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Digital Competence and Technology Adoption in Vocational Education: Evidence from Bosnia and Herzegovina

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Abstract: *The digital transformation of vocational education and training (VET) represents one of the key prerequisites for developing a competent workforce capable of meeting the challenges of Industry 4.0 and the digital economy. However, the successful integration of digital technologies into the educational process requires adequate digital infrastructure, continuous professional development of teachers, and the enhancement of students' digital competencies. The aim of this study was to assess the current level of digital readiness in vocational education in Bosnia and Herzegovina by analysing digital competencies, the use of digital technologies, existing barriers, and the need for additional training among vocational secondary school teachers and students. The research was conducted using an online questionnaire involving 392 teachers and 1865 students from different regions of Bosnia and Herzegovina. The results indicate that digital tools have become an integral part of the teaching process, with most teachers demonstrating an intermediate level of digital competence, while students use a wide range of digital technologies on a daily basis, including artificial intelligence-based tools. The most significant barriers identified by respondents were the lack of adequate equipment and insufficient internet infrastructure. The findings suggest that Bosnia and Herzegovina has considerable potential for the digital transformation of vocational education; however, its successful implementation requires systematic improvements in digital infrastructure, continuous development of teachers' competencies, and the strategic integration of modern digital technologies into the education system.*

Keywords: *digital transformation, vocational education and training (VET), digital competencies, artificial intelligence*

1. Introduction

Digital transformation has become one of the most significant drivers of educational system development worldwide. The rapid advancement of information and communication technologies, artificial intelligence, the Internet of Things, and other digital solutions has fundamentally changed the way knowledge is acquired and competencies required by the labour market are

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developed [1]. Digital transformation is particularly important in the field of Vocational Education and Training (VET), whose primary objective is to prepare students for employment in modern industrial and business environments [2]. Through the Digital Education Action Plan 2021–2027 [3], the European Commission emphasizes that the development of digital competencies among teachers and students is one of the key priorities of European education policy, with a particular focus on digitally competent educators, accessible digital infrastructure, and the responsible use of artificial intelligence in education.

Digital competence is now recognized as one of the eight key competences for lifelong learning defined by the European Union. It encompasses the confident, critical, and responsible use of digital technologies for learning, work, and active participation in society. In line with this objective, the European Framework for the Digital Competence of Educators (DigCompEdu) [4] was developed to define the competencies teachers require for the effective integration of digital technologies into teaching and learning. The implementation of this framework contributes to improving teaching quality, promoting innovative pedagogical approaches, and preparing students for the demands of the modern labour market. Bosnia and Herzegovina has made notable progress in recent years toward the digital transformation of education. The national strategic document *Priorities for the Integration of Entrepreneurial and Digital Competencies in the Education System of Bosnia and Herzegovina 2019–2030* [5] recognizes digital competence as one of the core competencies to be developed at all levels of education. An additional milestone was achieved through Bosnia and Herzegovina's accession to the Digital Europe Programme [6] in 2024, providing new opportunities for the development of advanced digital skills, the establishment of Digital Innovation Hubs, and the modernization of educational infrastructure. Nevertheless, despite the existence of strategic policy documents, the digital transformation of vocational education remains uneven due to insufficient systemic support, disparities in digital infrastructure, and limited opportunities for the continuous professional development of teachers.

A further challenge is the rapid adoption of artificial intelligence-based tools, particularly large language models, which are increasingly becoming part of students' everyday learning practices [7]. While students are quick to adopt these technologies, educational institutions and teachers often lack the competencies, resources, and institutional guidelines necessary for their effective and responsible implementation in teaching [8]. Consequently, there is a growing need to continuously assess the digital competencies of all stakeholders involved in vocational education, identify existing barriers, and define priorities for future digital transformation initiatives.

Accordingly, the aim of this study is to assess the current level of digital readiness in vocational education in Bosnia and Herzegovina by analysing the digital competencies of vocational school teachers and students, the extent of digital

technology adoption, the key barriers to implementation, and the need for additional professional development. The findings provide evidence-based recommendations that can support the further digital transformation of vocational education in Bosnia and Herzegovina.

