce in their professional and personal lives with the help of the acquired knowledge. Some former students become successful employees in various companies or in

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the state sector, others start businesses and employ other graduates. Businesses and entrepreneurs are essential components of the national economy. They produce goods, provide services, and generate employment. While entrepreneurship can be an attractive prospect for young people, they must also anticipate various challenges. The desired outcomes do not always materialise as expected. However, it is important to maintain a positive mindset and not lose optimism.

Labor markets and employment rates in Slovakia and abroad are more than ever affected by rapid technological progress, such as digital and automated technologies (Huľová, Tokoš, Bolčová, Hrmo, Krištofiaková, 2024).

Creativity, flexibility, communication, imagination, and many other qualities are prerequisites for successful business. Various internal and external factors can play a significant role in influencing success in business life. To secure the necessary financial resources, to create a suitable technical and personnel background, to assert oneself in the competitive struggle with other companies and to adapt to various rules, laws, and economic situations. Currently, due to changes in Slovak education, the concept of competencies—particularly key competencies—is increasingly discussed. Key competencies are often regarded as a new phenomenon in education. The term originated in the 1970s in the field of economics, where it referred to a set of specific requirements for job seekers. It was later adopted in the field of education in the late 1990s, serving as a bridge between the demands of employers in the labour market and the profile of graduates. The term competence is used both in professional and common language; and ability, skill, capability, effectiveness, capacity, desired quality, and others are used as synonyms for the group of terms. A person who has the abilities and skills, motivation, knowledge, etc. to carry out tasks well in a particular field is considered competent. Competence is usually applied to individuals, social groups, and institutions in case they successfully fulfil requirements and achieve goals set by their environment. The theory of key competences has not yet been completely formulated and neither does a comprehensive and widely accepted definition exist.

As Hrmo at al. (2020) state in their publication *Key Competences*:

> "Competence is the behaviour (an activity or a set of activities) that characterises excellent performance in a specific field. Key competences are the core competences within a broader set of competences. They enable individuals to address a wide range of mostly unforeseen problems, allowing them to adapt to rapid changes in the workplace, as well as in their personal and social lives."

According to Hrmo-Turek (2003): "Key competences are a set of interiorised, interconnected group of acquired knowledge, skills, abilities, attitudes and valuing approaches that are important for the qualitative personal development of the individual, their active participation in society, application in employment and lifelong learning."

Another definition states (Kissné Zsámboki, 2021):

> "Having competence means possessing a comprehensive set of personal attributes that enables an individual to successfully address challenges and situations in life. It allows one to orient oneself effectively, take appropriate actions, and adopt a constructive attitude. Key competences should enable individuals to continually update the skills and knowledge applicable in daily life. For a person in training not all educational activities (cognitive, training, and educative) need to be beneficial, but especially those, which are useful in standard practice, provide quality education and correspond with company requirements in the labour market. Not only the attended educative process or certificate of the attended educative process are crucial, but also the learning outcomes."

2 Vocational Secondary Schools in Slovakia

The school can be generally defined as "an institution that specialises in training as opposed to a company that offers training in conjunction with the production of goods. Some schools, such as those for barbers, specialise in one skill, while others, such as universities, they offer a wide and diverse set. Schools and companies act as substitute sources for specific skills" (Porubčanová, 2018). A secondary vocational school that offers opportunities for enhancing the employability of its graduates refers to a school where students can obtain upper secondary education, culminating in the matriculation exam. When evaluating a specific secondary vocational school, it is important to consider that its competencies are, to some extent, constrained by applicable legislation. With the education reform in 2008, state educational programmes (hereafter referred to as ŠVP) were introduced. These programmes define and delineate the content of education and training in schools, ensuring alignment with internationally recognised standards.

ŠVP defines:

a. the generally binding goal, content, scope and conditions of education at ISCED for the given groups of study fields,
b. the target quality of the student's personality, which the student has after completing education and training to reach,
c. rules for creating school educational programs, evaluation of results education,
d. binding basis for determining financial resources." (ŠVP)

The Vocational Education and Training Act of 2009 established the rights and obligations of all participants and created space for the involvement of employers and employers' unions as well as private investment capital in the vocational education and training system. The reform of secondary vocational education was supposed to enable a more flexible profiling of graduates of study fields according to the conditions of the school. At the same time, the fields of study should respond to the needs of the regional labour market and the individual abilities and interests of the pupils. All state secondary schools in the Slovak Republic are obliged to comply with the Education and Training Act (245/2008 Coll.). According to this law, the goal of upbringing and education is to "enable a child or pupil to get an education (according to this law), to acquire competences, especially in the field of communication skills, oral skills and written skills, use of information and communication technologies, communication in the state language, mother tongue language and a foreign language, mathematical literacy, and competence in the field of technical natural sciences and technologies, for lifelong learning, social competence and civic competence, entrepreneurial skills and cultural competence, command of the English language and at least one. For each group of study fields with experience, with through professional training and extension studies, there is one ŠVP, another foreign language and being able to use them, learn to correctly identify and analyse problems and propose their solutions and be able to solve them, develop manual skills, creative, artistic psychomotor skills, current knowledge and work with them on practical exercises in the areas related to further education or current requirements on the labour market, learn to develop and cultivate your personality and lifelong learning, work in a group and take responsibility. Thus, we see that the law responds to new trends in technology and the economy and focuses on the development of a wide range of knowledge, skills and abilities. On the one hand, we will be interested in how the secondary vocational school we have chosen helps to fulfil work with current knowledge, which is required by the labour market, and on the other hand, which area of competence employers value the most. Even though, at first glance, pedagogues have relatively high autonomy because they work in the classroom without external control, "in educational situations they are required to assess the child's needs themselves, react flexibly and carry out effective interventions. On the other hand, in educational situations, they are still significantly limited by the uniformity of educational objectives and contents, the overcrowding of which leads to the uniformity of forms and methods of education" (Marks-Lajčin, 2017).

3 Key Competences of a Secondary Vocational School Graduate

According to the ŠVP, a graduate of the Secondary Vocational School has the following key competencies to develop during their studies at this school: Competence for lifelong learning – with this competence, the graduate realises the need for autonomous learning as a means of self-realisation and personal development, is able to reflect on the process of own learning when acquiring and processing new knowledge, and applies various learning strategies. The graduate can think critically and evaluate information and use it practically and subsequently knows how to accept feedback (Barnová et all, 2019). The graduate can become familiar with motivational programmes that are aimed at solving problems. The graduate realises the need for autonomous learning as a means of self-realisation and personal development.

Social communication competences – with this competence, a graduate can use all available forms of communication when processing and expressing information of several types, including adequate oral and written expression. The graduate demonstrates proficiency in self-presentation and can communicate the results of their work to the public using professional language. They understand the significance of effective communication and apply appropriate forms of communication skills that serve as the foundation for successful collaboration. This is based on mutual respect for rights and responsibilities, as well as a commitment to personal accountability.

Competences to apply mathematical thinking and cognition in the field of science and technology – the graduate uses both mathematical thinking to solve practical problems in everyday situations and mathematical models of logical and spatial thinking. He knows how to use the basics of natural literacy, which will enable him to make scientifically based judgments, while he knows how to use the acquired operational knowledge to successfully solve problems.

Competences in the field of information and communication technologies – the graduate effectively uses information and communication technologies in his education, creative activities, project teaching, expressing his thoughts and attitudes when solving real-life problems. The graduate realises the importance of recognising virtual and real life and understands the opportunities and possible risks associated with the use of the Internet and information and communication technologies. Furthermore, the graduate knows how to think algorithmically and controls the operation of peripheral devices necessary for the operation of the used program. The graduate can assess the credibility of information sources, proceed critically to obtain information and then record, sort and store this information in such a way that he can use it at work or in his personal life.

Competence to solve problems – the graduate applies appropriate methods based on analytical-critical and creative thinking when solving problems. The graduate formulates arguments and evidence to defend their results and knows the pros and cons of individual solutions while considering their risk levels. In addition, the graduate can resolve conflicts constructively and cooperatively and can clarify the most serious features of problems in the form of systematic knowledge including the use of various generally applicable rules for this purpose. The graduate can evaluate the meaning of various information, independently collect information, sort it and use only those that are most important for clarifying the problem. The graduate can take creative risks, adequately criticise, take a clear approach towards solving problems, make quick decisions, be consistent, inspire others when seeking for ideas, initiatives and creating possibilities.

Civic competences – the graduate is aware of basic humanist values, the meaning of the national cultural heritage, applies and protects the principles of democracy. The graduate understands their personal interests in connection within the interests of the wider group. The graduate is aware of their rights in the context of a responsible approach to their duties, contributes to the fulfilment of the rights of others and can understand the systemic nature of the world. The graduate recognises that decisions made, and actions taken by individuals or groups will have an impact on the global present and future (Marks-Lajčin, 2016). The graduate is knowledgeable about issues related to uneven economic development, as well as ethnic, religious, and racial conflicts, including terrorism, and can propose ways to address these challenges. They understand the concepts of justice, human rights, and responsibility and can apply them within a global context. The graduate adheres to the law, respects the rights and individuality of others, acknowledges cultural specificities, and actively speaks out against intolerance, xenophobia, and discrimination. Additionally, they demonstrate an active interest in political and social events both in Slovakia and globally.

Social and personal competences – the graduate reflects his own identity, builds his own autonomy and independence as a member of the whole. Based on self-reflection, they set their goals and priorities in accordance with their real abilities, interests and needs. Significantly, the graduate participates in setting corresponding short-term goals aimed at improving own performance and knows how to verify and interpret information and subsequently establish hypotheses while creating a value system (Porubčanová, 2018). The graduate can fulfil a task plan aimed at the given goals and try to improve them using self-control, self-regulation, self-evaluation and own decision-making. At the same time, they can verify the acquired knowledge, critically assess the opinions, attitudes, and behaviour of others. Additionally, the graduate has a responsible attitude towards own health and takes care of their physical and mental development and is aware of the consequences of an unhealthy lifestyle.

Work competences – the graduate can set goals regarding their professional interests, critically evaluates their results and actively approaches the realisation of these goals. The graduate can accept and manage innovative changes, understands the principles of business and considers their assumptions when planning and applying them. The graduate can obtain and use information about educational and employment opportunities, understands and evaluates their participation in the educational process, including its outcome, which ensures the citizen's right to free movement to live, study and work in the conditions of an open market. The graduate knows how to assess the professional offer on the Slovak and European labour market and flexibly respond to it through further education. The graduate knows how to self-present and acts appropriately during a job interview, furthermore, can seek and assess business opportunities in accordance with the reality of the market environment, own assumptions, and other possibilities (Kissné Zsámboki, 2021).

Competencies aimed at initiative and entrepreneurship – the graduate can innovate the usual procedures for solving tasks, plan and manage new projects with the intention of achieving goals, not only in work, but also in everyday life. The graduate knows how to navigate various statistical data, knows how to use them for own business and both recognises and develops the qualities of a managerial employee with an aspect of communication skills, assertiveness, creativity and resistance to stress. The graduate uses the principles of constructive criticism while being able to criticise appropriately but also being tolerant facing criticism from others. In addition, the graduate knows the principles of safety and health protection at work (Ugrai, 2020).

Competencies related to perceiving and understanding culture, as well as expressing oneself through cultural tools, enable the graduate to demonstrate a higher level of artistic literacy through the expressive means of visual and musical arts. The graduate recognises the importance of art and cultural communication both in personal life and within the broader society. Furthermore, the graduate is familiar with the rules of social behaviour and consistently behaves in a cultured manner, appropriate to the context of the situation. He or she is tolerant and empathetic towards expressions of other cultures.

4 Conclusion

We know how important motivation is in the teaching process, how it can positively influence the student's view of the subject matter, how it can increase his interest in new knowledge and thereby increase his knowledge, skills and, in the future, the ability to achieve success on the labour market. On the other hand, we also know that there is no need to exaggerate the motivation, because it can lose its charm, and we easily fall into the pit of over motivation. For each lesson, you need to prepare a few activating spells that will work with the greatest certainty. They must be tested, because not every student, every class perceives motivational impulses in the same way. Each lesson, each topic and each group of students needs an individual approach when examining and choosing appropriate methods and means of motivation. We must consider many things that are an important basis for student activation. These are human qualities, but also the school's technical and personnel capabilities. We, teachers, must also keep up with the developing world and gain new experiences. It is also necessary to discuss with colleagues what experiences, feelings and results we have after applying a wide range of motivational methods and aids.
Key competences as a new phenomenon in education represent a mutual connection between upbringing in the family, upbringing and education in the school environment and

social influence on human development. Nowadays, the process of general competence development is perceived as a necessary process for applying to the labour market. All member states of the European Union deal with key aspects at least on a political level. Some countries of the European Union have enabled their citizens to participate in an open project for the development of lifelong learning.

Knowledge is only the basis of preferred core competencies of the individual and may not be sufficiently beneficial for individuals, even if they were associated with other components of competences. Acquiring key competencies is a life-long process. For these competencies to be developed qualitatively, we need to achieve a quality education system.

In applying for an e-learning course the process of initial motivation, the evaluation and classification of individual modules, and the process of exposure of the new curriculum are bound to be dealt with.

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To the Roots: Engineering Pedagogy

The Impact of Experimental Problem-Solving in Technical Education on Students' Knowledge Acquisition

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Abstract

Science and technical subjects are often considered to be difficult and not interesting for students. Teachers try to make the content of education more appealing by incorporating methods that engage students in independent work and problem-solving. One of the effective methods is experimentation. Currently, in addition to activating students during lessons, there is also an emphasis on their ability to evaluate the level of knowledge and skills they have acquired. In our research, experiments in the subject of technology were realised with a sample of 6th-grade primary school students. The goal of the research was to determine how students themselves evaluate the level of knowledge acquisition. The tool for formative assessment was a self-assessment record sheet that we designed. The article presents the research results that were obtained through statistical evaluation of students' responses.

Keywords: Experiment, Education, Formative Assessment

1 Introduction

Students' interest in science subjects at the primary school level in Slovakia has been declining (Fančovičová & Kubiatko, 2015). One contributing factor to this decline is the shift in educational priorities after 1989, when increased emphasis was placed on language studies, resulting in the marginalisation of science education. Consequently, the number of hours allocated to science subjects was reduced, leading to stagnation in practical and experimental instruction (Held et al., 2011, p. 10).

Specialised classrooms for practical subjects, such as technology classes in primary schools, were also eliminated. Research has shown that students' interest in the subject of technology is influenced by its practical focus, work with tools and equipment, and the workshop

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environment (Lukáčová, Bánesz & Štetková, 2024, p. 14). In studies conducted to uncover possible reasons for disinterest, students most frequently cited the difficulty of science subjects as a reason (Fančovičová & Kubiatko, 2015). Turning student disinterest into interest is possible by making science education more appealing and incorporating new teaching methods and approaches. Traditional lecture-based teaching does not motivate students, as it teaches 'how it works' without engaging them in 'why it works.'

Another factor affecting students' interest in science subjects is grading. Currently, students in science subjects are graded on a scale from 1 to 5. Summative grading is inadequate and insufficient, as it does not evaluate the students' actual knowledge or allow for assessment of their capabilities, acquired skills, opinions, or personal development. Summative grading with traditional scales once served as a decision-making mechanism reflecting student performance solely for parents (Szarka, 2017).

According to Kivunja (2015, p. 2119), the purpose of summative assessment is to provide "the primary means of communicating the nature and level of student achievements at different stages of education and at the end of study." Teachers often use tests for summative assessment to verify student knowledge, which encourages memorization and superficial learning (Black & Wiliam, 2010). In summative grading, students passively receive their grades, and there is no evidence that grades influence improvement in learning outcomes.

