Comparison of learning outcomes in the traditional and e-learning model in higher education

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Abstract— E-learning was a matter of personal choice, in line with individual preferences, commitments, and leisure, until two years ago. We found ourselves in a scenario where we all had to start working remotely, which had a significant impact on education as one of society's foundations. We were compelled to adopt two teaching models because of health restrictions: online and a blended hybrid model that mixes periodic face-to-face education with e-learning. Therefore, it is now critical to assess the outcomes. This paper addresses this topic, restricting its scope to the students' results and experiences. A survey is performed to assess students' perceptions of being taught online and in a hybrid model, as opposed to face-to-face, and to determine which type of learning they prefer. We investigated why two groups of students at different levels of study had such disparate survey results. The outcomes of students' midterm exams over the previous four years are analyzed to confirm the successful transformation of the traditional curriculum into an e-learning model.

Keywords— e-learning, e-teaching, distance learning, learning outcomes, higher education

I. INTRODUCTION

Higher education in Serbia has experienced numerous challenges and significant transformations in the previous 15 years. European standards have been implemented in education as a result of the Bologna Process, with the goal of reforming higher education to make it student-centered learning, to balance competencies, and to promote student mobility. At the same time, a formal model of e-learning in higher education was introduced. An institution that implements a distance learning model must ensure that this method of education provides the same levels of knowledge and skills as traditional education. For that purpose, the Republic of Serbia's National Council for Higher Education developed the standards that higher education institutions must achieve during the accreditation process for this method of learning. Simultaneously, the institutions must meet the necessary ICT and software requirements to deliver this model of education. According to the data from the National Entity for Accreditation and Quality Assurance in Higher Education in 2019, only 18 out of 270 higher education institutions (170 state-funded and private faculties and 80 schools of applied studies) have at least one accredited distance learning study program [1]. The latest report from this institution reveals that currently there are only 13 institutions with at least one accredited distance learning study programs [2]. In the evolution of higher education, there has been an increasing need for short and accelerated programs that are different from formal traditional academic programs. The implementation of the dual education system in higher education reflects the latest improvements in the education system in Serbia. Combining it with e-learning could make it more efficient.

The delivery of learning, training or education program electronically is called e-learning. According to some, it is a subset of electronic business technology i.e., a form of technology used to increase an organization's efficiency, decrease expenses, or expands market reach using the Internet. The application of these technologies achieves many advantages over the traditional ones:

- Ubiquity: Elimination of physical or time constraints;
- Global coverage: Geographic, temporal, and national restrictions have been erased thanks to the Internet, resulting in a potential market for the entire world's population;
- Universal standards: the standards and protocols on which e-business technology is based are universal and provide interoperability at the global level;
- Information wealth: Global market data can be obtained easily, inexpensively, and fast with high precision;
- Interactivity: Information technologies used in e-business technology are interactive and enable quality two-way communication, which provides useful feedback and adaptability;
- Personalization: User-specific content can be generated and supplied based on his preferences, needs, or other factors, which results in an individual's tailored environment (interface) that feels more comfortable.

Due to a health crisis, we found ourselves in a situation where working remotely was no longer a choice, but a necessity. Depending on the sort of employment, remote work is possible in some circumstances, but not in others, such as production facilities, construction, etc. The same path was followed in the education sector, where the e-learning model has taken on a substantially main role. People's mobility was limited by restrictions, but remote working, e-learning, and online collaboration platforms, as well as online leisure options such as gaming and video streaming, began to grow. These new circumstances have

underlined the Internet's critical role. As a result, Internet traffic volume has increased by roughly 40%, often at the expense of download performance, raising concerns about the Internet's robustness [3] [4].

Education is one of the pillars of every society, and it has experienced substantial disruption in recent years. Professors and students alike were pushed to reconsider how they used available technology to both provide and receive academic resources. However, whether or not this forced change was effective, it is time to examine the results of this period. Based on observations and experiences from higher education, in the next sections of this paper a critical analysis of e-learning issues will be presented, as well as results on students' preferences regarding preferred learning method. To confirm successful transformation of one traditional curriculum into an e-learning course, we conducted a comparative analysis of learning outcomes in each teaching model. Our hypothesis is that the transformation is effective if the results are consistent, regardless of the applied learning model.

