THE USE OF NEW EDUCATIONAL TECHNOLOGIES FOR PREPARING STUDENTS IN ENGINEERING: AN INNOVATIVE PERSPECTIVE ON ENTREPRENEURSHIP AND COMPETITIVENESS

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Abstract. This paper aims to explore the use of new educational technologies for preparing students in engineering, with a focus on innovative approaches to entrepreneurship and competitiveness. The study was conducted using mixed-methods approach, including a literature review and a survey of high school students in Bucharest, using a questionnaire as the research instrument.

The implications of this study are significant for both academics and practitioners in the field of engineering education. By highlighting the perspectives and needs of high school students, this paper provides insights into the potential of new technologies to enhance the quality of education and prepare students for future careers in engineering. These findings can inform the development of new research and practice methodologies in the field.

The key contribution of this paper is to demonstrate the unique value of new educational technologies for preparing students in engineering, as well as the potential of survey research in understanding student perspectives and needs. By highlighting the importance of innovative approaches to entrepreneurship and competitiveness, this paper offers an original perspective on the potential of these technologies to enhance the quality of engineering education and prepare students for future success.

Keywords: educational technologies, engineering education, entrepreneurship, competitiveness, innovation.

1 INTRODUCTION

We live in a time where people perform most of their daily activities with the help of digital technologies and computers. Learning to use information technologies has become extremely necessary in the digital age of the 21st century. These technologies have provided humanity with unlimited access to information that can be transformed into knowledge. [1] Current discussions regarding technology and its role in education carry considerable significance due to the rapid pace of technological advancements. [2]

The accelerated rate of emergence and change of new technologies in the field of education puts increasing pressure on teachers as they constantly have to learn new ways of integrating technology into the teaching and learning process. Expecting teachers to rely on what they have learned to be valid for years ahead is unrealistic. This prompts teachers to focus more on the teaching and learning process while separating the technologies they use. However, research in the field suggests that technologies should not be completely ignored, rather teachers need to keep up with technology to ensure long-term productivity. [3]

The scope of this paper is related to technical education and the use of educational technologies in this field. The paper explores how technology can be integrated into the teaching and learning process to support the preparation of students in the technical field. The relevance of this paper lies in the need to adapt teaching methods and utilize technology to develop students' technical skills and prepare them for the technological requirements of society today. A concrete example is the use of virtual simulations and educational games to allow students to practice technical skills and solve

domain-specific problems. Additionally, digital and computerized technologies can be utilized to provide access to online educational resources, interactive materials, and collaborative tools, enhancing learning and interaction between students and teachers.

This paper contributes to the development of knowledge and practices in the integration of educational technologies in technical education, providing current insights into the benefits and challenges associated with it.

2 TECHNOLOGY INTEGRATION IN THE TEACHING-LEARNING PROCESS: AN APPROACH FOR THE DIGITAL ERA

2.1. Enhancing Teaching and Learning in the Digital Age through Technology Integration

In the teaching and learning process, the integration of technology involves the use of the internet, computers, interactive media content, and other similar resources to support and enhance learning. Teachers can integrate technology in various ways, including using it for classroom instruction, computer-based applications, hands-on exercises, conducting research using internet resources, problem-solving and data analysis with the help of technology, creating multimedia projects, graphical presentations, simulations, and online collaboration among students. [4]

Technology can be integrated into classrooms in various ways to enhance the learning process. These integrations can advance teaching methods and even change the way classrooms function. In the digital age, it is crucial to equip students with technology. Teachers and administrators need to decide how to integrate technology into the curriculum and the teaching-learning process. One option is for schools to acquire equipment and software for all classrooms, ensuring equal access and security. However, due to budget constraints in many schools today, acquiring and maintaining devices for all students in a school is not always feasible. In such cases, depending on students' needs and the resources available in schools, classes can be conducted exclusively online, web-facilitated, traditional, or blended/hybrid learning.

Blended learning, also known as hybrid learning, refers to the regular use of digital technology by teachers in traditional classrooms or flipped classrooms. A flipped classroom is one that reverses the traditional style of acquiring and applying content. In a flipped classroom, students acquire knowledge outside of class hours. During class hours, teachers actively guide students in practicing the application of that knowledge. Online learning has its roots in distance education. An online learning course involves delivering content exclusively online, with limited face-to-face interaction. [5]

2.2. Integration of Educational Technologies in Technical Education

Educational technology is a systematic and organized process of utilizing modern technology to improve the quality of education (efficiency, effectiveness, authenticity, etc.). It provides a structured approach to conceptualizing the implementation and assessment of the educational process, encompassing both teaching and learning, and facilitates the application of contemporary teaching techniques. [6]

The implementation of various technological devices in the educational process accelerates the pace of teaching and makes it more engaging and receptive. The knowledge requirements that students need to acquire by the end of their schooling period are changing rapidly. [7] Regarding the preparation of students in technical fields, the integration of new educational technologies involves the use of various technological devices within the learning process. These modern technologies can include computers, tablets, mobile devices, specialized software, and other digital tools.