A different situation arises with formative assessment, where the student becomes an active evaluator of their own performance. Based on research results, Black & Wiliam (2010, p. 81) assert that "formative assessment can improve student outcomes." They view the classroom as a black box, into which students, teachers, rules, management demands, parents, tests, etc., enter from the outside. The output from this black box should be more aware and competent students, better test results, and satisfied teachers and parents. They identify the issue that if better output from the black box is expected, the onus for improvement is placed on the teacher, who must change the inner workings of the box. This insight led Black and Wiliam (2010, p. 82) to investigate a single aspect of teaching—formative assessment (FA). They argue that FA lies at the heart of effective teaching.

In FA, students are not to compare themselves to each other, so that the primary purpose of assessment is not competition but personal improvement. "Feedback for each student should focus on the specific quality of their work with guidance on what they can do to improve and avoid comparison with other students. This means students should be trained in self-assessment so they can understand the main goals of their learning and what they must do to achieve them" (Black & Wiliam, 2010, pp. 84, 85).

Formative assessment can also be used as a tool to evaluate the impact of incorporating students' ideas into the teaching of science subjects to improve student learning outcomes (Gerard, Spitulnik & Linn, 2010).

2 Experimenting in Science Education

In science education, teachers often use demonstrations and experiments. The choice depends on the educational intent. "A demonstration is used to show a phenomenon, law, etc. The purpose of a demonstration is to convey factual knowledge that prevents superficial understanding in students. Experiments, on the other hand, are specially designed situations for testing hypotheses. An essential part of an experiment is identifying variables—factors that can generally influence the experiment's results. Hypothesis formulation is the most significant factor distinguishing an experiment from other scientific methods" (Held et al., 2011, p. 53).

Experiments enable science teachers in subjects such as mathematics, physics, chemistry, biology, geography, and technology to make complex phenomena more accessible to students, particularly those that are difficult to grasp through theory alone. For instance, Beňuška (2024) effectively uses experiments in teaching high school physics to explain the causes of tornado formation. "Every experiment must have a clear purpose and objective. For meaningful experimentation, preconceptions (students' intuition based on personal experience) should be used as an appropriate starting point. Knowledge and its application must be implemented together" (Held et al., 2011, p. 10).

An essential condition for effective teaching through experiments is students' willingness and interest in solving problems. Experimentation in teaching contributes to integrating students' knowledge, which they gain through formulating ideas, observing, and reasoning (Gerard, Spitulnik & Linn, 2010). This means that students must possess scientific skills associated with scientific thinking. "These skills are essential for meaningful learning, which requires connecting new experiences with previous ones and integrating new concepts into a broader framework of related phenomena" (Held et al., 2011, p. 24).

For beginning teachers, incorporating experiments into education can be challenging. However, Duberman (1968) regarded the integration of experiments into education as a significant achievement, despite obstacles and a lack of experience. In current school practice, real experiments—classroom demonstrations—are often replaced by e-experiments.

In Slovakia, experiments were used as an educational approach in primary science education within the project "Let's Roll Up Our Sleeves" (Held et al., 2011, p. 78). This project was implemented as part of Slovak and French collaboration across multiple Slovak primary schools (NIVAM, 2024). The importance of experiments in developing students' thinking and reasoning is also evident from their inclusion in tasks in the European Physics Olympiad (EuPhO). In 2024, participants tackled three theoretical and one experimental problem, where solving the experimental task could earn them double the points of a correctly solved theoretical task (Mucha, 2024).

2.1 Worksheets as a component of experiments

In educational experiments, observed phenomena and collected data are recorded in writing. Throughout primary education, students should be guided in systematically and purposefully organising information obtained through empirical observation. Based on these observational records, students construct tables and graphs, describe relationships between variables, and draw conclusions and generalisations. According to the type of research-oriented concept, three types of written records can be used in education: worksheets, research journals, and research protocols (Held et al., 2011, p. 121).

Worksheets provide students with a systematic framework for documenting collected data, observations, and analytical processes (Syamsidar et al., 2021). They enable students to structure their thoughts and serve as an effective tool for enhancing learning (Toh et al., 2012). A key advantage of worksheets is that they facilitate understanding in experimental contexts (Amin et al., 2019).

A new trend in education is the development of interactive worksheets for experiments that can be adapted to current societal needs (Kotsis, 2024). ChatGPT is used in their creation. However, a barrier to their effective use in education is the insufficient preparedness of teachers in this area. Teachers require training to effectively use modern technologies (such as ChatGPT) to enhance students' knowledge (Kotsis, 2024).

The benefits that worksheets provide to students in learning motivated us to create experimental worksheets for primary school. As part of a study focused on the formative assessment of 6th-grade students in the subject of technology, we developed a workbook with example tasks for exploring the properties of technical materials. In this workbook, we designed 17 experiments focused on understanding the physical, mechanical, chemical, and technological properties of wood, metals, and plastics. Each experiment includes a worksheet for recording observed phenomena and findings. The worksheets are structured to guide students in gradually recording information from each step of the investigation.

Each worksheet includes a self-assessment record sheet, which serves as a valuable tool for formative assessment. In this self-assessment sheet, students were asked to express their satisfaction with their performance by choosing from three options: 'I am very satisfied,' 'I am satisfied,' and 'I need to improve.' They marked their choice with a cross on the self-assessment sheet. The content of the text in the record sheet varied according to the type of experiment.

3 Research Methodology

In our research, we examined the impact of experiments on students' self-assessment. The main goal of the study was to determine the level of knowledge and understanding in the cognitive domain through the implementation of experiments in the subject of technology within lower secondary education.

The primary tool for formative assessment in our study was self-assessment record sheets, which were included in the worksheets. The research subjects were 6th-grade students from fully organised primary schools. A prerequisite for a school's inclusion in the study was the

professional qualification of the teacher instructing the subject. Eighteen schools from various regions of Slovakia participated, with the research conducted from February to June 2024.
The target population of our research comprised all 6th-grade primary school students. We implemented a purposive representative sampling method, selecting students based on specific criteria, such as fully organised schools and the qualification of technology teachers. In total, 573 students of 6^{th}-grade participated in our study. Since we opted for a quantitatively oriented research approach, it was essential to define the research variables. In our case, the independent variable was the experiment, and the dependent variable was the level of knowledge acquisition by the students.
The research objective guided the formation of the primary hypothesis for our pedagogical study, which we tested throughout the research process. We formulated our main hypothesis as follows:
H: Conducting the proposed experiments will statistically significantly affect students' level of knowledge acquisition.
To evaluate the research results, we applied methods of mathematical statistics. For the statistical verification of the main hypothesis H, we used the χ^2 - goodness-of-fit test. This test is appropriate for statistically determining the significance of differences and testing the hypothesis regarding the dispersion of a normal distribution (Markechová, Tirpáková & Stehlíková, 2011).
In a χ^2- goodness-of-fit test, it is necessary to formulate both null and alternative hypotheses. The null hypothesis assumes that there is no relationship (association, difference, etc.) between the observed variables. In contrast, the alternative hypothesis posits that there is a relationship between the observed variables.

In our research, we established a working hypothesis, H1:
H1: Conducting the proposed experiments will statistically significantly affect the extent of students' knowledge acquisition.

We assessed the extent of knowledge acquisition based on students' formative self-assessment. The working hypothesis was tested using the χ^2 goodness-of-fit test at a significance level of $\alpha = 0.05$ with degrees of freedom $k = 2$. Our aim was to determine whether the observed frequencies (empirical) statistically differed from the expected frequencies (theoretical) that correspond to hypothesis H1. We evaluated knowledge acquisition based on students' responses about their ability to explain the observed phenomena.

To verify hypothesis H1, we formulated the following statistical hypotheses:
Null Hypothesis (H10): The frequencies of formative assessment scores regarding students' ability to explain observed phenomena are equal.
Alternative Hypothesis (H1A): The frequencies of formative assessment scores regarding students' ability to explain observed phenomena are different.

4 Evaluation of Self-Assessment Sheets and Interpretation of Results

To process the research results, we used the online statistical software VassarStats. By entering the values obtained from the evaluation of the self-assessment sheets into the statistical software, we obtained the values shown in Table 1. In the table, the students' responses are organized in the Category section as follows:
A – I am very satisfied,
B – I am satisfied,
C – I need to improve.

Cate-gory	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	330	191	0.33333333	+72.77%	+10.06
B	216	191	0.33333333	+13.09%	+1.81
C	27	191	0.33333333	-85.86%	-11.87
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

Reset Calculate

[Note that for df=1, the calculated value of chi-square is corrected for continuity.]	[For df=1, this is the uncorrected value of chi-square.]
chi-square = 245.25	
df = 2	[P is non-directional]
P = <.0001	

Table 1: Calculation of the χ^2 test criterion for the ability to justify observed phenomena.

As shown in Table 1, the critical value of the χ^2 test criterion $\chi^2_{0,05}(2)$= 245.25. Since the calculated value, 245.25, is greater than 5.991, we reject the null hypothesis H0. The table also presents the p-value (P = < .0001), which is commonly used in hypothesis testing. This p-value is less than the established significance level of α = 0.05, meaning we reject the null hypothesis and conclude that the frequency distribution of formative assessment in terms of students' ability to justify observed phenomena is significantly different.
Based on these findings, we assert that hypothesis H1 is valid, meaning that conducting the proposed experiments statistically significantly influenced the level of knowledge acquisition by students, as confirmed by their responses in the self-assessment record sheets.
For clarity, we evaluated the students' responses in the self-assessment sheets using descriptive statistics, as shown in Table 2.

	level of self-assessment	Absolute frequency	Relative frequency (%)
I know the reason why	very good	330	58
	good	216	37
	I need to improve	27	5
	TOTAL	573	100

Table 2: Evaluation of Self-Assessment Records in the Area of Students' Knowledge Acquisition.

The percentage analysis of student responses in the self-assessment records revealed that 58% rated their knowledge as 'very good.' The 'good' option was selected by 37%. It is encouraging that only 7% believe their knowledge is insufficient and feel they need to improve.

5 Conclusion

Formative assessment is not commonly practiced in Slovakia. In science subjects, including technology, summative assessment remains the preferred approach. Our research aimed to explore how students assess the level of knowledge they have acquired through conducting experiments and completing worksheets used to document observed phenomena. Based on the results from analysing the studied areas, we found that engaging in the designed experiments significantly impacts students' knowledge acquisition. Over half of the students rated their knowledge as very good, while 37% rated it as good. To generalise these findings, future research could compare data from self-assessment sheets with the results from a knowledge test focused on material properties.

Our study showed that students had no difficulty self-assessing their knowledge. They approached the assessment responsibly and aimed for an objective evaluation of what they learned through experiments. Some students who felt they needed improvement added comments to their self-assessment sheets, explaining why they believed their knowledge was insufficient. Examples include: "I can't explain it, but I really enjoyed the experiment," "I copied the answers from a friend," "It was great, but I don't understand why it happened," "I couldn't explain it without help from a friend," and "The teacher had to help me."

These student comments reflect a positive perception of the experiments, which we consider a significant factor in building a connection to science subjects.

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Application of Automatic Evaluation Systems for Flipped Classroom

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Abstract

Automatic evaluation systems play a significant role in the methodology of flipped classroom, as they provide the opportunity for continuous, immediate feedback to students, thus increasing learning efficiency. In this article, we present how these systems can be used in the environment of flipped classroom, with particular attention to the teaching of programming and other technological fields. Automated assessment tools, such as code review and testing platforms, allow students to learn at their own pace while allowing classroom time to be spent on interactive activities. The study explores the benefits and challenges of the systems and their impact on student performance and motivation. The results show that automatic assessment systems can increase student engagement, improve learning outcomes and promote the effectiveness of flipped classroom.

Keywords: Automatic Evaluation Systems, Flipped Classroom, Teaching Methods, Educational Technologies, Innovation

1 Introduction

The development of automated evaluation systems is one of the fastest changing areas of educational technology, especially in programming and technology education. The first generation of systems started to spread in the 1960s and 1970s and focused mainly on detecting syntactic errors and simple code validation. Such systems provided limited feedback, merely indicating when there was an obvious error in syntax or logical structure.
Since the 1980s, however, evaluation systems have evolved to include semantic analysis of programs, i.e. the logical correctness of programs as a function of their inputs. At the same

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time, 'online judge' systems for programming competitions appeared, which automatically evaluated solutions based on predefined test cases.

From the 2000s onwards, the systems also considered the runtime and memory usage of programs, i.e. their efficiency, which became particularly important for larger data processing systems and programming competitions. Newer platforms also compared algorithms with different efficiencies, highlighting solutions that were correct but less efficient – so students could now aim for optimised solutions.

The emergence of systems that integrate formative feedback has added a new dimension to evaluation systems, providing not only summative but also developmental feedback. These tools, such as code editors that provide syntactic highlighting and auto-completion, visualisation of the program's operation and a partial scoring system, support learners in correcting errors and improving solutions (Pacheco-Venegas et al., 2015).

In recent years, systems have supported multiple programming languages and provide the possibility to manage more complex projects where the code consists of multiple files and modules. Cloud computing allows students to access them from anywhere, which is a significant facilitator for distance learning and continuous practice (de la Peña et al., 2012).

Recent developments integrate artificial intelligence and machine learning tools, and systems now provide personalised feedback, recognising typical errors and learning paces to provide more targeted support. These systems motivate students with challenges and practical tasks that support individual progress (Flament et al., 2021).

Modern systems provide teachers with detailed statistical analyses and learning reports, giving them a comprehensive picture of students' progress, failures and strengths. And they provide students with continuous feedback on their performance and areas where further practice is needed, making the learning process more effective and targeted.

The development of automated evaluation systems provides comprehensive support for both students and teachers, enabling personalised, immediate and continuous feedback that motivates students and improves learning effectiveness. These systems are increasingly contributing to the renewal of digital education, particularly in programming and technology training.

The flipped classroom methodology is becoming increasingly widespread in education, as it fundamentally changes the traditional structure of learning and teaching. The methodology involves taking some parts of the learning process outside the classroom, while focusing on collaborative work and interactive, experiential activities in the classroom. Prior acquisition and processing of knowledge takes place at home, where students usually learn the basics through digital resources such as pre-recorded videos, online materials or other learning aids. This approach allows classroom time to be used more efficiently, as students arrive with prior knowledge and can work through the material through more in-depth, practice-oriented exercises, discussions, projects and other interactive activities, guided by the teacher. The flipped classroom methodology is particularly suitable in areas such as programming,

mathematics or other technology subjects where practical application and problem solving are central (Pšenáková et al., 2024).
Another advantage of the method is that it gives students the opportunity to learn the basics at their own pace, so they can spend more time working together on more difficult, complex problems in the classroom. It also supports the development of independent learning skills and students' ownership of their own learning process, which has a positive long-term impact on learning outcomes and motivation. New challenges in this kind of unconventional education should also consider students' rights (Bódi, 2023).
The aim behind the popularity of the flipped classroom methodology is to better adapt the educational process to the individual needs of students, facilitating active participation and in-depth knowledge acquisition. The integration of online learning technologies, automated evaluation systems and interactive learning materials further enhances the effectiveness of the methodology and allows for personalisation of the learning process, while maximising classroom time for collaborative activities and individual feedback (Szabó & Pšenáková, 2017a; Szabó & Pšenáková, 2017b; Pšenáková, 2019).
In this article, we address the following research question: How can automated evaluation systems support flipped classroom methodology in programming and technology education?

