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**	**$(P-O)^2$**		**$(P-O)/O^2$**
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**	**$(P-O)^2$**	**$(P-O)/O^2$**
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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