The field of engineering is highly complex and relies on a variety of innovative technologies. Technologies such as CAD (Computer-Aided Design)/CAM (Computer Aided-Manufacturing), 3D printing, and virtual reality are becoming increasingly popular among engineers. These technologies are used by engineers to create new prototypes and showcase innovative ideas to the public. Through these intelligent ideas, engineers contribute to the development of better products and designs. Moreover, educational institutions in the field of engineering employ smart technology to deliver quality education to their students. Teachers utilize CAD/CAS (Computer Aided-Simulation) software in classrooms to demonstrate practical applications, aiding students in understanding and applying their knowledge in real-world scenarios. Additionally, engineering schools incorporate methods like gamification and case studies to engage students

in the learning process. These strategies facilitate the teaching of relevant concepts and their application in real-life contexts. It is evident how smart technology enhances education and implementation in the field of engineering. Both current and future engineers utilize these tools in their daily work, and these advancements bring significant improvements to the teaching and learning practices employed by educators. [8]

Computer-based educational games and simulations can bridge the gap between experiential learning and passive learning in schools. These tools provide an active learning experience in a passive classroom environment, reducing the time and space needed for such an experience. This is especially beneficial for students preparing for technical universities. Serious games and simulations offer immediate feedback and self-paced guidance. Additionally, these games and simulations enhance scientific knowledge and motivate students to learn. They are attractive in education for various reasons. They have been successfully employed in industries to overcome time and space limitations in training pilots, astronauts, surgeons, and military personnel. The technological advancements and computer infrastructure required to utilize them in the classroom have significantly improved since the 1990s when educators recognized their value in developing 21st-century skills. [9]

A study conducted on a sample of 144 seventh-grade students regarding the effects of gamification elements on student motivation shows that the utilization of gamification elements in teaching leads to an enhancement in levels of intrinsic motivation, overall engagement, emotional involvement, and focused attention of students. Moreover, gamification tools that are highly interactive, challenging, and competitive motivate students to pay more attention in class and prove to be more beneficial for them in the process of learning the English language. [10] Also, enhancing entrepreneurial education poses a significant challenge for today's knowledge-based societies. The eSG (Serious Games) project tackles this issue by exploring the added value that serious games can offer, assisting students, especially those in the technology field, in becoming acquainted with the fundamental concepts of entrepreneurship and company management, supplementing existing theory and practice. [11]

Regarding the technological literacy of high school students, a study conducted in a high school context, involving both teachers who implemented the Project Lead the Way (PLTW) program and those who did not, reveals that the instruction of STEM (Science, Technology, Engineering, Mathematics) subjects has been influenced by family backgrounds, student interests, and prior academic achievements. Teachers who did not utilize the PLTW program tend to emphasize that a prospective engineer should attain high grades in mathematics and science, whereas instructors implementing the PLTW program tend to assert that these disciplines are effectively integrated into engineering activities. Additionally, the study concludes that the integration of STEM during high school presents challenges, and engineering education up to the 12th grade may serve conflicting purposes: either catering to an exclusive group of students or promoting technological knowledge for all. This dilemma adversely impacts the processes of teaching, assessment, and selection within the field of engineering. [12]

Several relevant ideas can be derived for the research hypotheses to be presented in the next section based on the previous literature review.

3 METHODOLOGY

The main research questions are:

(i) What are the new educational technologies used for preparing high school students for the engineering field?

(ii) How do these technologies influence the development of entrepreneurial skills and competitiveness in students?

The research hypotheses are as follows:

H1: Integrating educational technologies into the teaching-learning process supports the development of technical skills in future engineering students.

H2: The use of new educational technologies in the preparation of engineering students has a significant positive impact on the development of entrepreneurial skills and competitiveness, thereby enhancing their chances of success in a competitive professional environment.

H3: Integrating educational technologies in technical education improves students' preparation for the current technological requirements of society and increases their competitiveness in the field.

H4: Limited availability of technological resources and infrastructure in educational institutions can negatively affect the efficient implementation of new educational technologies in the preparation of engineering students.