2 Theoretical Background and Literature Review

Modern tools for learning computer programming include learning environments and automatic evaluating systems. These learning environments include basic programming environments, example-based interactive environments, visualisation/animation systems and intelligent tutoring systems (Gabaľová et al., 2023; Stoffova et al., 2023; Gabaľová, 2022). However, most of these systems lack evaluation tools that can be useful for formative evaluation of students during practical tasks. Automatic evaluation systems, on the other hand, often focus only on the evaluation of programs (online judges) and usually adapt the evaluation methods of programming competitions. Although these systems are effective in supporting the development of practical skills, the spirit of competition is motivating for students, but they are not suitable for formative assessment. This is due to limited feedback and lack of integration with the content and tools of the learning environment.
Educational environments provide comprehensive and developmental feedback to evaluate the functionality of computer programs. For a given programming task, students are asked to produce a solution, which is checked using the automatic evaluation tool of the learning environment. Summative feedback is provided through the analysis of the program, giving feedback on the correctness of syntax, semantics and efficiency, as well as possible errors, and a grade is assigned to the submitted solutions based on this feedback. In addition, the environment also provides formative feedback through a variety of tools to support students in improving their solutions before the assessment. These tools include a code editor for syntactic highlighting and auto-completion, automatic checking of correct programming

practices, interactive visualisation of programs from source code, a partial scoring system that gives partial points for incomplete solutions, a test module with customisable inputs, multiple file and project submission options, and support for multiple programming languages (Java, Python, JavaScript, C/C++/C#), as well as a manual evaluation module and interactive statistical reports for students and teachers (Restrepo-Calle et al., 2018).

The wider introduction of programming courses in educational institutions poses significant challenges in evaluating the diversity of students. Traditional, manual grading methods are increasingly difficult to maintain due to their demanding nature and the potential for human error and bias. In response, we have developed an automated evaluation system adapted to the complexity of modern programming education, which draws heavily on previous work in developing similar systems (Pietrikova et al., 2015). This system is designed to provide continuous and regular feedback, like the iterative processes in professional software development environments where code is regularly tested and improved. This approach not only supports the incremental development of programming skills but also responds to ongoing changes in industry standards.

The security and privacy of automated systems is key, as they handle sensitive student data and are exposed to potential breaches, including threats from malicious code submissions (Horváth, 2024).

Automated evaluation is a challenging area for the academic community, which plays an important role in reducing the evaluation workload. The authors of this paper present a new feature of the Easy Java Simulations (EJS) tool, the Automatic Evaluation Element (AEE), which provides automatic evaluation for virtual and remote labs created using EJS through the Goodle Grading Management System (GMS) server application. The integration of the two tools allows instructors to create interactive virtual and remote labs and automatically grade student work (Farias et al., 2016).

Automatic evaluation systems are playing an increasingly important role in education by making the evaluation process more efficient and objective, but they also face a few challenges. One of the main advantages of automated systems is that they significantly reduce the workload of teachers. By automating the evaluation process, teachers can save time, which they can then spend on supporting students and personalising their teaching. In addition, the systems offer the possibility to manage large numbers of assignments at once, which is particularly useful for mass online courses (MOOCs) and large class sizes where traditional manual evaluation would be extremely time-consuming (Dadi et al., 2020).

Another advantage of automated systems is that they ensure consistency and objectivity in classification. In contrast to human evaluation, where bias and error can occur, automated evaluation systems follow a consistent set of criteria, making the evaluation objective and reliable. In addition, automated evaluation allows students to receive immediate feedback on their work, which facilitates continuous learning and improvement by allowing them to react quickly to errors and suggestions for improvement. As an added benefit, these systems can also be more cost-effective, as they reduce costs associated with traditional paper-based evaluation, including production and administrative expenses (Pushak et al., 2011).

However, automated evaluation systems face several challenges. One of the biggest obstacles is the management of open-ended evaluations. While these systems perform well for multiple-choice or other objective questions, they are less reliable for assessing essays and open-ended responses. Current systems often use superficial measures such as grammar and coverage that do not always reflect the quality of content, making them unsuitable for objectively evaluating tasks that require deeper thought and reasoning (Ramesh, & Sanampudi, 2022).

The implementation and operation of these systems has additional technical and infrastructural requirements that are not within the reach of all institutions. The need for a significant technical infrastructure and expertise may limit the uptake of the system, especially in educational institutions that do not have the appropriate technical background. In addition, the attitudes of students may also affect the success of the system. Some students may be averse to automatic evaluation, especially if they are not familiar with the technology or are distrustful of the feedback provided by the system (Bello & Abdullah, 2021).

Furthermore, it is challenging to create flexible systems that can evaluate different subjects. Different disciplines – especially those requiring complex problem solving, creativity or critical thinking – expect students to have a wide range of skills that automated evaluation systems are not always able to measure adequately (Maaruf et al., 2023).

The flipped classroom is an innovative blended learning approach that reverses traditional teaching methods: it makes lectures and processing of course material part of out-of-class learning, often through video lessons, while in-class time is devoted to interactive, hands-on activities such as problem solving and group discussions (González-Gómez et al, 2016). This model encourages active participation and student engagement as classroom time focuses on direct practical applications and deeper understanding (Bosch Farré et al., 2024; Schmitt, & Cequea, 2020).

The flipped classroom offers several advantages. For one, it allows for better learning outcomes, as students often perform better compared to traditional teaching methods, having mastered the basics at their own pace. This model allows for personalised learning: students can work through material at their own pace, rewind and re-watch videos, repeating what they have learned as necessary. In addition, the model increases student engagement and motivation by encouraging active participation through interactive classroom activities (Lepkova et al., 2024).

The flipped classroom also helps to develop higher-level thinking skills and practical competences, as students not only passively absorb knowledge, but also apply and deepen it. Consequently, student´s satisfaction tends to be higher in this type of course, as the model is interactive and flexible, better adapted to the needs of the students.

The flipped classroom can be successfully applied in a wide range of educational contexts. For example, in engineering education, where basic language and technical skills are taught, it can

increase student engagement and improve student performance. In health sciences, particularly in community mental health courses, it can enhance learning and increase student engagement. It is also popular in primary education, for example in science courses, where it leads to improved student performance and more positive student feedback. It can also be used in logistics management courses, where task-driven teaching methods help to develop practical skills and teaching effectiveness. In the field of physical education, for example in basketball courses, the use of flipped classrooms through digital platforms improves students' initiative and learning efficiency (Koltsova & Boyko, 2022).
Alongside the benefits, the flipped classroom also has its challenges. One of the main obstacles is teacher preparation time, as creating and maintaining digital content requires significant time and effort. In addition, student preparedness is a key factor, as success depends on their willingness to engage with the material before class. If students are not prepared with the pre-learning material, the interactive part of the classroom will be less effective (Akçayır & Akçayır,2018).

3 Results

Automated evaluation systems can be effectively used in flipped classroom environments, especially in teaching programming and other technology areas, as they allow students to practice and receive feedback at their own pace outside of class time. In this model, students can engage with new material, such as video tutorials and online learning resources, at home or outside the classroom, and then spend classroom time primarily on interactive, problem-solving activities. Automated evaluation systems ensure that students receive feedback on their work in the pre-preparation phase, so that they can focus on deeper questions, in-depth exercises and more complex problems in the classroom.
Automatic evaluation systems are especially useful in teaching programming, as they give students the opportunity to test and improve their code independently. These systems provide immediate feedback on syntax, semantics and code effectiveness, so that students can react quickly to any errors. A partial scoring system built into the evaluation process encourages students to keep trying to improve their partially correct solutions. Code editors are often available in the system to assist coding with auto-completion and syntactic highlighting, and interactive testing facilities are also available to simulate the running of the program.
In other technology areas, such as data processing or web development, automated evaluation systems are also well suited for use in a flipped classroom environment. Students can practise writing code or software tasks at home and then use the classroom time for direct support and solving more complex problems. In addition, automated systems support multiple programming languages (e.g. Python, Java, JavaScript), so teachers can introduce them in different technological contexts.

The benefits of automatic evaluation systems linked to flipped classrooms include instant feedback, which helps students make continuous progress and reduces the evaluation workload for teachers. With automated feedback, students receive feedback more frequently than in a traditional classroom environment, allowing them to continuously improve their skills. By freeing up classroom time, teachers can spend more time explaining more complex topics and providing individual support to students, making the learning process more effective and personalised.

Take an example of the flipped classroom method being used in a programming course in a university introductory Python course. In this course, the teachers use an automated evaluation system to support the flipped classroom model, which gives students the opportunity to practice at home and then use the classroom time to solve more complex problems together.

The course design and use of the automatic evaluation system using the flipped classroom method:

1. Home preparation with video lessons and self-practice: students watch the video lessons and read a short introduction note on basic Python syntax, such as if-else structures and loops, before the class. At the end of the lessons, each student is given a short coding exercise that builds on the newly learned material, such as writing a simple calculator that can perform basic operations on user-specified numbers.

2. The system provides immediate feedback on the correctness of their code, including any syntax or logic errors. The feedback includes whether the code runs correctly, performs the calculations correctly and displays the expected result. If there is an error in the code, the system offers specific suggestions for improvements in syntax, variable handling or error handling.

3. Classroom lesson – Interactive, higher-level activities: at the beginning of the classroom lesson, students will already have a basic working code that they have created at home using the automated evaluation system. The teacher now gives more complex tasks that require, for example, the development of a calculator with several functions (e.g. adding additional operations, angle functions, memory management). During the lesson, students work in teams and the teacher helps them to understand more complex aspects of the program and to solve more difficult coding problems.

4. This means that they arrive at class with a basic understanding of the basics, where classroom time can be spent on solving more difficult programming problems rather than correcting basic mistakes. The interactive part of the class allows the teacher to focus more on the parts where students get stuck the most, which provides a more personalised and deeper learning experience.

Based on the results published in the literature and our own experience, we can conclude that this approach improves learning outcomes, as students receive quick and direct feedback on their work at home and can then focus on higher level, more complex problem-solving tasks in the classroom. The use of an automated evaluation system allows students to progress at their own pace, while teachers can save valuable time that can be spent on interactive tasks that require deeper understanding.

4 Conclusion

Automatic evaluation systems offer a few advantages, such as increasing efficiency, ensuring scalability and maintaining objectivity. However, they also face significant challenges, particularly in evaluating complex, open-ended tasks, and in being widely acceptable and adaptable to different educational contexts.

The flipped classroom methodology offers several benefits, including improved learning outcomes, personalised learning opportunities and increased student engagement. It has been widely and successfully applied in different educational settings, demonstrating its versatility and effectiveness.

Automatic evaluation systems in the flipped classroom environment can make a significant contribution to the effectiveness of the learning process in technological fields. They allow students to practise and develop independently, while teachers can use classroom time for activities that require deeper critical thinking and problem-oriented tasks.

Future research should move in several directions to develop the use of flipped classrooms and automated evaluation systems in technology education. One important area is the development of adaptive automated systems that can consider the individual progress, learning style and needs of students. These adaptive systems could provide personalised feedback based on students' prior knowledge levels to facilitate effective learning, particularly in programming and other technology courses.

Another important research direction is the development of improved error handling and deeper feedback, especially for open-ended tasks. While automatic evaluation systems are well suited for closed questions, they still face challenges in the evaluation of open-ended and complex tasks. Therefore, there is a need to develop algorithms that can assess solutions that require creative and critical thinking, which would contribute to the development of students' thinking skills.

Supporting real-time, collaborative feedback can also be important in the context of the flipped classroom model. The development of collaborative project work and real-time feedback systems could encourage collaboration and increase student engagement in technology training. In addition, measuring the effectiveness of the flipped classroom across different subjects and levels could be a promising area for research. This would allow understanding in which subjects and groups of students the flipped classroom is effective, and where additional support or different methodological approaches are needed.

The integration of artificial intelligence (AI) and machine learning into automated evaluation systems could also be an important future direction. AI-based systems could be able to detect student errors and support progress by providing personalised improvement suggestions, which is particularly useful in programming and other technology areas. In addition, studying student and teacher satisfaction could be key to the widespread adoption of flipped classroom and automated evaluation systems. Based on student and teacher feedback, systems could be refined to better meet user needs (Forman et al., 2023; Udvaros & Forman, 2023a; Udvaros & Forman, 2023b).

The issue of security and privacy is of particular importance for automated systems used in flipped classroom models. Protecting sensitive student data and defending against malicious code is essential for reliable operation, and future research should also address this area in depth.

These proposals can contribute to the further development of flipped classroom and automated evaluation systems and support the effectiveness and accessibility of technology education. Through research, personalised and active learning can become more widely available, improving learning experiences and outcomes in different educational environments.

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Connecting Physics Education and Students' Digital Literacy

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Abstract

Connecting physics education and digital literacy is a core element of modern science education. This paper focuses on how digital tools (e.g. simulations, interactive applications and data collection, etc.) can be integrated into school physics education. This is done to foster a deeper understanding of physics concepts while also developing students' digital skills. The understanding of theoretical science concepts is significantly improved, and the development of students' critical thinking or problem-solving skills is promoted. This supplement also provides specific recommendations on how teachers can effectively combine physics experiments with modern digital tools to prepare students for the digital challenges of today's world. In the digital age, it is essential for students not only to understand basic physics principles but also to be able to use digital tools to explore and apply them. Finally, recommendations are made for teachers to effectively integrate digital technologies into physics instruction and develop students in both directions.

Keywords: Physics Education, Digital Literacy, Technology in Education, Simulation, Digital Competence

1 Introduction

We are currently witnessing a transformation of the educational environment where digital technologies are becoming an organic part of the learning process. This change is particularly evident in the teaching of science subjects, especially physics, which has traditionally been based on an experimental foundation and empirical knowledge of the world (Beißwenger et al., 2020). Linking physics education to the development of digital literacy is a key challenge for contemporary educators but also opens new possibilities for more effective and attractive ways of teaching at different school levels (ISCED-2011 level 2-7).

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The education of future teachers can be seen on several levels such as teaching:
1) Skills related to a specific scientific subject (e.g., physics, chemistry) must become familiar with the didactic concepts of teaching skills related to the development of themselves as well as the students they will be teaching,
2) Didactic concepts for digital support for the teaching of scientific subjects and for the teaching of skills related to digitalisation, with the associated awareness of the impact of the 'digital world' on individuals and society, and to teach students the knowledge and skills needed to navigate a society increasingly characterized by digitalisation,
3) Using such forms to digitally support teaching and learning and the results of scientific modelling of objects in the real and digital world.

To summarise the above points, there is a need for scientific models to be firmly embedded in real-world learning and for the real and digital worlds to be connected both at the university level (in the preparation of future teachers) and at the lower school level (where these teachers will teach). It is impossible to teach students digital skills unless they have acquired knowledge of the relevant scientific approaches to investigating the real world to which the skills being developed relate. We are therefore referring to competencies and, consequently, subject-specific and digital literacies. To achieve these competency objectives, all stakeholders in teacher training must collaborate. In fact, digitalisation is a cross-cutting challenge that can only be addressed collectively, across disciplines and institutions.
Modern infrastructure is essential to achieve these objectives, but equally essential is the creation and sharing of didactic materials and methodological practices that equip teachers with the competences to teach in a digital world. Being effective teachers in a technology-driven environment, teachers must therefore develop not only professional knowledge but also skills in pedagogy and digital technologies. The success of teaching depends on how they can interrelate and apply these three components in a specific disciplinary context (Koehler et al., 2009).
This paper aims to present concrete examples of effective links between school physics education and digital literacy development, reflecting current trends in education, technological opportunities and societal demands. The proposed solutions are based on current research in the field of didactics of physics and digital education, considering both theoretical knowledge and practical experience in the implementation of digital technologies in teaching.

2 Research on Linking Science and Digital Literacy

According to an OECD report (2023), three quarters of students said they felt confident using tools such as learning management systems, online school platforms or video conferencing programmes, as well as searching for learning materials online independently. This data shows that simply being able to use technology tools is not enough; the key is for students to learn to take responsibility for their own learning process. The results also showed that students who use digital devices for about one hour a day in their lessons score on average 24 points higher on mathematics tests than those who do not use technology at all. This suggests that appropriate use of digital technology can have a positive effect on student achievement, while excessive or inappropriate use can, on the contrary, impair student performance.

The relationship between digital and scientific literacy and their impact on understanding science concepts (Fitriana, 2022). This study analysed the impact of digital and scientific literacy on students' ability to understand earth layer structures. The correlational research revealed that scientific literacy has a greater impact on understanding concepts (53.29%) than digital literacy (13.72%). Yet, it was found that the combination of both literacies leads to a better understanding of scientific topics. The results show that scientific literacy is key to achieving deeper understanding, while digital literacy is more of a supporting factor.

