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Digitization in the Teaching Process: The Significance of Digital Tools Integration

Nataša Papić-Blagojević[1,*], Željko Račić[1]

[1] Novi Sad School of Business, Novi Sad, Republic of Serbia

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ABSTRACT

Digitization, as the fourth industrial revolution, has stimulated changes in all areas of life. This paper highlights the importance of digitizing the teaching process, the evolving role of teachers, and the challenges they face in creating and implementing pedagogical-didactic models in a digital environment. To address these challenges, the DigCompEdu model was presented, which is primarily designed to help teachers develop digital competencies at all levels of education. The study was conducted on a sample of 221 students from the Autonomous Province of Vojvodina (Republic of Serbia) to evaluate their satisfaction with the digitization of the teaching process, aligned with the Strategy for Education Development until 2030. The results indicate that students generally support the digitalization of teaching, although the degree of satisfaction varies across different student categories. Based on the findings, it can be concluded that the digitization of teaching in the Republic of Serbia yields satisfactory results, and its continued progress requires ongoing upskilling and reskilling of teachers in this domain.

1. Introduction

The fourth industrial revolution initiated changes in all areas of life and work. The development and mass use of information and communication technology (ICT) have influenced changes in the habits and needs of everyone, especially young people and students [1]. The foundations of the traditional educational paradigm have been shaken because the needs of new generations of students are changing in the direction of digitalization. Therefore, digitization, i.e. the introduction and use of digital tools in the teaching process, is imperative for modern teachers [2]. The field of education is mainly reactive, as new disruptive technologies develop in other industries should be applied and accommodated into existing educational cultures and systems [3]. Today, there are many concepts of digitization which have a lot of positive implications in the field of education [4]. Digitization of the education system is one of the key components of the Strategy for Education Development until 2030 in the Republic of Serbia [5]. The Strategy aims to improve the educational system through the integration of digital technologies, modernization of teaching, and the

* *Corresponding author.*
E-mail address: npapic.blagojevic@gmail.com

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introduction of modern digital tools into the teaching process, aiming to bring the quality of the teaching process closer to the needs of contemporary students.

According to a survey conducted in 2017 [6], only 47% of teachers estimated that the level of equipment of schools with ICT is satisfactory, while more than half of teachers need regular access to digital cabinets. Regular and high-quality access to digital tools is crucial for effectively integrating technology into teaching and supporting modern education. Since 2018, following the digitization process, the pilot project "Schools for the 21st Century" has been implemented, which aims to provide training and support for teachers to contribute to developing digital students' skills and encourage school networking. In this regard, the specific goals of the Strategy for Digital Skills Development [7] were defined to ensure a timely response to intensive technological changes and thus contribute to developing the individual and society in the new circumstances. As a significant particular goal of the Strategy, the *Improvement of digital competences* in the educational system is defined, which implies the implementation of basic digital competences and the introduction of programming and computer-based problem-solving in curricula at all levels of education.

To successfully integrate digital competencies into the educational process, it is necessary first to define the specific areas of competence, and the levels of expertise, knowledge, skills, and attitudes required for each area. In this sense, the basis for improving digital competences in the education system in the Republic of Serbia is the Digital Competence Framework - Teacher for the Digital Age [8], by which applying teachers directly contribute to developing a digital teaching environment. At the same time, the development of teachers' digital competences not only means the technical application of information and communication technologies in the teaching process but also the development of conceptual solutions and the creation of an innovative educational environment to improve the teaching process. In this way, technology should enable the teacher to contribute to raising the quality of education, making it more relevant and efficient.

Further development of the Digital Competence Framework - Teacher for the Digital Age 2023 [9] introduced novelties related to the application of artificial intelligence in education with a greater focus on the well-being of students in the digital environment. On that occasion, 25 digital competencies desirable for the teaching profession were classified into six categories: (1) digital environment; (2) digital resources; (3) teaching and learning; (4) development monitoring; (5) supporting students in the learning process; and (6) professional engagement and development. In this way, the process of classifying and identifying desirable digital competencies is not finished; on the contrary, it has just begun, opening up space for further modification by the specifics of a particular educational context.

In order to further align education policies with scientific, technical, and technological development, the Strategy for Education Development until 2030 aims to improve the education system by integrating digital technologies and introducing modern digital tools into the teaching process. Within the framework of the Strategy, the obligation of educational institutions is defined in terms of undertaking activities related to the design and introduction of digital platforms into everyday teaching practice. The activities of this type, institution should align with their strategic goals by adhering to the standards for ensuring the quality of education to ensure consistency and quality in applying digital solutions.

