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Contents

International Journal of Research in E-learning
Vol. 11 (2), 2025, pp. 1–4

Editorial

The Editorial Board of International Journal of Research in E-learning (IJREL) is privileged to present a new volume 11(2) 2025. The content of the current issue was divided into four chapters and include eight articles. The first is devoted to Theoretical and Practical Aspects of Using Artificial Intelligence (AI) in Education. The second contains articles concerned with Methodological and Technological Aspects of Innovational Approach in Education", and contains three articles. The third includes research results on Immersive Technologies in Education. The fourth chapter is called Reports.

Chapter I is entitled "Theoretical and Practical Aspects of Using Artificial Intelligence (AI) in Education", and contains two articles.

The first article of the volume, titled "Determinants of Students' Perceived Usefulness of Large Language Models: The Role of Relevance, Enjoyment, and Ease of Use" was prepared by Snježana Babić from the Faculty of Informatics, University of Juraj Dobrila in Pula, Croatia. The author's Perceived Usefulness (PU) is a key determinant of technology acceptance and use. As Large Language Models (LLMs) such as ChatGPT become more common in higher education, it is essential to identify factors shaping students' perceptions of their usefulness. Grounded in the Technology Acceptance Model (TAM), this study examined the effects of relevance to academic learning, perceived enjoyment, and Perceived Ease of Use (PEOU) on PU. The study involved 102 students from a Croatian university and used Spearman correlation and multivariate regression analyses. All three factors showed significant positive correlations with PU; however, regression results indicated that only relevance to academic learning and perceived enjoyment were significant predictors. Together, they explained 71.8% of the variance in PU, while PEOU played a minor role. The findings highlight the need for pedagogically relevant and engaging LLM-based tools to support their effective integration into higher education.

Lucie Zormanová and Šárka Čípová, authors from Poland and Czech Republic, prepared the article titled: "The Use of Artificial Intelligence in Academic and Personal Life of Students of Pedagogy". This study compares how pedagogy students in the Czech Republic and Poland use artificial intelligence in academic and personal contexts. Using a quantitative questionnaire distributed to 275 students

from five universities in both countries, the research examined usage patterns and perceptions of AI. The results show that AI is widely integrated into students' academic routines, with Polish students using it slightly more frequently. The most common applications include information retrieval, preparing presentations, writing assignments, translation, grammar checking, and clarifying difficult topics. Students view AI as useful for their future teaching careers and express interest in further training, while also recognizing ethical and informational risks, and often verifying AI-generated content. Differences emerged between the two countries in frequency of practical use, perceived awareness, and attitudes such as feelings of guilt. The study highlights the need for systematic AI integration in education and the development of digital competencies in an international context.

Chapter II is titled "Methodological and Technological Aspects of Innovational Approach in Education", and contains three articles.

The manuscript titled "Low-Cognitive-Load Games as Attentional Support: A Scoping Review for Gen Z Learners" was prepared by Juraj Kovalčík, Magdaléna Švecová, Michal Kabát, and Martin Paučin, experts from the University of Ss. Cyril and Methodius in Trnava, Slovakia. The researchers analysed the generation Z learners, who often experience reduced attention and memory in digitally saturated learning environments. While technology-driven distractions and social media use are associated with poorer academic outcomes, emerging research suggests that low-cognitive-load digital activities – such as casual games, electronic fidgets, and short micro-breaks – may help sustain engagement. This scoping review maps studies published between 2010 and 2025 on digital micro-breaks, fidgeting tools, and low-demand activities in learning and work contexts, following PRISMA-ScR guidelines. The analysis of 33 studies indicates that brief, voluntary, low-effort activities can restore attention, reduce fatigue, and improve affect without impairing task performance, particularly when compared to more demanding interruptions. The findings also highlight the importance of timing, context, and learner control. However, evidence on memory effects and direct educational applications remains limited. Further experimental research in educational settings is needed to evaluate purposefully designed low-cognitive-load tools as attentional supports for Gen Z learners.