The study employed a mixed methodology, combining qualitative and quantitative research to obtain a comprehensive understanding of the subject. Data was collected through a questionnaire distributed to participating students. The questionnaire consisted of 5 single-choice questions and 10 open-ended questions. It was designed to measure the level of utilization and impact of educational technologies on the development of entrepreneurial skills and competitiveness in students. The questionnaire was created using the Microsoft Forms application and distributed to students through social networks. In the case study conducted in May 2023 in Bucharest, a total of 31 students participated, coming from both private and public high schools. This diversity in the sample allowed for a broader and representative perspective on the impact of educational technologies in high school education.

4 RESULTS

Out of a total of 31 students who completed the questionnaire, 9 students are in 9th grade, 7 students in 10th grade, 5 students in 11th grade, and 10 students are in 12th grade.

The use of educational technologies in schools. According to the responses provided by the students, it is observed that the majority (23 students) have used educational technologies during the teaching-learning process in school up to the present. This indicates an increasing trend in the use of these technologies in the educational environment. The utilization of educational technologies can be an indicator of the school's adaptability to new teaching and learning methods, as well as the importance given to the integration of technology in the educational process.

This result suggests that there is a concern for implementing technology in high school education, which can contribute to the development of students' skills in the field of engineering. However, it is important to note that there are also 8 students who indicated that they have not used educational technologies during the teaching-learning process. This can be attributed to factors such as limited resources, insufficient infrastructure, or a lack of availability of technology in their respective schools.
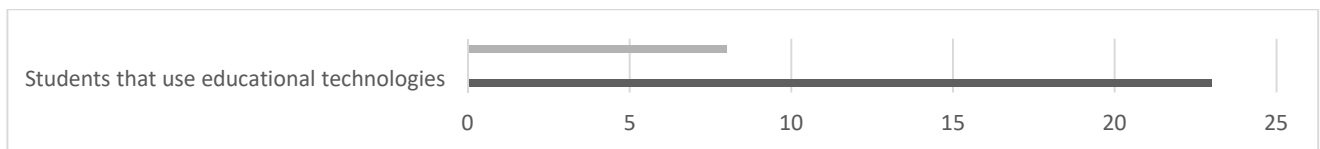

Figure 1: The use of educational technologies

Regarding the types of educational technologies used by students, the majority of study participants, specifically 19 students, mentioned that they have used virtual simulations. Additionally, 8 students chose the option related to serious games, and 5 students stated that they have used online learning platforms. Another 4 students selected the option regarding other types of educational technologies that were not listed among the provided options in the questionnaire but did not specify the type. Therefore, the interpretation of these results suggests that there is a variety of educational technologies used in the preparation of students during high school.

Table 1. The level of utilization of educational technologies based on students' grade level.

Grade	Number of students	
	Yes	No
9th grade	5	4
10th grade	4	3
11th grade	4	1
12th grade	10	0

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Development of technical skills through digital technologies. Regarding students' perception of developing technical skills through new educational technologies, a total of 27 students stated that they believe new educational technologies help them develop the necessary skills in the field of engineering. This indicates that integrating educational technologies into the teaching-learning process can have a positive impact on students' technical skill development. Only two students stated that they do not believe new educational technologies can contribute to the development of technical skills, and two students said they do not know if it's true or not.

Regarding students' perception of improving entrepreneurship skills through the use of educational technologies, 17 students answered "yes," 8 students said "I don't know," and the remaining 6 students stated that they have not noticed any improvements. Educational technologies can help students develop entrepreneurial skills such as critical thinking, decision-making, planning, communication, and collaboration. These skills are essential for success in a competitive professional environment.
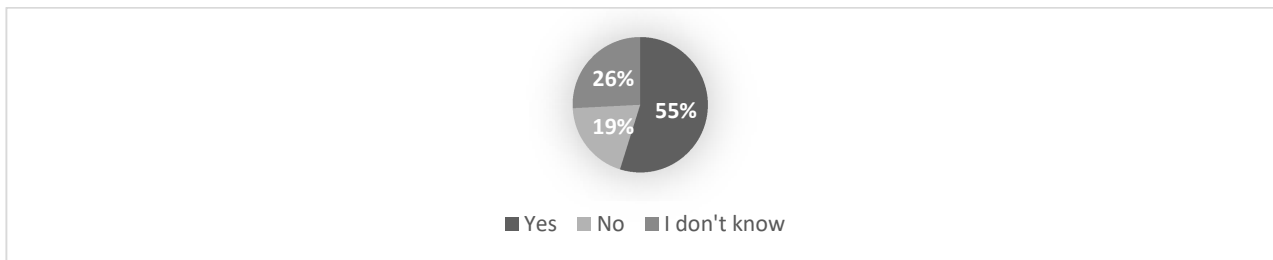