II. TRADITIONAL AND E-LEARNING MODEL

In the previous period, there were many discussions and research on the topic of e-education. The influence of modern technologies on the process of learning and education has greatly changed the traditional approach to education. The usual sage on stage approach is less and less dominant in education. Sage on the stage is a teaching approach where a professor lectures their students to impart knowledge. With little feedback, students are expected to take notes, learn, and repeat this information when asked. Students passively absorb the knowledge that the teacher presents to them. To meet the needs of new generations, lectures had to undergo a modernization process, which included the addition of interactive multimedia content to keep up with other social content and the environment. The discussion surrounding the employment of digital technologies in higher education is primarily focused on student learning rather than professor lecturing and their lack of adequate digital literacy [5]. Utilizing new technologies in education requires teachers to assume new responsibilities, develop a range of new skills, and undertake a long list of new roles. This is an ongoing research topic, which aims to find different instruments for measuring digital competence in teaching. For instance, the European Framework for the Digital Competence of Educators (DigCompEdu) [6] summarizes a teacher's digital competence in six areas, which are divided into 22 specific competencies, as shown in Fig. 1. Area 1 is focused with at the greater professional environment, i.e., educators' use of digital technology in professional contacts with colleagues, students, parents, and for their own career advancement. Area 2 examines the skills required to utilize, develop, and distribute digital learning resources effectively. Area 3 is responsible for overseeing and managing the use of digital technology in learning and teaching. The use of digital techniques to improve assessment is addressed in Area 4. The potential of digital technology for learner-centered teaching and learning practices is the emphasis of Area 5. The specific pedagogic abilities necessary to enhance students' digital competence are detailed in Area 6.

Students are constantly on social networks and text messaging, and they use a number of online platforms to express themselves. Young students are frequently described as having a natural affinity to digital technologies for everyday use. However, the main concern in terms of education is if they are capable of learning independently and with the same dedication in e-learning model. As a result, the guide on the side approach is becoming particularly crucial in the distant learning model. An educator who empowers students to study a subject area autonomously or through mutual interaction while providing them with learning resources, occasional guidance, assistance, and correction. Also, it is not enough for students to know how to utilize the various mobile devices and software that are available at a given time throughout their studies at a higher education institution. Given the quick rate of technology advancement, they must also be able to adapt to new digital settings and create habits that foster the continual mastery of new digital abilities [5] [7].

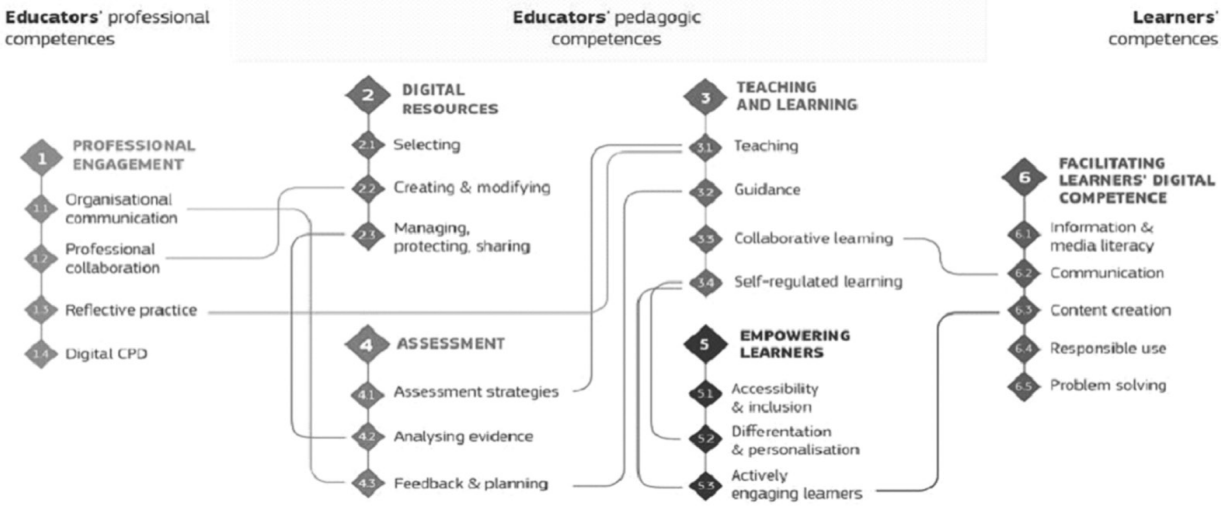

Fig. 1.The European framework for the digital competence of educators. Source: [6]

Professors who teach intensively online have been reported in multiple studies to have a higher rate of burnout than professors who do not teach online [7]. Intellectual property concerns are addressed as losing intellectual property rights to teacher's course materials that may include original approaches and creative concepts. Enforcing copyright and fair use of educational materials available online presents numerous challenges. It's not unusual to come across a simple link to another teacher's online materials within an online course. Are appropriate references sufficient for satisfaction, given the time and effort invested in creating course materials?