2. Research Methodology

This study was conducted to assess the level of digital readiness of vocational education in Bosnia and Herzegovina by analysing the digital competencies of teachers and students in vocational secondary schools. Data were collected using an anonymous online questionnaire developed within the **ERASMUS VETechConn (Elevating Vocational Education in Bosnia and Herzegovina and Montenegro through Collaborative Enhancement of VET Teachers)** project. Separate questionnaires were designed for teachers and students, consisting of closed-ended questions, multiple-choice items, and self-assessment scales for evaluating digital competencies.

A total of **2257 respondents** participated in the study, including **392 teachers** and **1865 students** from vocational secondary schools across different regions of Bosnia and Herzegovina. The teachers' questionnaire collected information on teaching experience, frequency of digital technology use in teaching, self-assessed level of digital competence, barriers to the implementation of digital tools, previous participation in professional development activities, and interest in future training. The students' questionnaire focused on the frequency of digital technology use in education, the types of digital tools used, self-assessment of digital competencies, perceived barriers to the use of digital technologies, and interest in further developing digital skills.

The collected data were analysed using descriptive statistical methods. The results are presented as absolute and relative frequencies, enabling the identification of digital technology usage patterns, key implementation challenges, and the need for further development of digital competencies among both teachers and students. Particular emphasis was placed on the comparative analysis of the responses from the two groups in order to identify common challenges and priorities for advancing the digital transformation of vocational education in Bosnia and Herzegovina.

3. Results

The results of the study are presented through an analysis of responses provided by teachers and students from vocational secondary schools in Bosnia and Herzegovina. The analysis focused on assessing the level of digital competencies, the frequency of digital technology use, the barriers to their implementation, and the respondents' willingness to further develop their digital skills. Since the study

included two distinct groups of participants, the findings are presented separately for teachers and students, followed by a comparative analysis of the key findings.

3.1 Digital Readiness of Teachers

A total of 392 vocational secondary school teachers from Bosnia and Herzegovina participated in the study. The largest proportion of respondents taught technical sciences (149), followed by social sciences (127) and natural sciences (89), while arts (16) and sports (11) were less represented. Most teachers (78%) had more than five years of teaching experience, indicating that the findings primarily reflect the perspectives of experienced educators.

The analysis showed that digital technologies have become an integral part of the teaching process. More than half of the teachers reported using digital tools either daily or several times a week, while only a small proportion indicated that they never use them. The most frequently used technologies included presentation and content creation tools (PowerPoint, Canva and Prezi), online learning platforms (Microsoft Teams and Google Classroom), and multimedia resources such as YouTube. In contrast, more advanced technologies, including artificial intelligence, virtual reality, and simulation software, were used considerably less frequently.

The self-assessment of digital competencies revealed that the majority of teachers considered their digital skills to be at an intermediate level, while approximately one-sixth assessed their competencies as advanced. At the same time, nearly one-third of respondents rated their digital competencies as basic or beginner level, highlighting the need for additional professional development and capacity building.

Regarding the barriers to the integration of digital technologies into teaching, the lack of adequate equipment in schools was identified as the most significant challenge. In addition to infrastructure-related limitations, a considerable number of teachers reported insufficient time to prepare digitally supported lessons and emphasized the need for further training in digital technologies. Fewer respondents identified the lack of institutional support or low student motivation as major barriers.

The results also indicate a high level of motivation for further professional development. A total of 341 teachers (87.0%) expressed interest in participating in additional training programmes, particularly in the development of interactive digital learning materials, the application of artificial intelligence in education, 3D modelling, and the use of virtual and augmented reality in teaching.