A Scratch-Based Simulation of Virus Spread as a Constructionist E-Learning Project" was developed by Maria Wisniewska from Public General High School of the Lodz University of Technology, Poland, and Zbigniew Wisniewski, from Lodz University of Technology, Poland. This qualitative case study examines a Scratch-based simulation project created by a primary school student during remote learning. The study investigates how designing a simple agent-based model in a visual programming environment supports the development of digital and computational competences. Data from the Scratch artefact, competition materials, and a retrospective interview reveal that creating the simulation fostered key computational practices, including decomposition, iterative refinement, problem-solving, and

reasoning about causal relationships. The findings highlight the value of accessible programming tools in supporting constructionist learning through the design and testing of executable artefacts. The study also suggests that simulation-based projects can enhance remote and hybrid education by promoting active experimentation and reflection, while noting limitations related to its single-case design.

Kamila Szwed and Anna Bąkała from Global Consulting Corporation, Poland, prepared the article titled "Decoding User Experience in Instructional Design for e-learning project". E-learning has become a key medium for delivering knowledge and skills, yet its effectiveness largely depends on how well it addresses users' needs and expectations. User Experience (UX) design plays a central role in the success of e-learning solutions and requires clear communication among Instructional Designers, stakeholders, and Subject Matter Experts. This article examines the relationship between UX and Instructional Design in e-learning projects, identifying principles and practices that support engaging and effective learning experiences. Based on an analysis of current trends, case studies, and expert in sights, the study proposes strategies to enhance learner engagement, satisfaction, and educational outcomes. It also presents a tool to support the interpretation and assessment of UX elements during e-learning project development, offering a practical roadmap for user-centered instructional design.

Chapter III is titled "Immersive Technologies in Education", and includes two manuscripts.

"Through University Students' Headsets: To Immerse or Not to Immerse in New Learning Experiences" was prepared by an international team of Authors – Iwona Mokwa-Tarnowska from Gdansk University of Technology and Viviana Tarnowska from Cranfield University. The researchers stressed that integrating technology-enhanced learning into university curricula requires a shift from traditional teaching toward active and collaborative learning approaches. Virtual reality (VR) is a promising innovation that can support immersive and interactive learning environments. This study examines students' perceptions of whether integrating VR into university courses increases their interest in understanding complex phenomena and enhances engagement and learning outcomes. The analysis is based on survey data collected in June–July 2025 from bachelor's and master's students at Gdansk University of Technology. The findings highlight both the perceived educational potential of VR and the instructional design challenges associated with its effective implementation in higher education.

Sobia Yasmeen, from the University of Bari Aldo Moro, Education, Psychology, Communication Sciences, Italy, prepared the manuscript titled: "Immersive Technologies (AR/VR) for Enhancing Learning in Multicultural Classrooms: Addressing the Needs of International Students". The researcher emphasizes that globalization has increased the cultural diversity of European universities, while also creating challenges for international students related to language barriers, cultural adjustment, and well-being. Immersive technologies such as Augmented

and Virtual Eeality (AR/VR) have emerged as innovative tools to address these issues by supporting inclusive, engaging, and motivating learning environments. This theoretical study analyzes recent literature within the European context, with a particular focus on Italy, using sociocultural theory, cognitive load theory, and self-determination theory as analytical frameworks. The paper identifies key challenges and practical solutions for implementing immersive technologies in multicultural classrooms. The findings suggest that inclusively designed AR/VR environments can enhance psychological safety, intercultural competence, student engagement, and deep learning in higher education.

Chapter IV is called "Reports", and includes one article.

Eugenia Smyrnova-Trybulska from the University of Silesia in Katowice, Faculty of Arts and Educational Sciences in Katowice, Poland, coordinator of the DLCC2025 conference, prepared "A Report from the International Scientific Conference "Theoretical and Practical Aspects of Distance learning" DLCC2025 (www.dlcc.us.edu.pl) subtitled: "E-learning & Interactive Learning. Generative Artificial Intelligence (GAI), Gamification and Immersive Technologies (AR/VR) in Educational Practice and Research". The 17th edition of the International Scientific Conference, "Theoretical and Practical Aspects of Distance learning" was held under the theme of "E-learning & Interactive Learning. Generative Artificial Intelligence (GAI), Gamification and Immersive Technologies (AR/VR) in Educational Practice and Research" on October 15th and 16th, 2025, at the University of Silesia in Katowice. It was organised by the Faculty of Arts and Educational Sciences in Cieszyn, Faculty of Social Sciences, the Faculty of Computer Science and Materials Sciences in Sosnowiec, the Institute of Pedagogy, and the Institute of Computer Science, University of Silesia in Katowice, Poland.