Learning to conduct courses using digital resources has an overall positive impact on online teaching approaches in higher education [8]. Due to health restrictions, during last two years, we used two models of teaching: online and a blended learning hybrid model. Hybrid learning model combines face-to-face education with online attendance. Lecturers have been given new roles in these models, compared to traditional education. On the other hand, students were given additional responsibility for conducting learning and successfully mastering the material with much less teacher's assistance. Higher education institutions that never had an e-learning model before were forced to completely change their teaching methods, and teachers were forced to adapt their courses and materials to an acceptable digital form in a very short period of time, without the support of course designers, computer experts, or graphic production staff. In addition to their professional competencies, teachers are tasked with mastering the skills of using digital distance learning platforms in a short period of time. Those who could not adapt so quickly, kept in the usual sage on the stage approach, conducting traditional lectures using well-known collaboration tools like MS Teams, Zoom, Slack, etc. However, at the time of global insecurity and health concerns, enormous effort has been invested by all teachers, and that is something that society must honor in some way.

It is important to measure student satisfaction, dedication, and achieved results, and dropout rate. The next section of this paper addresses this topic, restricting its scope to the students' results and experiences. We explore how students evaluate being taught online and in hybrid model, compared to face-to-face, and ultimately which model of learning they prefer on undergraduate and master's programs in the field of applied technical studies.

III. FINDINGS AND DISCUSSION

A. Preferred teaching model

During the current semester, a group of students in the first and second year of undergraduate applied studies were being polled, and an online survey was carried out with a group of students in the first year of master's applied studies. The aim of the survey was to find out which learning model students prefer. A total of 150 students were surveyed, corresponding to 67.57 percent of the total number of students who were eligible to participate. The poll was open to students who were enrolled for the first time in the specified year of study. The survey findings are presented in Table 1. Averages of 87 percent of undergraduates, regardless of the year of study, have a strong desire to participate in traditional classes. As expressed during the available discussion, the most common reasons for traditional learning model are foremost the social aspect, followed by a better understanding of the lessons and learning consistency. The students stated that it suits them better when they come to a higher education institution, make personal contact with teachers and colleagues, exchange opinions, study in a group, socialize at the same time and spend extra time together after classes. They admitted that having a set class schedule fits them considerably better than having to plan their own time. They attain substantially better learning continuity this way. A completely different choice of learning approach is noticeable among master's students, with 90 percent preferring the hybrid model. The majority of students in this group is employed or live outside of the higher institution's city, which are the primary reasons for their choice.

TABLE I. A SURVAY ON PREFERRED TEACHING MODEL

Students	Preferred teaching model		Polled
	Hybrid	Traditional	
1st year undergraduate	12.20%	87.80%	65.08%
2nd year undergraduate	13.56%	86.44%	72.84%
1st year master's graduate	90.00%	10.00%	64.10%

B. The success of transforming traditional curriculum into an e-learning model evaluation

The authors of this paper are teachers in the course Informatics, which is mandatory in the second year of all study programs in our department. A comparison of students' performance and activity in the online, hybrid, and traditional learning models is conducted by analyzing the results achieved in this course in the last four years. This course comprises one class of theoretical teaching and three classes of laboratory exercises per week. Because of the greater focus on practical teaching, transforming this segment of the curriculum into an online model posed a challenge, especially considering that in 2020, after just two weeks of the semester, the decision was made to transfer from a traditional to an online model. Creating study materials for online teaching is a difficult and time-consuming task. Although it is commonly assumed that young

people have a natural predisposition for digital technologies, our main concern was whether the generated online materials would be attractive enough for them to sustain their attention and approach learning with the same dedication. To meet the needs of new generations, the lectures are designed to include as much interactive multimedia content as possible, in order to remain coherent with other social networks' content and the environment to which students are accustomed. Complete teaching materials were uploaded on the well-known distance learning platform Moodle. This platform was chosen because it supports all guides on the side approach criteria necessary for conducting laboratory exercises, especially in light of novel circumstances. It was crucial to empower students to exercise autonomously with provided learning resources, enabling their mutual interaction using the platform's chat capabilities, and ensuring students monitoring, guidance, assistance, and correction. All laboratory exercises were covered by extensive video tutorials. MS Teams, a synchronic groupware solution for online meetings, is used for the theoretical parts of the course and consultations. Asynchronous groupware tools like e-mail and chat were used as additional communication channels. To ensure continuity in the hybrid teaching model, students were given lectures in electronic form for the entire curriculum, regardless of whether some lessons were conducted face-to-face. Although that is beyond the scope of this paper, it is interesting to note that we have encountered mentioned issues such as work overload, burnout, and intellectual property concerns.