The Action Plan [10] follows the Strategy by providing concrete steps and measures for implementing digital solutions in schools and providing suggestions and ways of training teaching staff to use new technologies. The action plan defines particular goals that, among other things, relate to establishing foundations for developing digital education at the pre-university level (Special goal 1.3) and digitizing higher education (Special goal 2.4). The achievement of this goal is foreseen through the introduction of digital platforms, the development of the register of competences and

the register of qualifications [5]. In this sense, it is envisaged that designing and introducing digital platforms will be undertaken with a pre-defined dynamic while respecting quality assurance standards and within the institutional framework. When it comes to developing the register of competences and the register of qualifications, the first step will be drafting legislation in this area and providing appropriate guidelines for their use.

In this way, it is envisaged that the continuity of the application of digital solutions will be ensured through all levels of the teaching process. The paper presents the current situation and the initiatives undertaken in order to digitize the educational system, as well as the results of research about the needs of students in the context of the use of digital tools in the teaching process.

2. The Role and Tasks of Teachers in the Digital Age

The role of the teacher is crucial in designing the digital form of the educational process because the development of pedagogy and teaching methodology in the digital age is still in its initial phase. Research shows that the traditional approach to the teaching process, in which the teacher is the central figure and the only source of knowledge, does not give satisfactory results. However, applying digital tools enables and encourages placing students at the center of the teaching process while the teacher's role is transformed into an advisory, moderating and collaborative one. Within this new educational paradigm, the role of teachers is to find a way to encourage students to independently study relevant digital content, which allows class time to be used for heuristic discussion that enables the maximum development of student’s potential and adequate preparation for business in the digital age.

Such a change in approach requires teachers to change their thinking and engagement in accepting dynamic technological changes, which implies the continuous improvement of professional knowledge and skills and the acquisition of other knowledge and skills [11]. In this way, the possibility of developing digital didactics and creating new principles and approaches to teaching and assessing achievements is opened [12].

Effective technology integration for topic-specific pedagogy requires developing a sensitivity to the dynamic relationship between the following knowledge components situated in unique contexts: content knowledge, pedagogical knowledge, technological knowledge, pedagogical content knowledge, technological content knowledge, and technological pedagogical knowledge [13].

When it comes to the European framework, of particular importance are DigCompEdu [14], which is primarily designed to help teachers and other stakeholders in education to develop their models of digital competences at all levels of education, as well as DigComp 2.2 [15], designed to support the development of digital competences of individuals through adequate examples of competence areas at all levels of development.

Figure 1 [16] shows the essential elements of the DigiComp framework in 5 areas. This important tool helps European citizens, and the workforce evaluate their digital skills, set learning goals, identify training opportunities, and enhance career prospects.

Fig. 1. DigComp Framework

However, the integration of digital tools in teaching faces numerous challenges. The biggest is the lack of teachers' motivation to acquire digital skills, particularly among teachers of older generations who rely predominantly on traditional pedagogical and didactic methods in their work [17]. The next factor that slows down the digitization of the teaching process is insufficiently developed technical and technological infrastructure in schools (weak internet connection, outdated equipment, etc.). It is necessary to make additional monetary investments to acquire the prerequisites for effectively implementing modern digital tools in teaching. Finally, it is essential to systematically organize additional training for teachers, enabling them to see the possibilities of primary digital tools and acquire technical and transversal knowledge, skills and competencies necessary for the effective digitization of teaching.

3. Methodology

To assess the current quality of the application of digital tools in the teaching process, a survey was conducted on a representative sample of students of the Autonomous Province of Vojvodina. The survey was conducted using a Google questionnaire and distributed online through available student databases. The questionnaire was completed anonymously, ensuring impartiality and trust in the research process. It was designed to include both general questions and closed-ended questions, as well as items formulated using a Likert scale, where students expressed their agreement with specific statements ranging from “Strongly disagree” (1) to “Strongly agree” (5). Two hundred and twenty-one respondents participated in the survey; of all respondents, 51.4% are students of bachelor studies, 24.6% are master's students, and 23.9% study distance learning programs (DLS).

The general goal was to examine the needs of students for digitization of the teaching process. The analysis of the results of the conducted research aims to find adequate pedagogical-didactic models, which can serve as guidelines for teachers to effectively integrate digital teaching tools (chosen by the respondents) to better prepare students for business in the digital age. In addition, the goal was to determine the extent to which students are satisfied with the current teaching models used in practice, as well as which digital tools students consider the most useful for improving the quality of the teaching process.

In line with the research objectives, the following research questions were defined:

RQ1: What is the significance of using different digital tools in the teaching process for students at various levels and types of study?

RQ2: How does the application of digital tools in teaching help students learn faster and more efficiently? Are there differences among different study levels?

RQ3: Does the use of digital tools directly enhance students' sense of active participation in the teaching process?

In addition to descriptive statistics, the study also employed inferential statistical methods, specifically one-way analysis of variance (ANOVA) and post hoc analysis, to examine the significance of differences in the use of digital tools depending on the study level. The quantitative analysis was conducted using IBM SPSS Statistics 25.