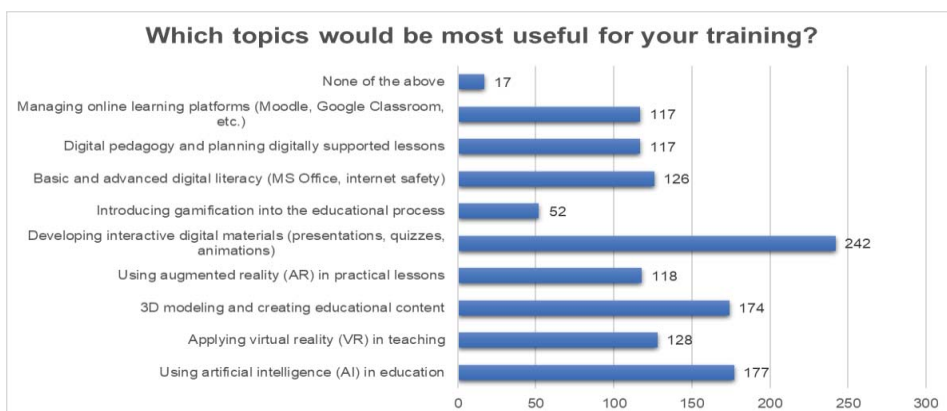


Figure 1. Chosen topics for training

Practical face-to-face workshops were identified as the preferred training format, although a substantial proportion of respondents favoured a blended learning approach combining online and in-person instruction.

The survey results show that vocational secondary school teachers in Bosnia and Herzegovina recognize the significant potential of digital technologies to enhance the educational process. The majority of respondents (138) believe that digital technologies will substantially improve the quality of teaching within the next five years, reflecting an optimistic attitude toward technological innovations in education. At the same time, a large number of teachers (135) view digital tools primarily as a valuable supplement to traditional teaching methods, while 99 respondents see the possibility of digital technologies replacing certain parts of conventional instruction. This diversity of opinions reflects openness to change as well as an awareness of the need for a balanced approach that combines the best of both worlds—digital and traditional.

3.2 Digital Readiness Of Students

A total of **1865 students** from vocational secondary schools across Bosnia and Herzegovina participated in the study. The largest proportion of respondents were first-year students (750), followed by second-year (573) and third-year students (396), while fourth-year students (146) accounted for the smallest share of the sample. Consequently, the findings primarily reflect the experiences and perceptions of students in the lower grades of vocational education.

The results indicate that digital technologies are widely present in the educational process. Approximately half of the students reported using digital technologies in school on a daily basis, while a considerable proportion stated that they use them several times a week or occasionally. Only a small number of respondents indicated that they never use digital technologies during school activities. These

findings suggest that digital tools are increasingly integrated into vocational education; however, their implementation is still not consistent across schools.

Artificial intelligence-based applications emerged as the most frequently used digital tools among students, with ChatGPT and similar AI platforms being reported more often than traditional learning management systems. YouTube, presentation software such as PowerPoint and Canva, and Google Classroom were also widely used. In contrast, advanced educational technologies, including virtual reality, 3D modelling software, and structured learning platforms such as Moodle, were used considerably less frequently, indicating that these technologies have not yet been systematically integrated into vocational education.

Most students assessed their digital competencies as intermediate, while a substantial proportion considered themselves advanced users capable of programming, video editing, or working with artificial intelligence tools. Nevertheless, a considerable number of students reported possessing only basic digital skills, suggesting that further development of digital competencies remains necessary.

The lack of adequate equipment and insufficient internet connectivity were identified as the two most significant barriers to the effective use of digital technologies in schools. Although only a relatively small proportion of students reported difficulties in using digital technologies, a notable number stated that digital technologies were rarely or never used in their schools. These findings indicate that infrastructural limitations continue to represent one of the main obstacles to the digital transformation of vocational education.