Digital school culture and its impact on scientific literacy (Litina & Rubene, 2024). Research has identified elements of digital culture that support science education, such as virtual labs, interactive multimedia, and project-based learning. These technologies contribute to improving critical thinking, scientific literacy, and the application of knowledge in practice. For example, virtual laboratories increase student engagement and develop scientific skills. Research has also highlighted the risks associated with over-reliance on technology, which can lead to a weakening of social skills. A balanced approach between technology integration and interpersonal relationships is recommended.

Factors influencing the digital competence of university students (Litina & Miltuze, 2023). An analysis of 23 studies revealed five categories of factors affecting digital competence: socio-demographic, individual, family, school and external factors. For example, students from urban areas or those who received formal ICT training showed higher competencies. The COVID-19 pandemic had a negative impact on students' self-assessment of digital competencies. It is recommended that students' individual needs and backgrounds should be considered when designing training programmes.

The relationship between digital and scientific literacy during the COVID-19 pandemic (Yusuf et al., 2022) examined the impact of digital and scientific literacy on the cognitive performance of biology students. Scientific literacy was found to have a greater impact on outcomes (regression coefficient of 0.499) than digital literacy (0.327). Integrating both literacies into educational methods improves students' ability to critically analyse information and adapt to online learning.

The role of digital literacy in scientific knowledge and communication (Dašić et al., 2024). The study highlighted the importance of digital literacy in the effective retrieval, evaluation and presentation of scientific information. Digital tools such as simulations and big data analysis support research accuracy and productivity. Digital communication of scientific results through blogs, media or visualisations are also important. Recommendations include the inclusion of digital skills in educational programmes and the promotion of interdisciplinary collaboration.

Digital literacy and social inclusion (Méndez-Domínguez et al., 2023). This study identified disparities in access to technology based on socioeconomic factors. Higher income and education were associated with better digital skills. Barriers such as lack of connectivity or low levels of digital competence were particularly evident among the elderly and socially disadvantaged groups. The study highlighted the need for a personalized approach and support in bridging the digital divide.

A review of studies shows that digital and scientific literacy are closely linked to modern education. While scientific literacy has a stronger direct impact on understanding and cognitive outcomes, digital literacy is an indispensable support for the development of critical thinking and the application of scientific knowledge in practice. Successfully integrating these literacies into the curriculum requires a balanced approach that takes into account socio-economic and demographic factors while supporting individual and group development.

3 Digital Competence in the Contemporary World

We encounter the impact of digitalisation daily. This can happen consciously, for example when operating tablets, smartphones or computers. Thanks to these innovations, we expect digital tools to make our private, working or school life easier. Digitalisation should therefore be seen as a transformative process that has significant implications for today's society, individuals and, of course, the shape of education (Nassehi, 2019).

Therefore, schools must remember their task is to educate students to become mature and responsible individuals (which includes preparing them for life in a digitalised world). Education that is limited to the use of digital media alone does not meet this requirement. Ideally, students should be encouraged to engage critically, creatively and communicatively with the diverse phenomena of science and digitalisation.

One model that describes students' competences in the context of digitalisation is the Digital Competences Framework for Citizens (DigComp). However, it is necessary to keep in mind the students' exploration of digitalisation as an object of learning (analysis, design, reflection on technological and media structures and digital systems as well as their socio-cultural interactions), which is not explicitly embedded in the document.

A feature of this approach is that there are two main challenges facing teacher education universities: 1) the need to clearly define the content of each subject, and 2) the need to align content and the development of the necessary skills across all levels of teaching. van Ackeren et al. (2019) highlight the lack of a systematic, interdisciplinary and subject-focused approach that effectively integrates media and digitalisation as teaching elements in the preparation of future teachers, which is crucial to enhance the quality of their education.

There is a need to define core digital skills standards for teacher education in higher education and to break them down into subject and generic competency areas. These standards should serve as a starting point for proposals to integrate digital skills into didactic, pedagogical and subject knowledge-oriented teaching.

The purpose is to create a framework that facilitates the structuring of the key competences needed to effectively integrate digital technologies into teaching. This framework would also support the systematic organisation and coordination of teacher training at all stages, enabling the design of coherent strategies for developing the competences of future teachers, reflecting current educational requirements and objectives. One possible example is DiKoLAN (Figure 1) (Becker et al., 2020).

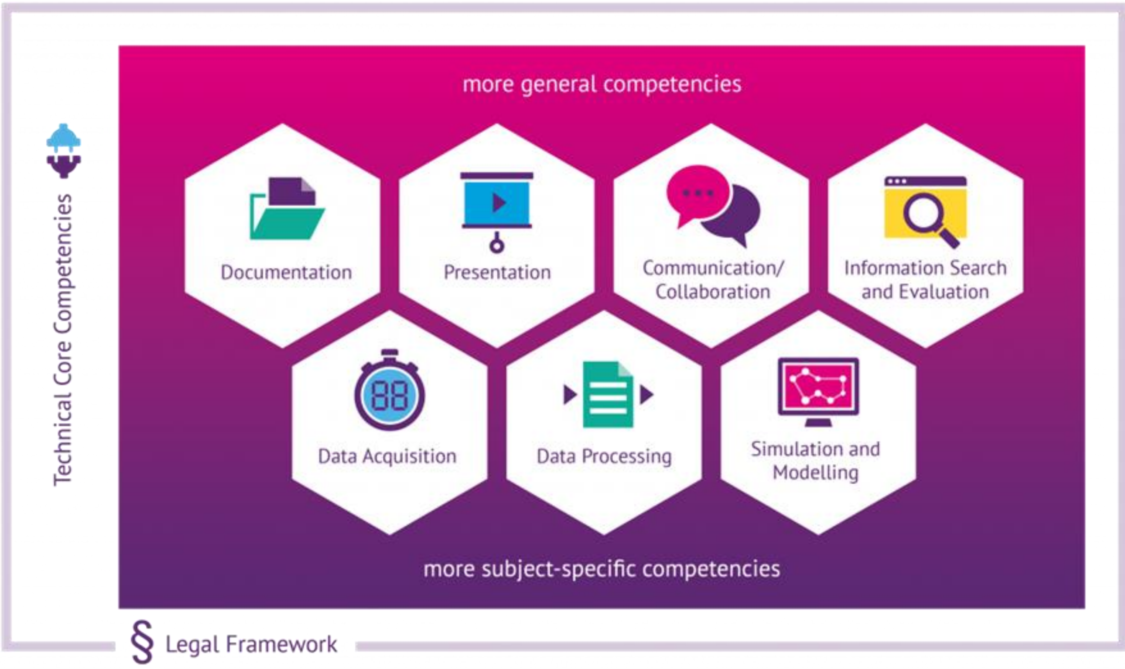

Figure 1: Indicative framework called Digital Competence and in Science (DiKoLAN), (Becker et al., 2020).

The work (Becker et al., 2020) resulted in the development of an orientation framework called *Digital Competencies for the Science Teaching Profession* (DiKoLAN), the layout is shown in Figure 1. According to Becker et al. (2020), the different components of the design represent:

- Documentation (DO) – Digitisation in education includes processes related to the creation, storage, management and backup of data in all phases of preparation, implementation and evaluation of teaching and classroom management. This includes not only the digital archiving of work products but also the secure handling of sensitive student data. At the same time, emphasis is placed on developing data literacy among teachers, enabling them to help students learn the skills needed to manage and store information effectively. Expectations of competences related to the practice of 'documentation' show close links with more subject-specific competence areas such as data acquisition and processing.
- Presentation (P) – The ability to effectively present ideas, results, and workflows is a key component of science education. Interactive whiteboards and other digital tools allow for the integration of multimedia elements and support students in creating their

own digital presentations. Modern science teaching should provide a space for students to share their outputs and projects with others. These activities can range from using presentation software to creating animations or, for example, presenting time-lapse videos documenting plant growth or recordings and photographs of microscopic observations. For teachers to be able to integrate such activities effectively into their teaching, it is important that they not only have a working knowledge of different digital media but also understand their potential benefits and limitations for the learning process.

- Communication and collaboration (CC) – Successful teaching relies on effective communication, information exchange and the ability to manage these processes. Therefore, an important part of teaching is the incorporation of communication techniques and collaborative strategies that enable learners to actively participate in the learning process. However, teachers need to be able to incorporate these elements deliberately and effectively into their teaching. Collaborative problem solving using digital communication tools not only promotes coordination of work but also facilitates the learning process and saves time in knowledge acquisition. Digital skills are therefore essential not only for creating effective learning environments but also for meeting the requirements of educational standards aimed at developing communication and information literacy skills.
- Research and evaluation (RE) – Effective information handling requires not only technical skills to retrieve information, but also cognitive skills to assess its relevance and metacognitive skills to evaluate the retrieval process itself. Solving problem-oriented digital and information tasks should be systematic and can be divided into five key phases: 1. Defining the problem precisely (i.e. formulating questions, activating prior knowledge, identifying task requirements and information needed); 2. Planning and executing the search (e.g., 3. Verifying and analysing the information found (e.g. checking sources, assessing their credibility and relevance); 4. Processing the information (i.e. reading and analysing texts, compiling content, critically evaluating the processed data); 5. Presenting the output (i.e. structuring the results, formulating the text and visualising the final product).
- Measurement and Data Acquisition (MD) – Digital technologies for measurement and data acquisition open opportunities to investigate phenomena that would be difficult to capture using analogue methods, such as rapid changes in motion or temperature processes. Computer-aided measurement provides an advantage, especially when studying very fast or slow processes, due to its accuracy and the ability to display data instantaneously. Measured values can be visualised in different formats, multiple datasets can be compared in a single graph, and axis scales can be dynamically changed for better interpretation. A key skill is the ability to read and analyse information from graphical outputs, linking this area to the 'data processing' competency. Hypothesis-driven experiments promote not only a deeper understanding of scientific processes,

but also the active acquisition of new knowledge through the processing and evaluation of digital data.

- Data Processing (DP) – Through the analysis and processing of measured data, conclusions can be formulated, or new research questions can be asked. In science education, working with data is an essential part of the learning process that benefits from the advantages of digitisation in several areas: data acquisition, data preparation (filtering, coding and analysis) and automation of data processing. Digital technologies allow access to datasets that reflect current scientific methods and provide students with relevant experience in the field. This allows science education to work with a variety of data formats such as series of measurements, images, videos, audio recordings, or text. Using digital tools such as statistical software or spreadsheets, these materials can be easily filtered, coded and analysed, either in preparation for teaching or directly in the classroom. This opens practical and efficient access to modern scientific methods for students.
- Simulation and Modelling (SM) – Computer simulations allow scientific processes to be modelled using basic principles and a limited number of variables. They are a key tool for exploring systems, analysing processes, and predicting their evolution based on rules. In science education, simulations serve not only to illustrate concepts to teachers, but also to students as a means of independent discovery. Thanks to the interactive nature of simulations, users can experiment with different parameters, explore relationships between variables and test their influence, making it easier to adapt students' mental models to the reality of scientific processes. This approach leads to a deeper understanding of the scientific content. However, the skills teachers need when working with simulations and models go beyond the usual competences associated with the use of traditional modelling tools, as they require the ability to work with advanced digital technologies and create dynamic learning environments.

Teacher education must therefore reflect the need to dynamically adapt educational concepts and structures to changing perspectives and demands. An example of this is the competency-based nature of school teaching, which is the result of the PISA studies. It is necessary to define areas of competence and to formulate developmental phases. The task areas, existing, prior knowledge and already developed levels of competence can then be formulated and considered in the university curriculum. To define the different contents and focal points, it is necessary to analyse a) the digital skills required for teaching and b) the level of competence of the students. The subject groups (physics, chemistry) should identify common requirements and areas of competence that will serve as a basis for the design of the curricula. Higher education teacher training is usually oriented towards the practical needs of school teaching, and therefore the necessary competences are often organized according to common areas that are relevant to lesson planning and delivery (Bauer, 2005). It is therefore appropriate to structure digital competences regarding specific activities and their application

in the educational process. In the case of science teacher training, this is complemented by subject-specific methods.
Achieving an adequate level of digital competence, even without direct school experience, can consist in the integration of digital tools into the teaching process, i.e. teaching and learning using digital media in the preparation of future teachers. This can be achieved both through general pedagogical methods and within specific subject area didactics.
On the other hand, preparing for learning and teaching through digital media to achieve competence goals at the learner level is difficult to achieve due to the lack of identified teaching and subject contexts. For this reason, it may also make sense to identify areas of competence for prospective teachers that do not correspond to the categories for learners. We therefore suggest the examples below for developing and linking digital literacy and science.

4 Specific Examples of Developing and Linking Digital Literacy and Science

In recent years, the term 'computational thinking', which originated in the USA, has been increasingly used to describing key approaches to thinking and working in problem solving in digital environments. This thinking forms the basis of any process that leads to the use of digital technologies and involves the ability to formulate a problem and its solution in a way that enables the application of digital tools (Wing, 2006). Skills such as abstraction, algorithmic reasoning and logical analysis are essential to the development of computational thinking. These ways of thinking and working, although primarily developed in the context of computer science education, are universal in nature. They are essential not only for computer science, but also for a wide range of other disciplines and professions in today's world, making them a key competency for the 21st century.
In the context of the DiKoLAN framework, clearly, computational thinking can significantly enrich simulation-based learning. Simulations are widely used in the analysis of material properties or in the development of new ones. They are considered a key scientific method and are referred to as the 'third pillar of science', alongside theory and experiment (Riedel et al., 2008). However, in school settings, work usually consists of using off-the-shelf simulations and models, while creating one's own simulations and models remains an untapped opportunity, although it has considerable educational potential (Basu et al., 2013).
Several suitable development environments (IDEs) are available for schools, such as NetLogo, (created specifically for simulations), Scratch (which allows modelling and simulation of different learning situations) or Trinket/GlowScript (an online tool for creating physics models). These platforms allow teachers not only to help students better understand subject concepts, but also to develop their digital skills, which are essential in today's technology-driven world. These tools promote an interdisciplinary approach to teaching and help to link

subject knowledge with the practical use of digital technologies. We may also see work with BeeBot robots, Lego WeDo Education.

Basic computing skills are relevant to children and adults due to their wide applicability beyond the specific subject. General education plays a key role in their development, and teachers across all school levels and subject areas are an important part of this process.

IT skills extend traditional approaches to media pedagogy and didactics with new competences that are essential in a digitally oriented world. The development of these skills is a task that must be addressed at all levels of teacher preparation to ensure that future teachers are able to meet the challenges of modern teaching. Recommended areas include algorithmic thinking, programming, data security and encryption, digital communication, working with databases, and big data analytics (van Ackeren et al., 2019). These skills enable the effective use of digital tools and technologies in the educational process.

Below, we suggest several activities that will help develop digital competences.

Programming physics applications

Programming can significantly deepen understanding of the laws of physics. When we allow students to transform physics theories into a programming language (creating their own programs and algorithms), they need to understand the theories well. This process helps them to uncover connections and better visualise how physics works in the real world (Somova & Enev, 2018).

A research study (Gjengset, 2022) has shown that students taught using the learning-by-coding method, where they program their own solutions to physics problems, perform better on physics knowledge tests compared to students who only use traditional calculus-based approaches.

A study (Gallego-Romero et al., 2020) focused on the use of Code board, a tool that is integrated into online Java programming courses and allows students to write, compile, and run code directly in a web browser without the need to install special software. The research divided users into two groups: anonymous and registered, and analysed their behaviour while using the tool, including frequency of access, number of compilations, and code modifications. The registered students showed a higher level of activity, running compilations more often, editing code, and spending longer periods of time working in a single session. In contrast, anonymous users showed lower engagement and were less active in modifying the code.