4. Results and Discussion

Based on the research conducted among randomly sampled students, 93% of the total surveyed students attended classes in which digital tools were applied. From their experience, digital tools were used within synchronous and asynchronous learning. The digital tools used most for synchronous learning are Zoom, Google Teams, and applications such as Slido and Kahoot for conducting quizzes during class. On the other hand, recorded video lectures and applications for collaborative learning and developing critical thinking, such as Padlet and Kialo.Edu, are the most used for asynchronous learning.

Observing students across different study levels in terms of their perception of the ideal lecture duration (*How long should a lecture ideally last*?), undergraduate and master's students share the opinion that the ideal length would be two academic hours (68.9% and 68.6%). In contrast, DLS students are divided in their preference between one and two academic hours.

The inclusion of digital tools is considered significant, particularly when analyzing the first signs of saturation with the teaching unit (*After how long you experience the first signs of satiety*?). In this regard, a noticeable difference emerges between undergraduate and master's students. For undergraduates, signs of saturation most commonly appear between 30 minutes and one hour in both traditional studies (39.3%) and online studies (47.2%). On the other hand, the largest proportion of master's students (37.1%) report feeling saturated between one and one and a half hours.

Across all student generations, quizzes are the most favored digital tool, especially among undergraduate students (82.2%), followed by DLS students (61.1%), while 57.1% of master's students indicated quizzes as their preferred tool. Students preferred quizzes over other digital solutions, primarily due to the possibility of interactively checking the material covered, the feeling that through the game, they gain knowledge and correct mistakes, learning simultaneously, but also gain the points necessary to form the final grade.

4.1 Descriptive Statistics Results

The results of the descriptive statistics presented in Table 1 for the selected set of variables that were part of the online questionnaire support the conclusion that students at all study levels consider as important the existence of an appropriate communication channel with the professor (*Mean* = 4.33; *Mean* = 4.86; and *Mean* = 4.80). In this way, students have the opportunity for more direct and faster communication with professors, as well as access to more precise and comprehensive information on topics of interest.

Table 1
Descriptive Statistics for selected variables

Variables	Bachelor studies		Bachelor studies-DLS		Master studies	
	Mean	SD	Mean	SD	Mean	SD
It is beneficial for students to have an open digital channel of communication with the professor.	4.33	1.106	4.86	0.424	4.80	0.531
Watching video lessons makes the learning process easier for me.	3.99	1.152	4.78	0.540	4.46	0.919
The technical quality of a video lesson is very important to me.	4.20	0.921	4.11	0.854	4.43	0.850
The presence of subtitles within the video lesson is very important to me.	3.47	1.177	3.44	1.157	3.71	1.100
The choice of background music for a video is very important to me.	2.77	1.287	3.03	1.464	3.34	1.235

According to results, video lectures are particularly important for DLS students (*Mean* = 4.78), but also for master's students (*Mean* = 4.46). The technical quality of video lectures is most appreciated by master's students (*Mean* = 4.43), while the presence of subtitles and background music in video lectures is not so important for students at all levels of study (Subtitles: *Mean* = 3.47; *Mean* = 3.44; *Mean* = 3.71; Background music: *Mean* = 2.77; *Mean* = 3.03; *Mean* = 3.34). This student opinion actually suggests that they do not have a strong stance on this issue, as the value (3) on the Likert scale represents "Neither agree nor disagree."

4.2 Results of the analysis of differences among students across different study levels

In order to examine the differences between students at different levels of study regarding the impact of the use of digital tools on increasing attention levels, a one-way analysis of variance (ANOVA) was conducted. Since the results of the analysis showed a significance level of Sig. = 0.007 < 0.05, it can be concluded that there is a statistically significant difference in the mean values of this variable (*Digital tools and student attention*) among the different levels of study (Bachelor studies, Bachelor studies – DLS, and Master studies), and that further analysis can be conducted.

Table 2
Post hoc analysis by study level

(I) Study level	(J) Study level	Mean Difference (I-J)	Std. Error	Sig.
Bachelor studies	Bachelor studies-DLS	-0.354*	0.136	0.027
	Master studies	-0.320	0.138	0.056
Bachelor studies-DLS	Bachelor studies	0.354*	0.136	0.027
	Master studies	0.034	0.173	0.979
Master studies	Bachelor studies	0.320	0.138	0.056
	Bachelor studies-DLS	-0.034	0.173	0.979

The post hoc analysis showed that there is a statistically significant difference at the significance level of $p < 0.05$ (*Sig*. = 0.027) between undergraduate students and DLS students regarding the perceived impact of the use of digital tools on increasing attention levels (Table 2).