Figure 2: Students' perceptions of entrepreneurship skill improvement with educational technologies

Relating to the perceived benefits of serious games and virtual simulations, students have mentioned the following: the opportunity to gain practical experience by exploring realistic scenarios, a deeper understanding of concepts and technical principles as they have the chance to visualize and interactively experience different technical phenomena and processes, the development of practical skills through problem-solving, decision-making, and the application of technical concepts in a simulated or gaming environment, as well as increased motivation and stimulation of interest and engagement through the interactive and enjoyable approach offered by new educational technologies. Students have also mentioned the educational technologies they consider effective in preparing them for technical universities. Virtual simulations were identified as the most efficient, as they provide an opportunity to experience realistic scenarios in a controlled virtual environment, allowing them to develop technical skills interactively and safely, without the risks associated with real experiments.

Serious games were also mentioned by students as effective educational technologies for developing technical skills, as they provide an engaging way to learn and grow. Students appreciated the interactive and competitive aspects of serious games, which motivate them to engage in the learning process and test their skills in a fun way. Additionally, students mentioned various online learning platforms that give them access to diverse educational resources, tutorials, and interactive learning materials, as well as equipment and devices such as 3D printers or different robots that help them apply their knowledge in a practical manner.

The development of entrepreneurship skills and increasing competitiveness. The majority of participants stated that the use of new educational technologies has greatly helped them develop entrepreneurship skills. Approximately 80% of respondents indicated that educational technologies have played a significant role in developing these skills, while only a minority of 20% considered the impact to be low or non-existent. Students who mentioned that new educational technologies have helped them develop entrepreneurship skills listed the following abilities: critical thinking, decision-making, problem-solving, planning and resource management, effective communication, and creativity. These results support hypothesis H2, which suggests that the use of new educational technologies in preparing students in the field of engineering has a significant positive impact on the development of entrepreneurship skills.

Relating to students' opinions on increasing competitiveness compared to other students, questionnaire respondents stated that new educational technologies have a significant impact on their level of competitiveness compared to their peers (74%), while the remaining respondents mentioned that they have not observed a significant influence.

Regarding the increase in students' chances of success in a competitive environment following the use of educational technologies, approximately 58% of students expressed confidence that the use of these educational technologies would

provide them with a competitive advantage and enhance their chances of success in the field of engineering, while a minority of 42% did not consider this usage to have a significant impact on their chances of success.

Furthermore, the results obtained from the question regarding the positive impact that educational technologies can have on preparing students for the current technological requirements of society and increasing their competitiveness in the technical field indicate that the majority of participants (approximately 70%) agree that educational technologies can significantly contribute to their preparation and competitiveness. This indicates that students are aware of the importance of using educational technologies to develop the skills and competencies necessary in a constantly changing professional environment.

The majority of students (approximately 77%) believe that the integration of educational technologies in technical education can enhance students' preparation for the current technological requirements of society. This suggests that students perceive educational technologies as a valuable resource to develop the skills and competencies needed to meet technological demands in a constantly changing world. The percentage of 23% of students who did not affirm the benefits of educational technologies in preparing them for current and future technical requirements stated either "don't know" or that they lack sufficient data to pronounce themselves yet.
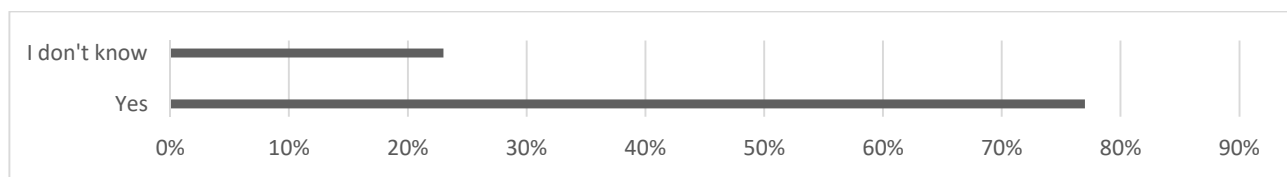

Figure 3: Students' perception of entrepreneurial skill improvement through the use of educational technologies

Difficulties and resources required for the effective use of educational technologies in technical education. The results obtained from the questionnaire indicate that a significant percentage of respondents (54%) encountered difficulties or limitations in using educational technologies in the learning process. Many of them mentioned that some difficulties stem from technical aspects, such as a lack of access to specific equipment and devices or inadequate infrastructure in educational institutions. Additionally, some respondents indicated difficulties in using online learning platforms or faced challenges in adapting to new technologies and teaching methods. Furthermore, time constraints and busy schedules were mentioned as factors that can affect the effective use of educational technologies.

