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).

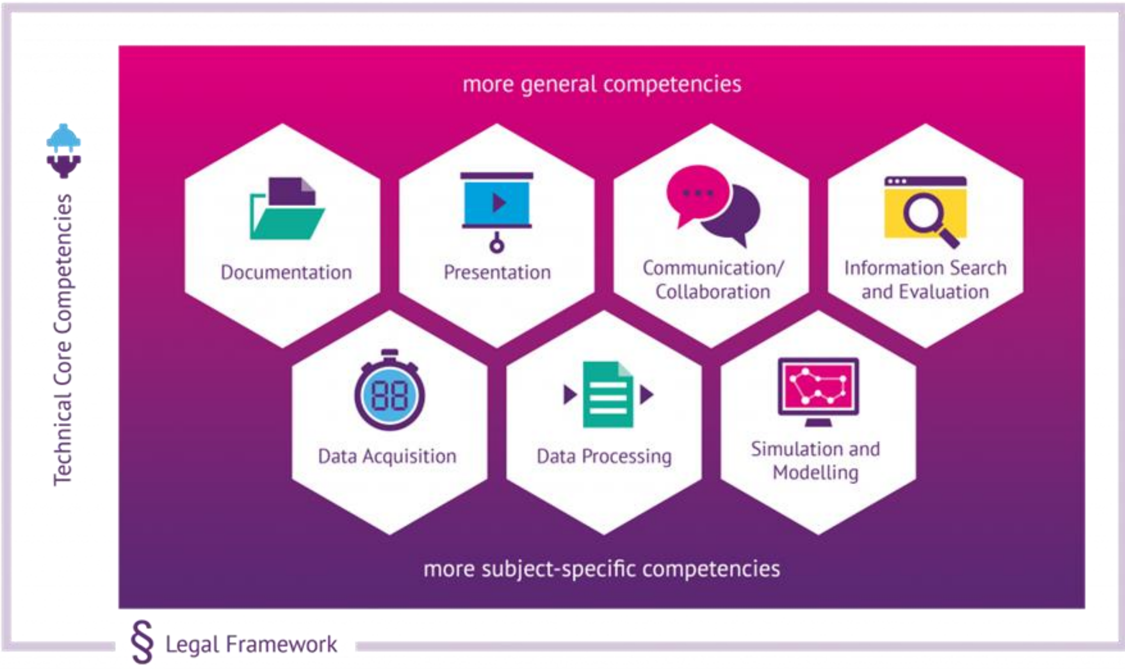

Figure 1: Indicative framework called Digital Competence and in Science (DiKoLAN), (Becker et al., 2020).

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.

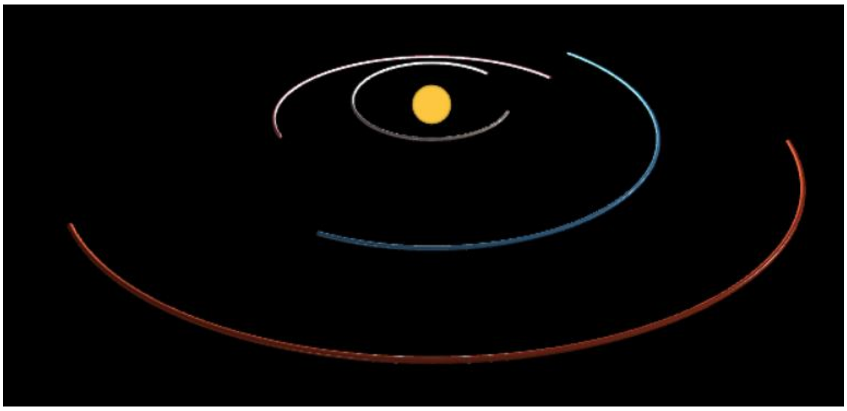

Figure 2 View of the solar system model – rocky planets.

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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