If the impact of the use of digital tools on easier mastering of the course material is analyzed, it can be stated that there is a statistically significant difference among the groups, i.e., levels of study, since the significance level is *Sig*. = 0.002 < 0.05. The post hoc analysis provides insight into the differences between specific groups (Table 3).

Table 3
Post hoc analysis by study level

(I) Study level	(J) Study level	Mean Difference (I-J)	Std. Error	Sig.
Bachelor studies	Bachelor studies-DLS	-0.557*	0.159	0.002
	Master studies	-0.268	0.161	0.220
Bachelor studies-DLS	Bachelor studies	0.557*	0.159	0.002
	Master studies	0.290	0.201	0.321
Master studies	Bachelor studies	0.268	0.161	0.220
	Bachelor studies-DLS	-0.290	0.201	0.321

The post hoc analysis showed that a statistically significant difference also exists by this criterion (*Digital tools and easier learning*) between undergraduate students attending classes in the traditional format and those enrolled in online studies.

Finally, an analysis was conducted to examine the differences among students at different levels of study regarding their assessment of the impact of digital tools on the sense of active participation in the teaching process. For this criterion as well, the significance level was below 0.05, specifically *Sig*. = 0.008, thus meeting the conditions for further analysis.

Table 4
Post hoc analysis by study level

(I) Study level	(J) Study level	Mean Difference (I-J)	Std. Error	Sig.
Bachelor studies	Bachelor studies-DLS	**-0.569***	0.183	0.006
	Master studies	-0.217	0.185	0.470
Bachelor studies-DLS	Bachelor studies	**0.569***	0.183	0.006
	Master studies	0.352	0.231	0.283
Master studies	Bachelor studies	0.217	0.185	0.470
	Bachelor studies-DLS	-0.352	0.231	0.283

The results of the post hoc analysis showed that there is a statistically significant difference between undergraduate students and distance learning students at the significance level of $p < 0.05$ (*Sig*. = 0.006) regarding the variable *Digital tools and active participation* (Table 4).

To more precisely determine the effect size of the selected variables for which statistically significant differences were found between undergraduate and DLS students, the η^2 (Eta squared) coefficient was calculated. This coefficient measures the proportion of variance in the dependent variable explained by the independent variable that is grouped [18]. An effect is considered small if $\eta^2 = 0.01$, medium if $\eta^2 = 0.06$, and large if $\eta^2 = 0.14$ [19]. The results of the estimated Eta coefficient are presented in Table 5.

Table 5
Eta squared coefficient

Variables	*η2* (Eta squared)	Effect
Digital tools and student attention	0.047	Medium
Digital tools and easier learning	0.061	Medium
Digital tools and active participation	0.047	Medium

Based on the results presented in Table 5, it can be concluded that the effect of the difference in mean values between undergraduate and online students is moderate for the evaluated variables *Digital tools and student attention*, *Digital tools and easier learning*, and *Digital tools and active participation*, and that these differences can be considered statistically significant.

Based on all of the above, it can be concluded that the research results support the claim that implementing digital transformation in education is essential for improving the quality of teaching and learning. The modernization of the educational system through the introduction of digital tools enables teachers, students and pupils at all educational levels to have better access to materials, more efficient mastering of the material and greater interactivity. Also, training of teaching staff in digital tools and ensuring adequate technical infrastructure are essential steps in this process. In the Republic of Serbia, as in many other countries, investing in the digital transformation of education can significantly improve educational and scientific research results and thus prepare educational institutions for the challenges of modern society [20].

5. Conclusions

The traditional concept of teaching does not give satisfactory results. Changes in the educational paradigm, stimulated by the fourth industrial revolution, place the imperative of implementing digital tools in the teaching process before teachers. In the digital age, they must be prepared for constant upskilling and reskilling. In the Republic of Serbia, this initiative is supported by the Strategy for Education Development until 2030, where one of the goals is that through continuous improvement of professional and other necessary knowledge and skills, teachers will fully meet the challenges of digitization of education and training.

In order to examine the impact and significance of differences related to students' affiliation with specific levels of study, a survey was conducted involving 221 active students. The analysis showed that for the selected variables — *Digital tools and student attention*, *Digital tools and easier learning*, and *Digital tools and active participation* — there is a statistically significant difference between students of *Bachelor studies* and *Bachelor studies – DLS*. To assess the strength of the difference in mean values between these two groups, the Eta squared coefficient was used, which indicated a moderate effect size for all three variables. In this way, the initial assumptions defined through the research questions — focused on examining the significance of using various digital tools at different levels of study — were confirmed.

The research on students' needs in the context of digitization showed that students fully accept the use of digital tools in teaching and that better access to educational materials and greater interactivity help them acquire professional knowledge and skills necessary for successful business in the modern age.

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Conflicts of Interest

The authors declare no conflicts of interest.

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