The results (Gallego-Romero et al., 2020) highlight the benefits of registration, which promotes deeper engagement and motivation among students. However, they also suggest a trade-off between ease of access and the need to register. The study recommends incorporating registration to enhance student interaction with the tool, and to consider embedding it in course evaluations. These findings provide valuable insights for improving the design of online learning courses, particularly through the integration of interactive and motivationally aligned tools that can enhance learning effectiveness.

In this section we will work with the Trinket/GlowScript IDE. This environment was created by the authors primarily for demonstrating physics processes, so it already contains a library of objects that we encounter in physics when exposed to new matters. They've included a sphere, cube, cylinder, needle, circle, and more. They also inserted arrows (which can be used when working with vectors) and a spring, for example to demonstrate oscillating motions. The author of the model/visualisation is not required to figure out how to render certain elements and can focus more on the physics nature of the problem being investigated. In Trinket/GlowScript it is possible to model, for example, the motion of large bodies, the movement of electrons through a circuit, and other processes. The system itself sets the appropriate scale for the correct representation. Thus, if the student can correctly describe the problem from a physics perspective and then mathematize it, the connection to digital technologies can be made.

A concrete example is the creation of a model of a part of the Solar System. Explain to students that there is a gravitational force between the celestial bodies we will be working with (Earth, Moon, Sun) and that the Earth-Moon pair orbits the Sun. The distances and masses of all three cosmic bodies take on such values that they remain in their orbits and do not tend to change their state. They are therefore at a suitable distance not to be attracted by the sun, and they have no such energy of motion as to leave its orbit.

Let us determine the gravitational force between the bodies, using Newton's law of gravitation:

$$F_{\mathrm{g}} = G\frac{mM}{r^2}$$

The syntax of the code is not complicated. A lot of emphasis is placed on the clarity of the code. Because it is important for students not only how the model fits, but also how it works.

```
Fgrav = G * Sun.mass * Planet.mass * (Sun.pos - Planet.pos). norm() / (Sun.pos - Planet.pos).mag2
Planet.acceleration = Fgrav / Planet.mass
Sun.acceleration = Fgrav / Sun.mass

Planet.velocity = Planet.velocity + Planet.acceleration * dt
Sun.velocity = Sun.velocity + Sun.acceleration * dt

Planet.pos = Planet.pos + Planet.velocity * dt
Sun.pos = Sun.pos + Sun.velocity * dt
t = t + dt
```

The graphical output is shown in Figure 2.

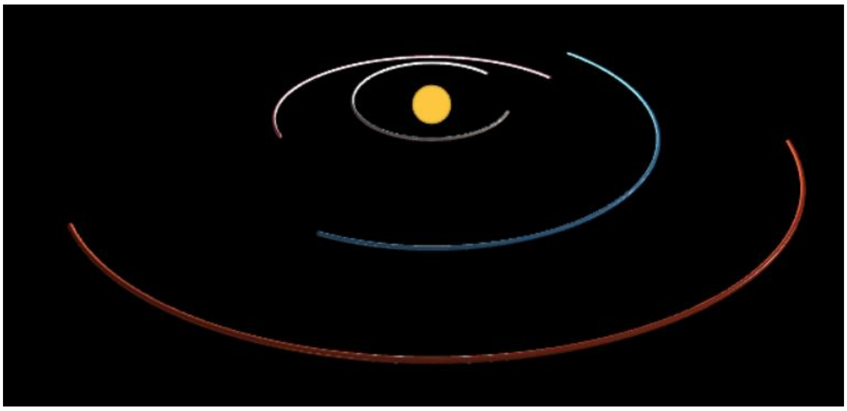

Figure 2 View of the solar system model – rocky planets.

Feedback from school practice – The solar system model was used by primary school teachers (ISCED-2011 level 2). The model was built by students with a teacher in Computer Science. The physics teacher worked with the model first and focused on the rocky planets and their moons. Then the students worked with the model, where one of the tasks was to sort the planets according to their orbital speed and orbital period around the Sun.
From this perspective, there may be only one example, but the overall work was spread over several subjects in the school, so from our perspective it is perceived to be a multi-subject activity.

5 Discussion

The findings of this paper, which focuses on the integration of digital technologies into physics education, confirm that the systematic integration of digital skills into science courses is not only effective but also essential for preparing students for the challenges of today's world. The paper shows that linking physics education with digital competencies can make a substantial contribution to improving learning outcomes and enhancing student motivation. The high rate of improvement in physics knowledge among students who worked with digital technologies suggests that linking theoretical knowledge with practical use of technology is an enriching approach for students that meets the requirements of modern education.
Particularly, attention should be paid to the didactic and pedagogical aspects of integrating digital tools. The results show that teachers who have had the opportunity to acquire digital competences and methodological support show higher effectiveness in using technology in physics teaching. The quality of technical equipment and the availability of tools for experimentation and simulation significantly influence the success of digital learning. The results of the research showed that schools with better equipment and modern software tools showed higher results in digital literacy tests than schools with limited technological resources. This suggests that investment in modern digital infrastructure is a key prerequisite for successful implementation of digital technologies in education.

Student motivation and interest in digital technologies in physics education is also an important issue. The results show that students who had the opportunity to work on real projects using programming and data analysis showed higher engagement and interest in the field. This approach provided them with a deeper understanding of physics concepts while allowing them to develop analytical and algorithmic skills. Motivating students to actively engage in the learning process is a fundamental prerequisite for successful learning, as confirmed by the significant increase in intrinsic motivation among students who had the opportunity to participate in digitally oriented tasks. This increased motivation was also reflected in increased self-confidence and the ability to transfer the acquired knowledge and skills to other areas.

Factors related to teaching and training should also be considered. Research data shows that sufficient digital competence of teachers is essential for the effective use of technology in teaching. Teachers who received training in the use of digital tools were better able to integrate technology into their teaching and were more responsive to students' needs. This suggests that the development of teachers' digital competencies should be part of their professional preparation. Therefore, this research supports the idea that improving the education system around teachers' digital competences should be implemented at the institutional level with a view to promoting interdisciplinary collaboration.

The research also highlights the importance of an interdisciplinary approach, where digitalisation is not isolated as a purely technical skill but is linked to specific disciplines. In this context, competences in computer science and programming are shown to enrich students not only in the field of physics but also in broader contexts. Such an approach also appears to be important in view of the expectations of the labour market, where the combination of professional knowledge with digital skills is increasingly required. An interdisciplinary approach also promotes more effective learning and improves students' ability to apply digital knowledge in practice.

However, the issue of linking digital technologies with science education also involves challenges that should be carefully considered. One challenge is the potential overload of teachers when implementing new technologies in the classroom. Lack of systemic support can lead to teacher stress and fatigue, which can negatively affect teacher performance and the quality of teaching. It is therefore essential that schools provide teachers with sufficient support not only in the form of technical equipment, but also in the form of methodological support and continuous training.

Overall, the results of this study suggest that integrating digital technologies into physics education is an effective approach to developing students' digital competences and expertise. However, this process requires a systematic approach involving quality technological equipment, sufficient methodological support and quality teacher training. As a result, students' knowledge level, analytical and algorithmic skills, motivation to learn and readiness for future career opportunities are increased.

6 Conclusion

Basic computer knowledge and didactic and methodological possibilities of implementation must be included as mandatory content in the module descriptions. Only primary school teachers who have already dealt with these aspects and discussed didactic issues in their studies will be able to implement the requirements of the Ministries of Education and Culture in an appropriate way and to create up-to-date teaching that engages, opens and explains the world in which children live, while providing knowledge that is relevant to the lower secondary level.

It has been shown that the teaching of computer science can play a role not only in the didactic disciplines discussed but has long been a subject of pedagogical practice (albeit in very different forms). Accordingly, it is important for teacher training to provide teachers with the skills they need to discuss and use digital topics and methods in informatics-based teaching.

Research results clearly show that linking physics education with digital competences has positive impacts on students' knowledge levels and their readiness for a technology-oriented world. This study confirms that the integration of digital tools in physics education leads to increased understanding of physics concepts, development of analytical skills and enhanced motivation to learn. This approach responds to the needs of modern society, which increasingly requires graduates to be not only technically proficient but also digitally literate. As teachers play a key role in the delivery of digital competences, it is essential to ensure that they are sufficiently prepared to use digital technologies in the classroom. This process should be systematic and include not only training but also ongoing methodological support to enable teachers to develop the skills and experience needed to work effectively with digital tools.

An interdisciplinary approach is also important, emphasising that digitalisation is not an isolated phenomenon but is intertwined with all fields of education. This approach promotes more holistic learning and gives students a broader perspective on problem solving and the use of digital technologies. Interdisciplinary collaboration between disciplines such as physics, computer science and education create the basis for the effective integration of digital technologies into the educational process and strengthens students' preparedness for the complex challenges of the 21st century.

Research data shows that students who have worked with digital technologies during their physics education achieve better results, are more motivated to learn and show higher levels of digital competence. This trend is particularly evident for students who have had the opportunity to learn about programming and working with data. Learning physics combined with programming and data analysis not only provides students with practical skills but also improves their ability to solve problems and apply physics knowledge in reality.

As digital technologies continue to evolve, there is a need to emphasise a flexible approach to teaching and learning. The rapid pace of technological change requires teachers and students to be able to adapt to new tools and methods. This is why it is important for educational institutions not only to invest in technical equipment, but also in teacher training and the promotion of innovative pedagogical approaches.

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To the Roots: Engineering Pedagogy

Selected Strategies for Problem Solving in Secondary Schools

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Abstract

Problematic situations in the educational process pose a significant challenge, affecting not only the effectiveness of teaching but also the quality of the educational environment. This paper explores key problematic situations that secondary school teachers frequently encounter, including disciplinary issues, student demotivation, and difficulties in understanding the curriculum. The authors aim to analyse these situations in terms of their potential causes, their impact on the educational process, and possible intervention strategies. The paper provides an overview of proven strategies for effectively addressing these problems, with an emphasis on developing pedagogical skills and building positive relationships between teachers and students. Research findings show that a proactive approach to problem situations can significantly improve the quality of teaching and contribute to a healthy school climate. The paper offers insights for teachers and school leaders on how to better manage the challenges of everyday teaching practice.

Keywords: Problem Situations; Educational Process; Vocational Education; Prevention; Solution; Communication

1 Introduction

Schools are currently challenged with the important task of implementing learning technologies that are centred around human needs. Today teachers are expected not only to impart information and develop students' practical skills, but also to teach them how to independently seek and obtain information and conduct independent research. Thus, the

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effectiveness of the educational process is highly dependent on the teaching methods that teachers use. Although the introduction of innovative teaching methods may pose some problems and reduce the effectiveness of learning, it is up to teachers to select the methods that best suit the needs of the class and the learning objectives. While the core knowledge framework is still key, modern methods can develop students' key competencies that result in creativity and social skills (Turek, 2010). Teaching techniques that foster active student engagement include dramatisation, scene enactment, and staging methods. These approaches serve as effective complements to traditional lecture-based instruction, enhancing students' understanding of the concepts being discussed. The selection of an appropriate teaching method is crucial not only in school education but also in broader pedagogical contexts. Future teachers should be exposed to a diverse range of teaching methods during their studies, enabling them to select the most suitable approaches based on specific educational requirements. An essential part of pedagogical competence and therefore part of the preparation of a future teacher is also resolving problem situations. We will further focus on staging methods for the proper development of a teacher's pedagogical competences.

2 The Basics of Staging Methods

The staging method capitalises on individuals' natural need to communicate, engage, and express themselves while learning. In this approach, students actively participate in the teaching process, taking on an interactive role in their own education (Průcha, 2017), (Kotrba & Lacina, 2011), (Lucas et al., 2012). The basis of the staging method lies in fulfilling the goals of teaching through the students' own activity, in stimulating their productive activity associated with creative thinking, emotional experience, while solving problem situations within the pedagogical practice (in a group, class, plenary). This approach fosters experiential learning. Experiential learning begins when our direct contact with the world or with ourselves causes a change in behaviour, interpretation of phenomena, degree of independence or creativity (Kotrba & Lacina, 2011), (Lucas et al., 2012). Two key elements of the method are the direct involvement of the student in the problem, unguided by an external agent – the teacher, and the change that occurs in the student in terms of understanding or self-understanding. Experiential learning involves the exploration of personal feelings, attitudes and values through which cognitive skills can be applied either directly during the activity or as a later response to it.
The staging method can be understood as a didactic method, the basis of which is a problem from a real social environment in the context of group work. The actors of the educational process thus participate in the problem solving and teaching itself. In general, participatory methods have a contribution to educate active creative work of conceptual workers, problem solvers, organisers and managers. There are teaching methods that innovate professional education not only for managers (making it more effective, more interesting, combining

teaching with training, theory with practice) but also for students and teachers. Teaching and learning can only take place effectively if the style and methods of work in school are brought closer to situations in everyday life (Lucas et al., 2012), (Tesařová, 2016). Participatory methods go beyond the narrow framework of the school environment by simulating the relations of social reality (Válek & Šmejkalová, 2024). They are highly motivating for students, force them to actively participate in problem solving, develop independence and creativity in their thinking, are not infrequently associated with a strong emotional experience for students and additionally allow them to defend their point of view in a sophisticated way in the learning collective. All these aspects are pedagogically extremely effective as well as extremely sensitive, as they create and deepen students' intellectual skills and social competences immediately applicable in their future professional and personal lives.
According to Šmejkalová (2001), the use of participatory methods presents certain challenges in school practice, which define the limitations of their applicability:

- Students usually need to have some knowledge about the topic.
- The teacher must overcome/relinquish directive control and dominance in the classroom.
- The method requires more teaching time and organizational preparation.
- Lack of appropriate study materials and aids needs to be considered.

The staging method, as one of the participatory methods, places increased knowledge demands mainly on the teacher. The difficulty lies in the preparation of the staging, the realisation and the evaluation. The staging method is of irreplaceable importance due to its activating potential, dynamizing charge and complex influence on the student's personality.
A special role in the implementation of the staging method can be played by video recordings, which provide not only records of the situations solved, but also of the attempts to solve them. However, the most important moment is the audiovisual experience of the performance itself, acting as the most effective and often personally surprising feedback (Průcha, 2017), (Nováková, 2014).
In accordance with (Olimov & Mamurova, 2022), we find that it is necessary for the above method for the teacher to adjust his/her approach to the student and to science. Specifically, then, according to (Olimov & Mamurova, 2022), we are talking about, for example:

a) Determining the role of the student in the process of learning and personal development (the student actively participates and self-evaluates as a disseminator of subjective experience and at the same time).
b) Normative requirements for the student's professional development.
c) The creative abilities and skills of the teacher, which are of great importance in the organization of the educational process.

The current relevance of the topic is indicated by current research in this field of education. Mostly it is focused on health care education where doctors, nurses or other health care personnel are trained, for instance (Zulissetiana et al., 2024), (Johnson et al., 2021), (Halpin & Gopalan, 2021) and the method is also used in primary schools (Papageorgiou, 2022), (Behak & Bsharat, 2021), (Şengül & Tükenmez, 2009) and in secondary schools there are (Kucharčíková & Tokarčíková, 2016), (Puri, 2022), (Olimov & Mamurova, 2022) and (Leupin, 2016).

For instance, Papageorgiou (2022) investigated Greek primary school teachers' attitudes towards the inclusion of dramatisation in the educational process and its benefits. Special attention is paid to the analysis of differences in views based on gender, age, length of experience and experience of working with immigrant pupils. The analysis uses statistical methods to process the data. The inclusion of information on the number of immigrants who have come to Greece in recent years helps to better understand teachers' willingness to work with these pupils and to explore how demographic factors influence their attitudes towards dramatisation.