This volume brings together diverse studies exploring the dynamic transformation of e-learning and educational practice driven by artificial intelligence, immersive technologies, and user-centered design. Together, they emphasize the importance of pedagogical relevance, engagement, inclusivity, and thoughtful instructional design in effectively integrating innovative technologies across diverse educational contexts and levels.

The Editorial Board extends its best wishes to all readers for continued inspiration, curiosity, and enthusiasm in exploring innovative approaches to teaching and learning. We trust that the insights presented in this volume will support scholarly endeavors, enhance educational practice, and inspire confident experimentation with emerging technologies. It is our hope that these contributions will stimulate further research, foster meaningful collaboration, and strengthen a shared commitment to shaping the future of education.

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Determinants of Students' Perceived Usefulness of Large Language Models: The Role of Relevance, Enjoyment, and Ease of Use

Abstract

Perceived Usefulness (PU) is one of the most important determinants for the acceptance of technologies as it strongly influences both the intention to use and the actual use of the technology. As large language models (LLMs), such as ChatGPT, are increasingly used in higher education, it is important to understand what factors influence students' perceptions of the usefulness of LLMs for academic learning. Based on the Technology Acceptance Model (TAM), this study investigated the role of relevance to academic learning, perceived enjoyment, and perceived ease of use (PEOU) on students' perceptions of the usefulness of LLMs. The study involved 102 students from a Croatian university. The data were analyzed using Spearman correlation and multivariate regression analysis. The correlation analysis showed that all three factors had a statistically significant positive correlation with the perceived usefulness of LLMs. However, the regression analysis showed that only relevance to academic learning and perceived enjoyment of using LLMs for learning were significant positive predictors, while perceived ease of use played a minor role. Together, these two variables explained 71.8% of the variance in students' perceptions of the usefulness of LLMs. The results emphasize the importance of identifying the factors that shape students' perceptions of the usefulness of LLMs as they are an important predictor of intention to use the technology. The findings suggest that there is a need to develop LLM-based tools that are pedagogically relevant and engaging for students and that can serve as guidelines for their successful integration into higher education.

K e y w o r d s: Large Language Models (LLMs); Technology Acceptance Model (TAM); perceived usefulness; relevance for academic learning; perceived enjoyment; higher education

Generative Artificial Intelligence (GenAI) includes systems that use deep learning to autonomously generate new content, including Large Language Models (LLMs) such as ChatGPT, Gemini, Claude and Copilot, which can generate human-like text and are increasingly used in higher education to support learning and teaching (Belkina et al., 2025; Giannakos et al., 2025; Mienye & Swart, 2025). Understanding the factors that shape attitudes towards LLMs is crucial for their successful integration into higher education as the acceptance of new educational technologies depends on students' perceptions of their usefulness, ease of use and motivational aspects (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh & Bala, 2008). Previous research has shown that the successful integration of LLMs into higher education requires a simultaneous management of technical, pedagogical and ethical challenges. García-López et al. (2025) emphasised the need for sustainable and scalable infrastructure, a balance between personalisation and equity in learning, protection of data quality and security, and the introduction of ethical guidelines and human oversight, while Belkina et al. (2025) argued that GenAI transforms teaching and student support, but must be aligned with pedagogical frameworks in order to be implemented responsibly. Similarly, Tillmanns et al. (2025) emphasised the importance of aligning GenAI technologies with health professionals. In the context of this research, these findings emphasise the importance of aligning LLMs with students' pedagogical goals and needs, which has a direct impact on their perceived usefulness – a key factor in the acceptance and use of new technologies. Furthermore, Giannakos et al. (2025) caution the need for careful implementation and evidence of pedagogical effectiveness. Mienye & Swart (2025) also highlight the potential of LLMs for personalised learning and task automation, but warn of ethical challenges in terms of privacy, opacity and bias. They advocate the use of explainable artificial intelligence (XAI) and human oversight to ensure trust and accountability in the use of GenAI tools.