Regarding respondents' opinions on the technological resources and infrastructure required for the effective implementation of educational technologies in preparing engineering students, the majority of respondents mentioned the following resources and infrastructure as essential: specific equipment and devices, specialized laboratories and facilities, high-speed internet access and various communication networks, relevant and free educational software and applications, and training and support for teachers. These results highlight the importance of investing in technological infrastructure and relevant resources in educational institutions to enable the effective implementation of educational technologies in preparing future engineering students. The table below presents the difficulties mentioned by students, correlated with the necessary resources to overcome them.

Table 2. Challenges and resources required for optimal use of educational technologies

Difficulties and limitations	Required resources
Lack of access to specific equipment and devices	Providing adequate equipment and devices
Inadequate infrastructure of educational institutions	Investments in infrastructure to enable the use of educational technologies
Difficulties in using online learning platforms	Training and support for the use of platforms
Difficulties in adapting to new technologies and teaching methods	Training and support for learning new technologies
Time constraints and busy schedules	Reorganizing programs to enable the efficient use of technologies

Perspective and recommendations regarding the effective integration of educational technologies. Students' perspectives on the effective integration of educational technologies in the teaching-learning process can be summarized into four themes: (1) the need for consistent integration of educational technologies into study programs and lesson plans, (2) leveraging the interactive and practical capabilities of educational technologies, (3) providing adequate resources and support for teachers in using educational technologies, and (4) promoting collaboration and group activities through educational technologies. Students recommended expanding and diversifying technological resources, ensuring adequate infrastructure, developing training programs for teachers, and promoting collaboration and practical projects to improve the use of educational technologies in preparing students for technical universities.

5 DISCUSSION

This research study found that educational technologies have a positive impact on the preparation of high school students for engineering. These technologies include serious games, virtual simulations, online learning platforms, and equipment such as 3D printers and robots. They help students develop entrepreneurial and competitive skills by improving their critical thinking, decision-making, planning, communication, and collaboration skills.

In relation to H1, the integration of educational technologies contributes to the development of technical skills, as they place students in situations that help them learn and apply skills such as complex problem-solving, programming, computer-aided design, simulation, and the use of specific technological tools and equipment. Educational technologies also have a positive impact on the development of entrepreneurial and competitive skills, supporting H2.

Educational technologies can help students prepare for the current technological requirements of society and increase their competitiveness in the engineering field. However, since the research is based on the responses of some students, and with regard to this subject, students had response options, the results may not be in line with reality in schools.

Limited resources in schools, as well as infrastructure, can negatively affect the efficiency of the implementation of educational technologies. This hypothesis is also confirmed by the responses provided by students. In this regard, those responsible should take the necessary measures to equip schools adequately so that students can have learning experiences that motivate and develop them as much as possible.

This study is relevant to the field of education because it focuses on the use of new educational technologies in the preparation of high school students in Romania for engineering careers. It provides information on the potential of new technologies to improve the quality of education and prepare students for future careers in engineering.

6 CONCLUSIONS

The study highlighted that educational technologies have a significant impact on students' preparation in the field of engineering. Integrating these technologies into the teaching and learning process can support the development of technical, entrepreneurial, and competitive skills of future students. The use of virtual simulations, online platforms, and serious games has proven to be effective in developing technical skills and has stimulated students' interest and engagement in learning.

Study participants recognized the benefits of educational technologies and appreciated the fact that they better prepare them for technical universities. The use of educational technologies can contribute to shaping a new generation of engineers capable of meeting current and future technological requirements and thriving in a competitive professional environment.

7 RESEARCH LIMITATIONS AND FURTHER RESEARCH

The present study has a few limitations that can be addressed in future research. One important aspect to consider is the small sample size used in this study. A more extensive approach with a larger sample could provide more precise and generalizable results. Furthermore, further research can explore and compare the effectiveness of different educational technologies in developing technical skills and other competencies required in the field of engineering. For example, the

benefits of using virtual reality, 3D printing, or artificial intelligence in the learning process can be investigated. Furthermore, another limitation of the study is that the research was based on students' responses to a questionnaire that included both closed-ended and open-ended questions. Therefore, the closed-ended responses provided by the respondents cannot be empirically validated, potentially introducing discrepancies between reality and research findings.

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