The analysis (Papageorgiou, 2022) looks in more detail at the comparison of attitudes by demographic characteristics, where all the groups studied show very positive values, often exceeding the average of 4. For example, statements about the effectiveness of dramatisation as a teaching method or its benefits for foreign language learning and the release of emotional charge are rated very positively. Similarly, statements about stimulating imagination, creativity and socialisation through dramatisation score high regardless of the teachers' length of experience.

In gender-based comparisons Papageorgiou (2022), the differences are minimal, and likewise for the group with 7-12 years of teaching experience, where statistically significant differences are limited. For groups with longer teaching experience (13-18 years and 19+ years), positive attitudes towards dramatisation are even more pronounced. An examination by age shows that older teachers (41+) have more positive attitudes towards dramatisation, suggesting that recognition of the benefits of dramatisation to the educational process increases with age and experience.

3 Choosing the Appropriate Social Reality for the Staging Method

The family plays a crucial role in shaping students' behaviour at school. The educational environment that parents create has a direct influence on how children/ students behave and what values they acquire.

Students who grow up in an environment where they are supported, praised and where the emphasis is on education tend to be more active, confident and engaged in school. Conversely, students who experience a lack of support or are exposed to stress and conflict may have problems with behaviour, concentration and motivation.

Parents' uncritical defence of children's/students' risky behaviour, such as making excuses for misbehaviour or ignoring problems, can have long-term negative consequences. Such behaviour can lead to an individual being unable to recognise the limits and consequences of their behaviour, which can negatively affect their relationships with others and their ability to function in the school environment.

The staging method, if it works, can enhance the effectiveness of the educational process. However, like any other teaching method, it works differently in specific times, places and conditions. The absence or inappropriate modification of certain factors can reduce or eliminate the educational effect of a model situation. (Šmejkalová, 2001), (Milmeister et al., 2022), (Olimov & Mamurova, 2022).

The implementation of the model situation method requires a well-thought-out methodological and organisational preparation, including specific teacher skills. It is necessary to build on students' previous knowledge and skills acquired in the frontal teaching method, in discussions and in group problem solving. This allows students, in addition to the repetition of theoretical postulates, also feedback on the degree of success of choosing the optimal approach to the development of teacher preparation for the lesson and its subsequent application in the classroom. (Šmejkalová, 2001), (Milmeister et al., 2022), (Olimov & Mamurova, 2022)

Students often have the idea that preparing a teacher for a unit of instruction is only a matter of their professional training, i.e., they prepare only in terms of content. Therefore, the course *Education of Pedagogical Competencies of Teachers* at the Faculty of Education, Masaryk University, was taught using the staging method.

The challenges faced not only by novice teachers but also within our primary (ISCED-2011 Level 2) and secondary school system (ISCED-2011 Level 3) include student discipline issues, truancy, bullying, and student aggression. Selected risk behaviours in Czech schools are shown in Table 1 and in Table 2. Students often come from teaching practice with questions about communication with parents of students. Parents' actions may not always be conforming as they may not acknowledge that their child has educational or parenting problems. The authors prepared a static case study for students and then a production with the theme of the troubled parent.

Table 2 provides a more detailed look at the frequency of risky behaviour among students in the secondary school system (ISCED-2011 level 3) for the school year 2022/2023.

To put the values from Table 1 and Table 2 into proper context, it is necessary to present the numbers of primary schools (ISCED-2011 level 2) and secondary schools (ISCED-2011 level 3) in the Czech Republic in each school year, as shown in Table 3.

	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019
Cyberbullying	23.0	20.5	24.5	29.9
Verbal aggression against teachers	32.9	33.1	32.0	33.3
Physical aggression against teachers	3.4	6.2	3.4	4.4
Aggression. violence. bodily harm	33.7	32.9	34.2	30.7
Substance abuse	8.2	10.8	8.4	9.2
Smoking	22.6	25.0	26.1	26.8
Damage to property. vandalism	33.2	30.9	31.3	32.4
Theft	26.3	24.6	24.2	23.5
Truancy	45.7	43.5	44.8	43.8
Other	7.6	10.4	10.9	19.7

Table 1: Percentage of schools with cases of risky behaviour for given periods, source (CSI, 2016) and (Spitzerová et al., 2023).

	Very often	Frequently	Occasionally	Does not occur
Cyberbullying (intimidation or verbal abuse outside school)	1.4	1.5	10.6	86.5
Physical violence between pupils	1.4	1.3	12.1	85.2
Truancy	4.9	10.6	37.8	46.7
Destruction of other people's belongings or school premises (vandalism)	2.4	3.0	22.6	72.0
Intimidation or verbal abuse between students	3.2	5.9	23.5	67.4
Cheating	15.4	24.7	44.8	15.1
Foul language, swearing	21.2	28.2	37.6	13.0
Disruption in the classroom	20.7	36.8	37.4	5.1

Table 2: Prevalence of risky behaviour in the classroom from the students' perspective (in %), source (Spitzerová et al., 2023).

		2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2022/ 2023	2023/ 2024
Primary schools	**Schools**	4 115	4 140	4 155	4 172	4 261	4 276
	Classes	44 091	45 116	46 023	46 774	51 190	51 541
	Students	880 251	906 188	926 108	940 928	1 007 778	1 000 346
Secondary schools	**Schools**	1 304	1 307	1 308	1 290	1 294	1 304
	Classes	19 546	19 380	19 266	19 225	20 378	20 938
	Students	427 107	424 849	421 535	420 814	463 200	484 758

Table 3: Number of schools, classes, children, pupils and students in the education system of the Czech Republic by type of school, source (Czech Statistical Office, 2024).

Unpleasant interactions with the parents of underperforming students can exacerbate the situation. If teachers and school staff approach parents with criticism rather than attempting a constructive dialogue, it can lead to tensions and misunderstandings. Parents may feel attacked and, as a result, may be less willing to collaborate in finding solutions, which can negatively impact the support the child receives at home. Therefore, future teachers are introduced through the staging method to an often-dreaded situation, i.e. dealing with the student's parents.

Overall, family environment and educational practices have a major impact on students' school behaviour and success. Thus, it is essential for the teacher to communicate effectively and respectfully with parents so that together they can support student success.

3.1 Description of the scenario and evaluation of the implemented method by students

During the seminar, students compared the teaching method Case Study Solution and the Staging Method. The same problem situation was deliberately chosen, namely, 'teacher's negotiation with parents'. In the first case, it was a case study, where students were provided with a story, which they each studied and thought about possible solutions. The solutions were then presented to each other by the students in a jointly guided discussion.

In the second part of the lesson, students solved the same problem through the staging method. The teacher gave out the roles of the parent, the teacher and the other students watched the staging. To illustrate, the scenario was as below.

SITUATION 8: Discipline in the classroom
The role of the parents
Christopher had just started secondary school and from the beginning he was accompanied by behavioural problems. At first impression he seems quiet, but he managed to win over his classmates who then "served" him. He often had conflicts with classmates who did not want to submit to him. He ignored his teachers and behaved in a purely purposeful manner. He was very quick to comment and put down teachers in front of the whole class. Christopher was above average intelligence. As parents, you are in frequent contact with the school. They would come in to complain about various teachers, their attitudes and practices. Father included the school with various suggestions as to what the school should change to help Christopher thrive better. Teachers agreed that Christopher was smart and handled the curriculum with ease. However, they also must consider his totally inappropriate behaviour, which lowers his grades by at least one grade. Thanks to a lot of pressure from his parents, Christopher has so far managed to get through to Year 2 'only' with a reprimand from his class teacher. A week ago, the situation in the classroom escalated. There was an incident in which Christopher grabbed a classmate's hand and cruelly broke a bone in the wrist of her left hand. Resistance arose not only from their parents, which culminated in a request to transfer Christopher to another class, and better yet – to another school.

You're Christopher's parents, you've been invited to the school by the class teacher. You are fundamentally opposed to any solution proposed by the teacher: reassignment, discipline, ... you show no regret.   ***You argue: the field of education, which is in another school 50 km away, the intellect of Christopher, the girl certainly caused her own injuries, the school is to blame.***
The role of the teacher
Christopher had just started secondary school and from the beginning he was accompanied by behavioural problems. At first impression he seems quiet, but he managed to win over his classmates who then 'served' him. He often had conflicts with classmates who did not want to submit to him. He ignored his teachers and behaved in a purely purposeful manner. He was very quick to comment and put down teachers in front of the whole class. Christopher was above average intelligence. As parents, you are in frequent contact with the school. They would come in to complain about various teachers, their attitudes and practices. Father included the school with various suggestions as to what the school should change to help Christopher thrive better. Teachers agreed that Christopher was smart and handled the curriculum with ease. However, they also must consider his totally inappropriate behaviour, which lowers his grades by at least one grade. Thanks to a lot of pressure from his parents, Christopher has so far managed to get through to Year 2 'only' with a reprimand from his class teacher.   A week ago, the situation in the classroom escalated. There was an incident in which Christopher grabbed a classmate's hand and cruelly broke a bone in the wrist of her left hand. Resistance arose not only from their parents, which culminated in a request to transfer Christopher to another class, and better yet – to another school.   ***What are you going to do? You invited Christopher's parents to school, you don't feel good about it, but you have to address the situation.***

After the scenario/situation was played out, there was a discussion first on the role of the teacher. The student in the role of the teacher specifically stated, "*I was surprised at what the parents came up with. I thought that I would tell them how it is and what the options are for moving forward and we would reach a common solution. And I didn't expect what they came up with and how they would react. As a few things came up, I reacted badly. And it was complicated. If I had dealt with this situation in real school, I would have invited the teachers who were present at the incident.*"

The students who played parents said, "*Our role was designed to be aggressive and to defend our child at all costs. We were ready to argue towards the end*." ... "*The teacher reacted well. And he tried to convince the parents of his truth, but by the end he was clueless and probably would have resorted to an argument*."

The other students in the role of spectators evaluated the situation negatively. According to them, the teacher was at a disadvantage because he was not present at the incident with the student:" ... *As a result of the teacher not being present in the particular situation, it was all the worse for him*." The students agreed that the teacher should have taken a colleague "*...who was present at the situation to discuss with the parents and preferably to discuss together what situations may arise and what specifically I want to address with the parents. Maybe even the school psychologist should have been present*."

During the discussion, students were offered solutions by the teacher, such as:

- Assess criminal responsibility (Youth Responsibility Act).
- Consultation with the Police of the Czech Republic.
- Talk individually with Christopher about how he would handle the situation now.
- Talk to Christopher's parents. (Getting from a position of 'the school is fighting with you' to a position of 'the school wants to work with you to find a solution to this situation').
- Open a discussion with the pupils in the classroom about rights, violations and aggression.
- Recommend family therapy to parents.
- Recommend expulsion from school to the principal.
- Set up, support long-term cooperation with a school counsellor or an external psychologist.
- Create an agreement between a teacher, parents, school, or other stakeholders.

4 Discussion

We employed two different participatory methods: the case study and the staging method, as outlined in the previous article (Válek & Šmejkalová, 2024). In our case, the content was comparable. We know the opinions of the experts, so we asked the students themselves. We agreed with their opinion that each of these methods is activating, and we cannot say clearly which one is better. The first method, i.e. the case study, is described and students discuss the story given by the text. The second method, the staging or role-playing method, depends on the scenario played out and the actors themselves getting into the role. We agreed that the staging method provides more opportunities for discussion, is more attractive and more comparable to reality.

5 Conclusion

A staging situation simulating a lesson determines the level of learning, skills and social competences through their practical application to a concrete example. In this sense, it verifies:

- The level of theoretical knowledge necessary to deal with the relevant social reality
- The student's ability to integrate the theoretical knowledge acquired in the different study disciplines into a functional whole.
- The ability to apply knowledge from pedagogical and psychological disciplines.
- The level of the student's decision-making skills.

- The student's ability to search for optimal solutions within the framework of pedagogy, didactics.
- The student's ability to establish, maintain and terminate social contact with pupils, with parents.
- The student's ability to obtain relevant answers from pupils during the teaching to the control questions from the discussed material.
- The student's ability to maintain consistency in verbal and non-verbal communication.
- The student's ability to control himself/herself even in emotionally stressful situations, to implement assertive behaviour.
- The student's ability to anticipate the consequences of his/her decisions.
- The student's socially and legally acceptable attitudes towards health and environmental protection.

Participatory methods extend beyond the narrow confines of the school environment due to their relative fidelity in simulating the dynamics of social reality. In doing so, they also eliminate the encyclopaedic and subject-specific barriers to learning, fostering the development of the necessary skills and competencies. On the other hand, however, it is precisely this characteristic aspect that places increased demands on the professional competence of teachers, which usually exceeds their existing teaching qualifications. This is also the reason why the use of didactic tools is rejected by many teachers and why in many cases they continue to use the pedagogical methods that were current during their studies.

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The Impact of Digital Technologies on Contemporary Education

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Abstract

The position of the student in today's educational process is significantly influenced by the influence of digital technologies, which can have both positive and negative effects. For students to be able to educate themselves effectively and successfully in today's digital society, there is a need to have knowledge of digital literacy, i.e. the ability to work with digital technologies so that they are not dependent on them, but on the contrary make their lives easier or enable them to have a good standard of living thanks to them. The functioning of the student within the teaching process is also significantly influenced by social networks, which often impact their life values and attitudes towards education.

Keywords: Digital Learning Material, Social Networks, Digital Literacy, Education

1 Introduction

In a deeper analysis of the learner's position in the current dynamic era characterised by the digital revolution, which is linked to a multitude of technical innovations and changes, the learner is confronted with several specific factors that affect their performance and behaviour during the learning process. The fundamental objective of any educational process is to enrich the learner with theoretical and practical knowledge that they can use in their working career and future adult or family life. Another aim of the educational process is also to shape the personality of the learner and to lead them to positive values in life, so that they will be ready to successfully enter real life after graduation.

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2 Current State of the Education System

In this subchapter we will focus on the analysis of the current state of the education system. The aim is not only to describe the negative aspects of the current education system, but also to propose potential solutions. Specifically, for instance, a deeper analysis of the current system of secondary and higher education in the Czech Republic may reveal that it may appear unfashionable and inefficient from the perspective of the student. Consequently, the student may develop a negative state of mind that discourages them from pursuing deeper study and work in the classroom. From students' point of view, and perhaps also employers', the school system is not adapting to current dynamic trends in the labour market. Particularly, for instance, today's secondary school students often study more than ten subjects in one school year and sometimes as many as fifteen (Fernstermacher, Soltis, 2008, p. 9). Thus, students certainly gain the necessary general social insight. Figuratively speaking, this system of knowledge is 'a bit of everything'. Compared to modern and developed countries, this may be an unfashionable or impractical style of education that may ultimately reduce the qualitative competitiveness of a country's economy. In some modern education systems, fewer subjects with more time allocation are proposed with the aim of greater practical focus and specialisation for practical application.

In our system, therefore, there are many courses that allow students to develop a broad social outlook. Thus, students learn a lot of different theory, but realistically they may not be able to remember and organize it in a systematic way in the long run. They often do not know how to connect it logically or deduce it into other schools of thought. Thus, students often must memorise a lot of theoretical knowledge in an unsystematic way, most of which they do not actually use in practical life. They thus become generalists rather than necessary specialists for the labour market. It is important to ask, however, what is the fundamental difference between those actual concepts that directly touch on learner applicability and the labour market? We will explain in the next subsection.

A more modern option could be a comprehensive change in the education system. Where the first year would be general possibly even with the current fifteen subjects. However, the student would then choose a specific specialisation to pursue in greater depth during the remaining years of study. This would create a system of education with fewer subjects but the same number of hours. The subjects would be profile-oriented and would systematically prepare the knowledge corresponding to the profile sought after and demanded by employers on the labour market. The main objective would thus be to build the most practical education and knowledge that the student can use in real life. In the current education system, students do build a broad general knowledge base. However, they may not be able to connect them systematically and may gradually forget them under the influence of the effect of extreme information overload (Domborovská, Šidlichovská, 2021, p. 50), but most importantly they may not be able to use them realistically when looking for a job.