Research Problem. Large language Models (LLMs) are increasingly used in higher education, but the factors that influence students' perceptions of their usefulness for learning have not yet been adequately explored. Previous studies have rarely examined a combined influence of relevance to academic learning, perceived enjoyment and perceived ease of use on students' perceptions of usefulness. This lack of evidence limits our understanding of how students evaluate the pedagogical value of LLMs, and hinders their effective integration into teaching and learning practices. In addition, previous studies have analysed students' perceptions and usage behaviours of GenAI tools, including LLMs. Chan & Hu (2023) have shown

that students have a generally positive attitude towards GenAI tools, highlighting their usefulness and relevance for personalised learning, writing, brainstorming and research, but also have concerns about accuracy, privacy and ethical issues. Similarly, Almassaad et al. (2024) found that most students use GenAI tools, especially ChatGPT, primarily for defining and clarifying terms, translating, generating ideas, and summarising literature. Students highlight both the benefits, such as easy access, time savings, and immediate feedback, and the risks, such as unreliability of information, plagiarism, reduced interpersonal interaction, and the impact on learner autonomy. Both studies emphasise the need for ethical guidelines, academic integrity policies, and support systems to maximise the benefits and minimize the risks associated with their use.

Research Focus. To address this gap, this study investigates how relevance to academic learning, perceived enjoyment, and perceived ease of use help shape students' perceptions of the usefulness of LLMs, which, according to the Technology Acceptance Model (TAM), is an important predictor of intention to use educational technologies. The aim of the study is to find out which of these factors are the strongest predictors of perceived usefulness in order to improve the understanding of students' perception and acceptance of LLMs in higher education. The results can serve as a basis for their strategic and pedagogically justified implementation in the education system as well as a basis for the development of a theoretical framework for future research in this context. The theoretical framework of this research is based on the TAM (Davis, 1989) and its extensions (TAM2: Venkatesh & Davis, 2000; TAM3: Venkatesh & Bala, 2008). According to the basic TAM, perceived ease of use (PEOU) and perceived usefulness (PU) are important predictors of intention to use, with PEOU not only directly influencing intention but also increasing PU. TAM2 introduces job relevance, which indicates the extent to which the user believes the technology is directly related to their goals and tasks; higher perceived relevance also increases PU (Venkatesh & Davis, 2000). TAM3 additionally includes hedonic motivation, operationalized as perceived enjoyment, which increases PEOU, and research (Yi & Hwang, 2003; Moon & Kim, 2001) shows that PU can also be directly influenced. Several studies have analyzed the motivation and intention to use GenAI tools using TAM and TTF concepts. Alshamy et al. (2025) have shown that students use GenAI more frequently when they perceive it as relevant and useful for certain academic tasks (brainstorming, writing, summarizing). Perceived usefulness and perceived ease of use were found to be important predictors of intention to use, and the TTF emphasizes the importance of matching the tool's capabilities to educational tasks. Similarly, Diao et al. (2024) found that the most important predictors of intention to use were precisely perceived usefulness and attitude towards GenAI, while expected effort and habit were weaker predictors. Singh & Paiva (2025) showed that perceived intelligence and technological novelty of GenAI tools increase both PU and PEOU, which then influence satisfaction, attitude and continued intention to use. Gong et al. (2025)

extended the TAM by including learning motivation, self-efficacy, perceived risk and previous usage experience and showed that PEOU positively influences PU and attitude towards using LLMs, while perceived time risk negatively influences PU.

Methodology of Research

General Background of Research. This study builds on the TAM (Davis, 1989), TAM2 (Venkatesh & Davis, 2000), TAM3 (Venkatesh & Bala, 2008), which identifies PU and PEOU as important predictors of technology use. TAM2 adds job relevance as a determinant of PU, while TAM3 includes hedonic motivation (perceived enjoyment) as an antecedent of PEOU and PU. As LLMs are increasingly integrated into higher education, understanding the factors that shape students' perceptions of usefulness is critical to their pedagogically meaningful implementation.