In order to analyze the success of the implemented transformation of the traditional curriculum into the model of e-learning, we reviewed the available data on the outcomes gained by students in the preceding four years at midterm exams. A midterm grades are a snapshot indicating how a student is performing academically in the course. Classes were held traditionally in 2018 and 2019, so these statistics serve as a baseline for comparison with the outcomes attained in 2020 when classes were delivered online and in 2021 when a hybrid approach was used. Average outcomes gained by students are presented in Fig. 2. Regardless of the applied model of education, the outcomes from both midterms are uniform in all four years evaluated; even a slight improvement in the hybrid model of teaching is noticeable. From the foregoing, it can be inferred that the process of transforming a traditional curriculum into an e-learning model has been done effectively. It is worth mentioning that the students expressed great pleasure with the manner and quality of available lessons, to our great satisfaction.

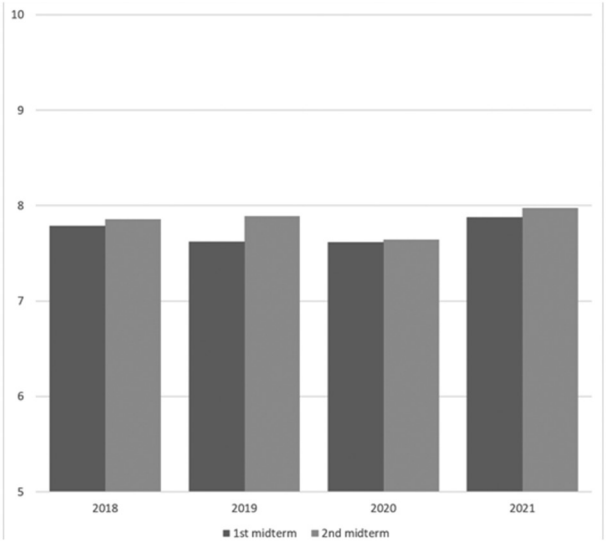

Fig. 2 Average outcomes in the preceding four years at midterm exams

A summary of similar research was given in [9], all of which concluded that in terms of knowledge transfer, it is possible to achieve the same learning outcomes by applying distance learning or traditional education. However, concerns regarding generalizability need to be taken into account in terms of the scientific fields to which the research relates. This study focused solely on non-STEM (Science, Technology, Engineering, and Mathematics) courses. These results may not translate into the comparable performance of students in STEM courses that require a laboratory-based component. However, a few promising studies in the field of science report the effective transfer of traditional undergraduate biology courses to online learning [10], as well as the conclusion that hybrid learning in an embryology course had no difference in overall student performance [11]. Our research supports these findings, demonstrating that in the field of computer science, transforming a traditional curriculum to an e-learning model can be carried out efficiently, achieving the same learning outcomes.

IV. CONCLUSIONS

When considering the e-learning model, all relevant criteria must be considered from the perspectives of students and institutions. From the students' point of view, the advantages are that they allow a certain group of people, usually employed students, to learn at their own pace and at a time that suits them. Simultaneously, it helps to save time for students who live outside of the institutions' city, as well as reducing the expenditures of travelling and accommodation during their studies. On the other hand, e-learning must be a personal choice based on individual desires, abilities, and preferences. The benefits of this model were acknowledged by older and more mature students, mostly due to their other engagements, according to research conducted on students who were compelled to study online or in a hybrid model. Young people, on the

other hand, are concerned about receiving the same quality of education as in the traditional approach. The social aspect of conventional education is very essential in terms of developing social and professional life. Student organizations organize forums, lectures, sports competitions, student parties, tourist vacations and excursions, humanitarian initiatives, and other activities. All these activities and benefits are significantly reduced in distance learning. Nonetheless, based on the presented research, we may conclude that e-learning matches traditional education in terms of knowledge transfer.

The advantage of e-education, from the perspective of educational institutions in Serbia, is shown in the ability to extend market reach and the total number of students, bearing in mind that accreditation requirements for physical resources and number of active teachers are lower than in traditional. Significant investments in ICT equipment, as well as the hiring of IT experts, who are now the most expensive work power in the market, are required. Much more teacher engagement and collaboration with assistants, editors, course designers, computer experts, and graphic staff members are required for well-prepared lecturing. As a result, the number of accredited study programs based on the distance education model at Serbian higher education institutions has decreased. However, after being forced to use this model of learning for the past two years, it is anticipated that interest in this model of learning will grow, resulting in a rise in the number of newly accredited study programs. The combination of a dual education model and short study programs offered via distance learning could be the next great advancement in higher education.

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