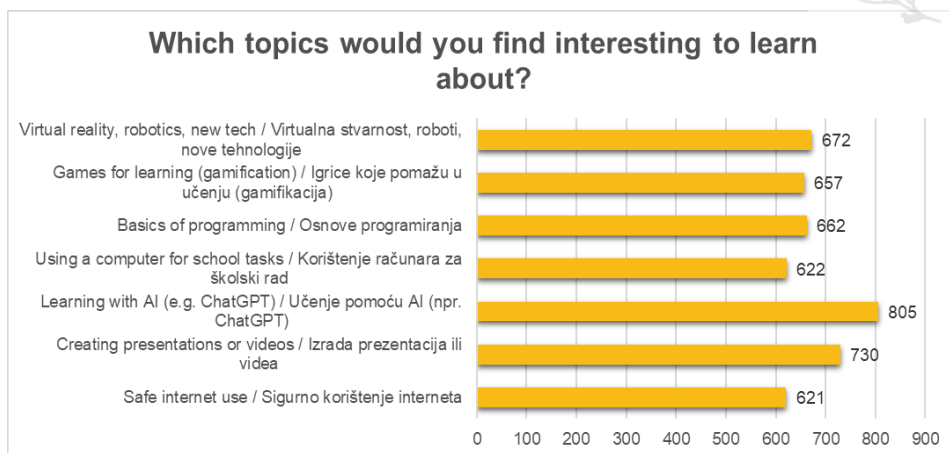


Figure 2. Interesting topics for students

The survey also revealed a strong interest in further developing digital competencies. More than four-fifths of the students expressed willingness to participate in additional digital skills training. The highest level of interest was

observed in topics related to artificial intelligence, content creation, virtual reality and robotics, basic programming, digital safety, and gamification. Regarding the preferred mode of learning, students favoured practical face-to-face workshops, followed by blended learning approaches combining online and classroom-based instruction.

In addition, students demonstrated a highly positive perception of digital technologies in education. Most respondents agreed that the use of digital tools improves the quality of learning and facilitates a better understanding of educational content. Moreover, they recognized the continuous development of digital competencies as an important prerequisite for successful learning and future employability.

3.3 Comparative Findings

The findings suggest that both teachers and students recognize the importance of digital technologies in vocational education. However, successful digital transformation requires not only investment in infrastructure but also continuous professional development for teachers and systematic integration of innovative digital tools into teaching practice.

Table 1. Comparison of key findings for teachers and students

Indicator	Teachers	Students
Use of digital technologies	Frequent, mainly for teaching preparation and delivery	Frequent, mainly for learning and completing school tasks
Self-assessed digital competence	Predominantly intermediate	Predominantly intermediate
Main barriers	Lack of equipment, limited time, need for training	Lack of equipment and internet access
Interest in further training	Very high (87%)	Very high (over 80%)
Priority topics	AI, digital content creation, VR/AR, 3D modelling	AI, programming, robotics, digital content creation

3.4 Recommendations

Based on the findings of this study, several recommendations can be proposed to support the digital transformation of vocational education in Bosnia and Herzegovina.

First, investment in digital infrastructure should be prioritized to ensure that vocational schools have adequate equipment, reliable internet connectivity, and access to modern educational technologies. Addressing these infrastructural challenges would enable more effective integration of digital tools into everyday teaching and learning activities.

Second, continuous professional development programmes should be provided for teachers, with particular emphasis on practical training in emerging technologies such as artificial intelligence, virtual and augmented reality, 3D modelling, and the development of interactive digital learning materials. Such programmes should focus not only on improving technical skills but also on strengthening teachers' pedagogical competencies for the effective integration of digital technologies into the classroom.

Third, digital competencies should be systematically embedded within vocational education curricula. Beyond basic digital literacy, students should be provided with opportunities to develop practical skills related to artificial intelligence, programming, robotics, data analysis, cybersecurity, and other Industry 4.0 technologies that are increasingly demanded in the labour market.

Finally, stronger collaboration between vocational schools, higher education institutions, industry partners, and policy makers is essential for creating a sustainable digital education ecosystem. Such cooperation would facilitate knowledge exchange, improve curriculum relevance, and ensure that vocational education responds effectively to ongoing technological and labour market changes.

Implementing these recommendations would contribute to strengthening digital readiness among both teachers and students while supporting the long-term digital transformation and competitiveness of vocational education in Bosnia and Herzegovina.

5. Conclusion

This study assessed the digital readiness of teachers and students in vocational education in Bosnia and Herzegovina. The findings indicate that both groups recognize the importance of digital technologies and demonstrate a strong willingness to further develop their digital competencies. However, challenges related to digital infrastructure and the systematic integration of advanced technologies into teaching remain significant. Strengthening digital competencies, improving school infrastructure, and providing continuous professional development for teachers are essential steps towards supporting the digital transformation of vocational education and preparing learners for the evolving demands of the digital economy.

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