Investing in education and school systems is one of the country's major strategic investments. The level of investment in education is therefore also a frequent measure of a country's success. Therefore, in the case of a negative scenario of long-term underfunding of the education system, this may be reflected in its declining quality. This may result in several students leaving for better quality universities abroad. This is the so-called brain drain. This may be reflected in the absence of important professions such as quality doctors, lawyers, IT specialists, teachers and many others. The absence of certain professional groups can lead to overall uncompetitiveness, particularly in the fields of science and the general quality of life within society. This issue is directly reflected in several areas of the school system. One problem is the level of teachers' financial remuneration, which has been mediocre for a long time and is reflected in the composition of the teaching staff. Many teachers are female, and the male component is significantly absent. Male teachers are often unable to make the teaching profession provide the required standard of living for their family. Therefore, the teaching profession is often unattractive for them. Several countries in Europe are systematically trying to motivate young people to become teachers through several benefits such as free accommodation, training opportunities and financial benefits

2.1 Education in the Digital Age

In contemporary society, there is an increasing demand for specialisation and expertise. Consequently, systematic education plays a crucial role. Lifelong learning is becoming an ever more prominent topic of discussion. To maintain one’s job and social status it is necessary for the individual to be educated throughout their life. In the case of long-term non-education, the individual is at risk of becoming unnecessary and uncompetitive in the labour market. Nevertheless, today, under the influence of the use of digital technologies, some believe that education is unnecessary and everything important can be found on the Internet. This is a partially true and logical attitude based on trends in society when most processes are being downplayed. However, critical thinking is disappearing, and physical and digital convenience can arise. Thus, quality education and information outlook are still indispensable components of career success in a digital society (Domborovská, Šidlichovská, 2021, p.11). Systematically building a high level of knowledge is a long-term process, with results in the form of specific expertise emerging over several years. Therefore, persistence and patience are essential. However, in the context of contemporary society, which places a premium on achieving results and success as quickly as possible, this process may not be feasible for many students.

3 The Importance of Digital Literacy in Education

Digital literacy is the ability to use the internet effectively. Specifically, to avoid being the target of, for example, a scam text or email scam. On the other hand, good digital literacy skills can allow us to work comfortably from home. A high level of digital and information literacy acts as a preventive tool that allows us to be able to analyse qualitatively uncontrolled information coming from the Internet objectively and with insight. A positive factor of the digital revolution is the fact of increased digitisation of available information, which has a positive impact on the modernisation processes of education in society. The portfolio of available information accessible through modern technologies has significantly expanded. However, in real terms, there is currently no increase in the educational level of society. On the positive side, however, is the increased job mobility and the number of job opportunities and possibilities arising from working with digital tools. For example, home office work or the emergence of many new types of work such as in online marketing and many others.

There are both positives and negatives when analysing the impact of digital technologies on an individual's everyday life. In terms of positives, the previous sentence mentioned digital work and information mobility. However, on the negative side, more and more individuals are gradually becoming dependent on digital tools. Specifically, this includes, for instance, dependence on social networks and the Internet in general. The consequences can be impaired communication, emotional numbness and loss of empathy. The given assumptions are primarily based on a scientific study by the German psychiatrist Manfred Spitzer, which is widely available in book form with the title Digital Dementia (Spitzer, 2018, p. 48). In the given scientific study, which the author conducted in New Zealand on a representative sample of 1,000 individuals, he tested the effects of multiple hours of internet use on the level of education and the development of personality psyche. Spitzer came to some interesting findings. It is important to say, however, that the author does not perceive the Internet a priori negatively. It is certainly a revolutionary tool that has made every day human life significantly more dynamic and easier. However, the German author takes the liberty of pointing out the negative aspects resulting from its excessive use.

For example, when excessive, continuous use of the internet for several hours can lead to symptoms of digital addiction. In his study, Spitzer suggested a maximum digital time limit when the effects on normal behaviour and communication become real. He based his conclusions on the fact that if we spend more hours a day on digital tools than we sleep and do for months or years our brains do not naturally regenerate. There are potential consequences, such as the decline of multiple key abilities. This can include a decline in vocabulary, a tendency towards depression, emotional numbness and an overall loss of life motivation (Spitzer, 2018, p. 48). In extreme cases, this can lead to gradual brain degeneration resulting in digital dementia. It is important to add a technical note at this point. If an individual uses the internet to work effectively or as part of their profession for more than five hours a day, they are not at risk of potential digital dementia. The risk is unproductive time spent on the internet, whether in the form of social networking or computer games.

3.1 Teaching and digital learning material

In terms of the aspects of the functioning of contemporary society that are affected by the digital revolution, it is important to address the factors of the impact of digitalisation on the teaching process and the learning material. Therefore, to begin with, in the context of the quality of the teaching process, we consider it important to briefly focus on the issue of teaching substance. So, what should quality learning material look like? The main objective of a quality teaching substance should increase the attractiveness of the material presented that should be achieved by following and then practically using modern teaching trends. This could be, for instance, the increased use of more clearly structured texts. Looking more closely at the specific elements of qualitative improvement of teaching, we can also use the means of complex visualisation alongside the traditional tools of presenting teaching material. Specifically, this may involve the direct use of documentary demonstrations, various practical examples or animations, which aim to offer students an alternative practical perspective alongside the theoretical one, allowing them to perceive the teaching material from a different perspective.

The main goal of modern teaching material is to make it attractive enough for students. In this regard, the responsibility and role of teachers increase, as they need to present the material in an interesting and attractive way, so that the students are interested and at the same time the professional aspect of the material is maintained. This is a very difficult task nowadays, which also shows the teachers' mastery and creativity. Teachers and professionals often use a selection of interactive teaching methods as part of modern teaching strategies. Specifically, various modern multimedia digital devices such as large LCD devices that have a few modern touch functions are used, for instance, to teach mathematics and many other subjects (Holecek, 2015, p. 31). When teaching and using the before mentioned digital devices, a new type of learning material is used, which can be referred to as digital. Under the influence of the fourth digital revolution and the continuous dynamic transformation of societies, there is a growing trend of incorporating modern digital technologies into teaching.

The form of teaching through digital devices has its positives and negatives, which are important to analyse and describe. Positive factors may include ecological and economic aspects. When most of the teaching materials are prepared in the form of digital presentations of pdf or ppt files and others. Thus, students do not need to use paper textbooks or workbooks in their learning. They can also study the lectures, and the material presented through their smartphones or other digital devices, anytime and anywhere. This teaching style thus lowers the toll on the environment. Digital learning thus has a positive environmental dimension. It also has an economic dimension. Studying becomes cheaper for students as they can save money on notebooks and stationery.

A given style of study also has its share of negative influences. On the one hand, digital learning material significantly spares the environment. It also saves the cost of studying. A student's costs are limited to owning a digital device such as a smartphone, tablet or laptop. Thus, it is one of the modern progressive methods of education. However, the given method of education might not be strictly better. A negative factor may be that with more digital learning material, the human brain of the learners will not retain the amount of information as when learning from, for example, a book or a workbook (Hasan, 2024, p. 103). Therefore, some learners prefer to take notes in a notebook in writing, as an example. This point is because our brain is evolutionarily accustomed to record information from books and notebooks that are made of natural materials. It is not yet accustomed to remembering information from digital devices, which the brain perceives as unnatural. This may be a relatively temporary condition where it will become natural for future generations, simply put, the brain will gradually become accustomed to the environment. However, this may take several generations (Hansen, 2021, p. 120).

3.2 Getting information from books and the Internet in teaching

At this point, it is important to ask the question where can the average student get quality and validated information for his general knowledge? Therefore, to know how to work and obtain information properly has always been an important advantage for the successful study of a learner. However, for the purpose of our work, we decided to briefly focus on comparing the specifics of information retrieval from the internet and book sources. Both have their specifics and are very significant for the successful orientation of contemporary learners. In the first case, the possibility of obtaining information from book sources. In the case of information obtained from books, there is an assumption that the book will be factually true. Thus, books, especially specialist books, should guarantee an impartial and objective view. Therefore, we can potentially work with a given type of information obtained as verified (Spitzer, 2018, p. 67). The veracity of the information presented can be guaranteed by the professional label of the publishing house or by peer review by multiple experts or reviewers. In the latter case, the internet can serve as a potential source of information. The Internet is the widest information source that has directly marked the global information revolution. Thus, the Internet is a wide and, most importantly, fast well of information in all possible fields. Through this network, where billions of individuals get access to information in case of internet connectivity, a wealth of information is disseminated all over the world.

For a closer historical comparison, in the past, it took several weeks to transmit information from Europe to the US by a letter or telegram, for example. Today, with an internet message, such as an e-mail or a social network message, information reaches the other side of the world in a matter of seconds. Another positive aspect of the Internet is the possibility of working through the home office system, which has brought about a revolution in employment law. Nowadays, however, there is often a debate about the quality and veracity of information. In the case of the Internet as a source of information, the aspect of verifiability and truthfulness of the information offered must be addressed. Through the Internet we have access to a range of interesting information. The Internet is thus an imaginary infinite well of information. However, the information system is often not regulated in terms of verifiability and

truthfulness. Thus, through the Internet, we can often access information that is often fictitious and unrealistic. Verified scientific theories are often questioned and alternative facts are presented as true. This increases the importance of information literacy.
However, there may be a problem if a large segment of the population begins to perceive false information as true. This creates room for manipulating public opinion by using so-called hoaxes. Consequently, a situation may arise where many individuals fall into a state of information confusion. In this state, individuals are often uncertain about what is true and what is not. One consequence of this can be, for instance, increased aggression and hostility on social media. How can this situation be addressed to enable citizens to achieve the highest possible level of information verifiability? One of the proposed recipes for maintaining as much information objectivity as possible could be an imaginary information rule of the Internet. What would this look like in practice? For example, if we come across a particular piece of information that interests us and we want to work with it as if it was true (Domborovská, Šidlichovská, 2021, p. 30). Then we should verify it using at least three independent verified sources. If we fail to do so, we may start spreading information that we admittedly consider to be true, though realistically, it may turn out to be fabricated and untrue.

4 Education and Artificial Intelligence?

Artificial intelligence, abbreviated as (AI), is increasingly becoming part of the digital society. Discussions on this topic have provoked both positive and negative reactions. Briefly summarised in terms of positive factors, AI can help, for example, in healthcare and in various other fields to make human life function more smoothly. On the other hand, from a negative perspective, people are concerned about the security aspects, lest we put ourselves at risk of possible dependence and vulnerability from AI. Simply put, should it begin to control us. But the question is, what will be the impact on the processes of education?
Under the influence of the digital revolution, it is often discussed which professions will gradually disappear or be replaced. The fact is that some professions are gradually disappearing (bank clerk, accountant). This raises the question: what will be the future status of the teaching profession? Will teachers gradually be replaced by digital technology or artificial intelligence? Based on current developments, it can be assumed for the time being that the teaching profession will not be replaced, and its importance will remain undeniable. Thus, the teaching profession still exists in an active physical and not digital form. However, the future may bring some surprising dynamic changes, such as we have been experiencing over the last decade. Gradually, a version of the digital teacher will emerge that works comprehensively with artificial intelligence in teaching and its preparation.
One of the trends is that although the position of the teacher and their influence, for example, through the involvement of digital learning materials (pdf, ppt) is constantly evolving, it is still of primary importance. Since the teacher is the main qualitative provider of knowledge and

with his specific qualities such as pedagogical tact and personal charm will still play an indispensable role even if we can already supplement it in the form of teaching through digital technologies. Looking at current trends, where we see artificial intelligence gradually beginning to penetrate everyday life, the question arises: can artificial intelligence in any form teach and replace the role of the teacher? (Mařík, Černý, Trčka et al., 2024, p. 120).

From our point of view, the answer takes several forms. From a slightly exaggerated futurological point of view, artificial intelligence can replace teachers in the delivery of educational material, for instance in the form of a hologram. It cannot, however, replace the teacher's educational dimension of influence on the learner, which is a very important component of the overall teaching process and the teacher's influence. When summarised comprehensively, it can act as a quality supplementary form in the future. In recent years, specifically since 2020, when the global world has been thrown into the so-called corona isolation, a crisis has arisen where space has been created for the closest possible integration of digital technologies into teaching. Under the influence of emergency circumstances, a digital form of teaching has emerged. This was a short-term emergency and crisis solution that fulfilled the fundamental purpose of maintaining continuity of teaching. The teacher brought his teaching into a virtual digital form.

However, when analysing the positives and negatives of digital learning during the corona crisis, we could see several facts. For example, the fact that the digital long-distance type of teaching fulfils certain qualitative elements of teaching became apparent. However, it can only have a positive effect as supplementary teaching as we have seen a weaker approach of students who, although they had comfortable and convenient conditions for studying, often were not motivated to take an active approach to studying with specific aspects of digital education. That's why the face-to-face active physical type of teacher's teaching seems to be irreplaceable.

Mainly in terms of the active involvement of the student and the overall interaction of the teaching. It must be added that digital education also has several positives. For example, a handpicked lecture by an important expert from another continent can be delivered remotely. Some universities are gradually switching to imaginary hybrid teaching. When part of the lectures take place in the form of online teaching, part face-to-face. If necessary, the student could choose according to his wishes. However, the conditions are created for the availability of education at greater distances, thus saving the travel costs of teachers and students. At the same time, student service and comfort are increased. The quality and professional content of education must remain a priority, and a digital learning system can make a positive and effective contribution to the expansion of society's level of education.

5 Suggestions for Improving the Current System of Education in a Digital Society

For society to become modern, stable and functional, it is important to be able to face and adapt to digital trends in society. Therefore, we propose the following solution to improve the current situation. The first proposal could be a certain form of Internet regulation. This is a very demanding and specific option. The Internet is a symbol of freedom of opinion and overall communication additionally as previously mentioned, the Internet is also a never-ending well of available interesting information. However, the given information is not regulated and fact checked. We have avoided this solution for several years. However, the current state of society, which is affected by the increased level of violence and aggression in virtual space, creates an environment for the necessity of a debate on certain forms of regulation. After all, the Internet today has the power to influence significant events, including elections—for instance, Donald Trump's victory in the 2016 US presidential election. Therefore, some form of systematic regulation should be considered to safeguard the fundamental principles and achievements of the Internet, namely the dissemination of objective information. However, this must be balanced with preserving its educational value while preventing the spread of falsehoods and the promotion of aggression.

Another solution could be a potential change in the media's information strategy, which would not focus primarily on the highest possible sales and profit, but on expert information on current social problems. Eliminating the aspect of media tabloidization towards deeper professional analysis of social problems. The last important proposed solution is to change the education system of citizens with the aim of maximizing the level of digital and information literacy. The goal is for most of the population to be able to filter the information they receive so that they do not become victims of hoaxes and various distortions that can manipulate public opinion in society. Citizens in today's modern societies receive information through state-of-the-art digital technologies. This should be a positive aspect in terms of options and the amount of information received.

However, we often observe a decline in society’s overall knowledge level. There is a lack of fundamental general awareness necessary for analysing common social and political issues, creating a breeding ground for speculators and supporters of conspiracy theories. Another concerning trend is the impact of modern digital communication technologies. When used as a supplementary tool in education, they can have a positive effect. However, if adolescents are exposed to digital media for more than seven hours a day from an early age, it can have significantly negative effects on their cognitive development, leading to serious developmental and learning disorders.

6 Conclusion

Thus, digital communication technologies certainly have an indisputable positive influence on the development of society. However, they also have several negative effects. We perceive the increased frequency of several types of mental disorders among teenage generations as alarming and therefore feel the importance of dealing with this specific issue, which can have a complex effect on the quality level of future generations and their ability to filter and analyse information. This can create a worldwide layer of misinformed individuals who will be easy prey for populist politicians. From the point of view of the analysis of the influence of the Internet, we can state that it is a positive tool for the development of global communication between people. The Internet is a fountain of maximum freedom of opinion. It is not regulated. There is a lot of interesting information on it. However, because it is not regulated, it also contains a few falsehoods and conspiracies that many people take as true, and it distorts their view and judgement.

The problem is the fact that an ordinary person cannot objectively verify and evaluate information on the Internet. The result is a very serious fact that people stop trusting everyday reality. They see something unfair and fraudulent behind everything. This can be dangerous for the spread of mob psychosis and aggression among people. Most children use the computer not to search for information, but to play games and kill free time, which can later negatively affect their emotional side and ability to respond empathetically to others. Young people can thus become emotionally apathetic or unambitious. In the short term, this may not appear problematic, but over time, a lack of social contact can lead to depression and anxiety. Human beings are inherently social, even if they temporarily convince themselves of self-sufficiency. Eventually, they seek connection with others. Therefore, the digital education of parents plays a crucial role. It is essential that they teach their children how to use the Internet and digital technologies responsibly — ensuring they do not become dependent on them but rather use them to enhance their quality of life.

Due to the transfer of communication to the Internet and social networks, young people may lack the personal confrontation and exchange of opinions that help stimulate the brain. Under the influence of communication moving to social networks, the style of communication among people is changing whether interacting with friends, partners or at work. The result can be emotional lability or a feeling of abandonment or even depression. It can be linked to not being able to handle critical situations that life brings, which creates the phenomenon of social deficit and digital convenience.

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The Impact of Teacher Shortages on the Quality of Education and Training at the Secondary Vocational School of Transport, Kvačalova 20, 821 08 Bratislava

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Abstract

The shortage of qualified teaching staff has become a pressing issue within regional education in Slovakia, particularly impacting vocational institutions. This study examines the personnel challenges faced by the Secondary Vocational School of Transport in Bratislava, highlighting the persistent deficit in skilled teachers despite over 12,000 graduates from pedagogical faculties between 2021 and 2024. Many secondary vocational schools struggle to attract graduates, leading to approximately 890 unfilled teaching positions in the Bratislava Region as of July 2024. The shortage is particularly severe in vocational education, where specific qualifications are required, often unavailable through traditional pedagogical training. Consequently, schools are compelled to hire professionals from industry. Low teacher salaries and the predominance of retirees applying for teaching roles exacerbate the issue, affecting the age distribution and overall suitability of staff. These factors collectively risk undermining the quality of vocational education and training.

Keywords: Quality of Vocational Education, Shortage of Teaching Staff, Real Age Structure of Teaching Staff, Impact of Shortage of Teaching Staff on Quality

1 Introduction

The lack of qualified teaching staff is currently an acute problem of regional education in the Slovak Republic. The purpose of this paper is to provide an insight into the current state of

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personnel provision of vocational education and training in the conditions of the Secondary Vocational School of Transport in Bratislava. Between 2021 and 2024, more than 12,000 graduates completed their studies at pedagogical faculties in Slovakia, but despite this number, Slovak education still faces a significant shortage of qualified and high-quality teachers. Several thousand students graduate from the faculties of education every year, yet secondary vocational schools have a shortage of job seekers from the ranks of graduates. According to the *edujob.sk* portal, as of 1st July 2024, there were approximately 890 unfilled teaching positions in the Bratislava Region. This issue is particularly pronounced in secondary vocational education, where schools face a severe shortage of specialists with specific qualifications. To ensure professional training and education in specialised fields—often not covered by pedagogical faculties—schools are increasingly compelled to recruit experts directly from industry. The second influencing factor is the salary of teachers, which does not provide a sufficient financial incentive in Slovakia. Persons of retirement age largely apply for the positions of teaching staff. This phenomenon significantly affects the age structure of the school's teaching staff. The lack of teachers can also lead to the hiring of employees who do not meet the personality requirements for the work of a teacher. The mentioned factors can negatively affect the overall quality of training and education.

2 The Structure of Teaching Staff at the Secondary Vocational School of Transport

The structure of the pedagogical staff of the Secondary Vocational School of Transport consists of teachers of general education subjects, teachers of specialised subjects, teachers of practical training and masters of professional training. The monitored sample consists of forty teaching employees of the school. According to Table 1, the average age is 54.27 years, the minimum age is 22 years, and the maximum age is 73 years, the structure of the age distribution is not uniform. Figure 1 shows the processed age structure according to age categories. The most dominant is the age category from 52 to 67 years old, consisting of seventeen employees, the category from 67 to 82 years old consists of seven employees, the prospective age group from 22 to 37 years old consists of eight employees, and the group from 37 to 52 years old also consists of eight employees.

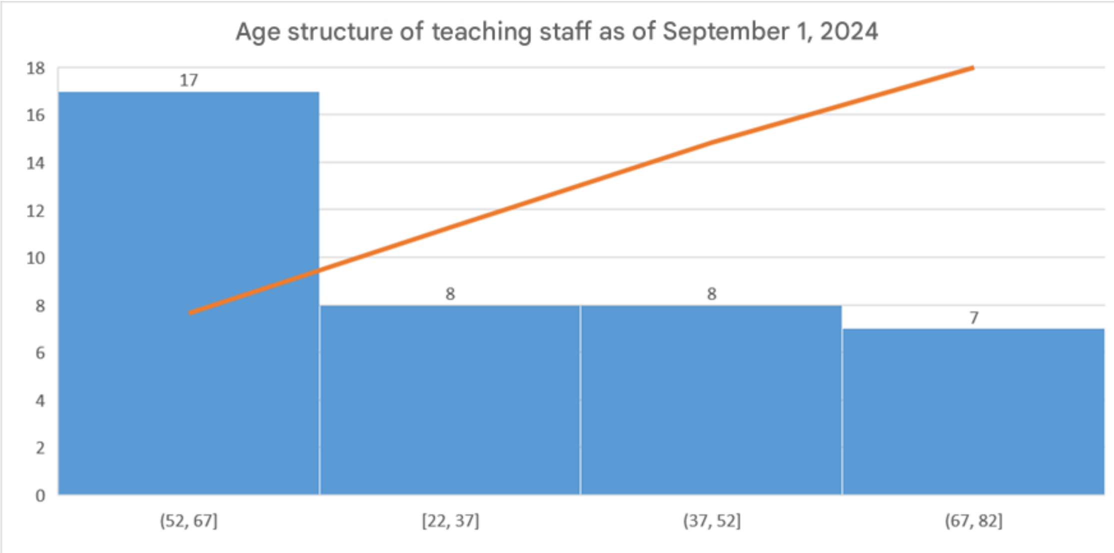

Figure 1: Graph of the age structure of the teaching staff of the school as of 1st September 2024.

Further in the survey, we monitor the length of employment on the same sample of forty employees as of 1st September 2024. Descriptive statistics of the sample with an average duration of 4.82 years at the school, a maximum of 38 years and a minimum of 1 year are recorded in Table 1, the distribution is not uniform. Figure 2 shows the proportional distribution of the duration of employment at the school: 1 to 3 years 55%, 3 to 10 years 32.5% and 10 to 40 years 7.5%.

Mean	4,825
Standard Error	1,219440551
Median	2
Mode	1
Standard Deviation	7,712419222
Sample Variance	59,48141026
Kurtosis	11,12160089
Skewness	3,262143371
Range	38
Minimum	1
Maximum	39
Sum	193
Count	40
Confidence Level(95,0%)	2,466551329

Table 1: Descriptive statistics of the employment time of teaching staff at the school as of 1st September 2024.

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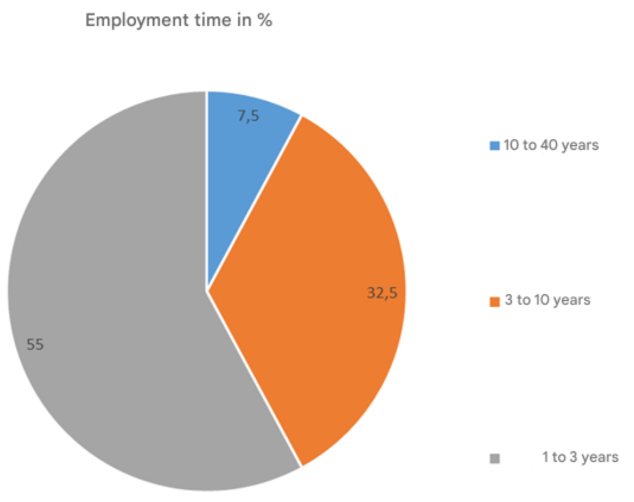

Figure 2: Graph of the percentage of time spent by teaching staff at the school as of 1st September 2024.

The percentage ratio of employees in retirement and pre-retirement age is 47.5%, the ratio for the age category between 50 and 59 years is 22.5%, and the other categories are evenly distributed, which does not correspond to the length of employment at the school. From the statistics mentioned, it follows that in the future there will be a serious problem with the staffing of professional training and education in the organization.

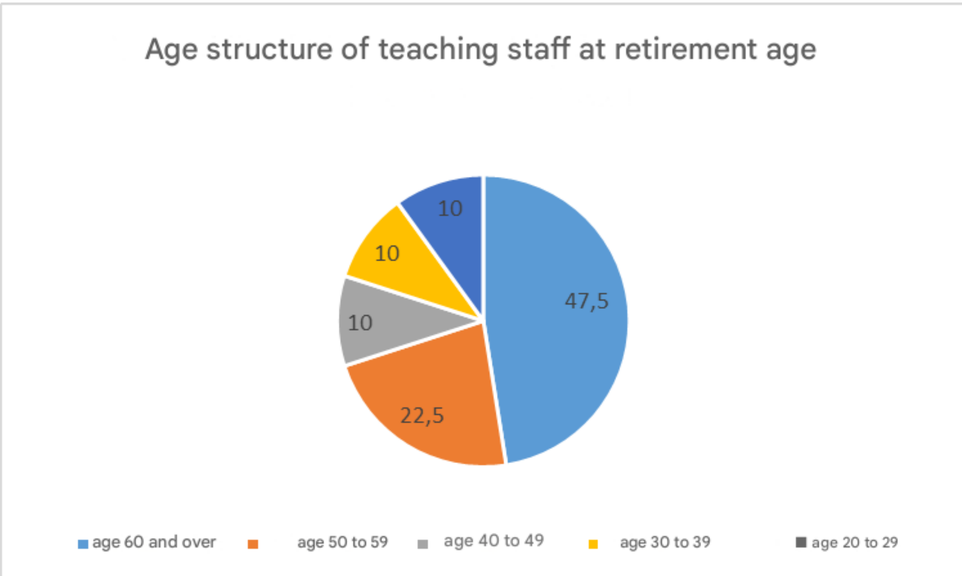

Figure 3: Graph of the percentage of teaching staff at the school in retirement and pre-retirement age as of 1st September 2024.

Further we focused on the qualitative observation of the behaviour of teaching staff in the monitored period of the school year 2023/2024. Through observation, we identified the listed deficiencies, which we segmented into 3 groups:

1. Long-term employees

Teachers who have been working at the school for a long time are loyal, often without significant absences, they have mastered administrative procedures, which is a benefit from an operational point of view. However, low motivation often leads them to reject innovative approaches, digital technologies or further education. Changing the usual procedures is difficult for them, which has a negative effect on the dynamics of teaching, they often feel professionally burnt out. In addition, many teachers do not use available methodological tools, which limit the effectiveness of their teaching and does not meet the requirements of the modern school system.

2. Employees coming to the school after reaching retirement age

Although retired teachers are experienced educators with authority and good relations with students, they are in many cases sceptical of modernising the approach to education. They are often not willing to perform additional duties, such as classroom management or supervision of students during breaks. The lack of computer literacy among some older employees also limits the introduction of innovations in the educational process and the necessary administrative activities. Health problems often lead to their long-term absence, which disrupts the flow of education and increases the pressure on the rest of the teaching staff.

3. Graduates

Graduates of pedagogic faculties come to a school full of plans, determination and ideas, but not all of them successfully complete the demanding adaptation process and persist in education as a quality young teacher. New graduates of pedagogic faculties who come to a school prove to be unprepared for the practical challenges of the teaching profession. Most of them do not know how to work with EduPage, which makes it difficult for them to adapt smoothly. Inadequate classroom management skills lead to problems in maintaining discipline, authority and student motivation.

	school year 2023/2024	school year 2022/2023	school year 2021/2022	school year 2020/2021
Faculty of Education UK	575	685	789	675
Faculty of Education PU	518	428	500	452
Faculty of Education KU	476	472	514	564
Faculty of Education UJS	192	168	202	194
Faculty of Education UKF	450	547	471	514
Faculty of Education UMB	332	372	348	374
Faculty of Education TTU	621	524	531	472

Table 2: Number of I. and II. degree graduates of pedagogical faculties of universities in the years 2020/2021-2023/2024.

3 Implications for the Quality of Education

Due to the acute shortage of personnel, the school management often finds itself in a situation where it accepts applicants with insufficient qualifications or unsuitable prerequisites. Lowering the quality criteria for hiring teaching staff leads to an increased volume of work at the school management level and more intensive monitoring and solving of problem situations. At the same time, teachers are aware of the lack of employees, which in some cases leads to a weakening of work commitment and long-term sick leaves.

The poor quality of employees has negative consequences not only on the pedagogical process, but also on workplace relations. Over the course of three years, we noted the following phenomena:

– Inappropriate communication of school teaching staff towards students and parents via social networks. Spreading information with inappropriate content and manner, including sending inappropriate photographs.

– Inappropriate behaviour of teaching staff towards students in intimate and sexual topics, including sending photographs with intimate content.

– Inability of the teaching staff to implement the educational process.

– Manifestations of verbal and non-verbal attacks against students.

– Inappropriate clothing and insufficient hygiene of teaching staff.

– Manifestations of intolerance towards students of a certain social group and discriminatory attitudes towards students from Ukraine.

– Solving personal problems, private matters of school employees and spreading misinformation and lies during classes.

These cases clearly illustrate that the quality of employees has a direct impact not only on vocational education and training, but also on the overall atmosphere and culture in schools. The absence of basic ethical standards of behaviour is apparently a global problem, as it occurs in media, politics, etc. At least minimal acceptable personality criteria for an employee should be required upon completion of formal pedagogical education.

4 Recommendations for Improving the Training and Hiring of Teachers

The Secondary Vocational School of Transport, like other educational institutions, faces an urgent need to increase the number of qualified employees. Ignoring this problem can seriously jeopardize the functioning of the school system.

Currently, employees of formal educational institutions are significantly overloaded, as they are forced to perform their work tasks in an excessive amount and under conditions of increased psychological stress. The situation is further complicated by frequent substitutions, excessive working hours and increased pressure from some parents. Based on the above facts, we recommend the following steps to increase the quality of teaching staff and professional training:

- More intensive and higher-quality preparation during university studies: Improve educational programs at pedagogical faculties with an emphasis on practical skills and the ability to work with technologies.

- Introduction of talent tests in communication: To verify the abilities of applicants for the study of pedagogy in the field of interpersonal communication.

- Introduction of subjects such as rhetoric and voice exercises: Provide students with the basic prerequisites for authoritative and effective communication with the class.

- Long-term teaching practice during studies: Ensure that students gain enough experience and better adapt to the real conditions of the school environment.

- High-quality teaching of school software, e.g. EduPage: Ensure that new teachers master basic technical tools for teaching management and communication with students.

- Psychological tests for school employees: To address not only the pedagogical but also the personal maturity of employees.

- Education in the field of appearance, hygiene and appropriate dressing.

- Fair financial evaluation based on the quality of work: Consider differentiated remuneration of teachers according to performance and approach, not only according to the number of years employed.

- Code of ethics for school employees: Establish clear ethical rules and carry out regular monitoring of activities on social networks.

These measures can help enhance the quality of education in vocational schools while fostering a safe and motivating environment for students. The school environment should primarily serve as a place where students acquire knowledge and develop personally—all personnel and systemic measures should be aligned with this objective.

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