Sample of Research. A total of 102 students from various fields of study at the integrated Juraj Dobrila University of Pula took part in this study. Most of them came from the Faculty of Informatics (64.7%), followed by the Study of Design and Audiovisual Communication (10.8%), the University Undergraduate Study of Early and Preschool Education (6.9%), the Faculty of Engineering (7.8%; 4.9% Mechanical Engineering and 2.9% Computer Engineering), the Faculty of Economics and Tourism "Dr. Mijo Mirković" (3.9%), the Academy of Music (2.9%), the Faculty of Natural Sciences (2.0%), and the Integrated University Teacher Study (1.0%). This sample largely matches the one used in our earlier study (Babić, 2024, p. 36), with only two additional participants. The sample consisted of 53.9% female students, 43.2% male students and 2.9% who preferred not to state their gender. In terms of study status, 53.9% were full-time students and 46.1% were part-time students. Most of them (72.6%) rated their academic performance as average, 22.5% as excellent and 4.9% described themselves as students with learning difficulties. As for their experience with generative AI tools, 94.1% of the participants said they had used ChatGPT in their daily lives, while 5.9% had never used it. When asked about using ChatGPT as a tool for academic learning, 76.5% said they had used it for this purpose, while 23.5% had not. Half of the students (50.0%) said they had been using ChatGPT for less than a year, 27.5% for about a year and 22.5% for more than a year. Most of them used ChatGPT for academic learning several times a week at university (62.8%), while a smaller proportion (30.4%) used it several times a week at home. All students reported using ChatGPT to support their learning, while a much smaller proportion also mentioned other GenAI tools such as Copilot (9.8%), Gemini (7.8%) or Claude (2.0%). Students rated their knowledge of using ChatGPT for academic learning as good (M = 3.44; SD = 0.77) and their satisfaction with ChatGPT as very good

(M = 3.61; SD = 0.89). In terms of perceived usefulness, 42.2% said that ChatGPT helps them most of the time, 40.2% said it helps them to some extent, and 8.8% considered it essential for their learning. They mainly use ChatGPT to explain assignments and exercises (57.8%), to find additional study material (52.0%), to get help with coding and programming (47.1%), to prepare for exams through a question-and-answer simulation (40.2%) and to develop creative ideas (40.2%). They use it less frequently to solve mathematical and technical problems (29.4%), to analyze study materials (26.5%), to write seminar papers and other assignments (23.5%) and least frequently to learn and practice foreign languages (12.7%). The biggest benefits they cited were saving time (64.7%) and easier access to information (61.8%), while the smallest proportion of students said that ChatGPT helped them to develop critical thinking (13.7%).

Research Questions. The main objective of this study was to identify potential predictors of students' perceptions of the usefulness of LLMs (such as ChatGPT, Copilot, Gemini and others) as a learning aid. In this context, the following research questions were formulated:

1. Is there a relationship between relevance for academic learning, perceived enjoyment, perceived ease of use, and perceived usefulness of LLMs among university students?
2. Which of these factors are significant predictors of university students' perceived usefulness of LLMs?

Hypotheses. Based on the research questions, the following hypotheses were formulated:

H1: Relevance for academic learning is positively related to students' perceived usefulness of LLMs.

H2: Perceived enjoyment is positively related to students' perceived usefulness of LLMs.

H3: Perceived ease of use is positively related to students' perceived usefulness of LLMs.

Instrument and Procedures. The survey was conducted in September 2024, after the competent authorities of the respective higher education institutions had given their consent to conduct the survey at the integrated Juraj Dobrila University in Pula. It was based on a voluntary and anonymous basis. The online instrument was distributed to participants via a forum in the faculty's e-learning system (used for online and hybrid teaching) and via student groups of the course on Google Chat. The instrument and procedures were described in the previous paper (Babić, 2024, p. 38). In this paper, selected constructs were analyzed based on the TAM (Davis, 1989), TAM2 (Venkatesh & Davis, 2000), TAM3 (Venkatesh & Bala, 2008):

- *Perceived usefulness of LLMs* – indicates the extent to which students believe that using LLMs helps them learn and accomplish academic tasks (adapted from: Davis, 1989).

- *Perceived ease of use* – indicates the extent to which students perceive the use of LLMs as easy and effortless (adapted from: Davis, 1989).
- *Perceived enjoyment* – refers to the experience of satisfaction and enjoyment when using LLMs (adapted from: Venkatesh & Bala, 2008).
- *Relevance for academic learning* – indicates the extent to which students view the use of LLMs as related to their academic goals and tasks (adapted from: Venkatesh & Davis, 2000).

Reliability analysis showed that all scales used in this study had good to excellent internal consistency: relevance for academic learning ($\alpha = 0.942$), usefulness ($\alpha = 0.942$), enjoyment ($\alpha = 0.902$), and ease of use ($\alpha = 0.812$), indicating high reliability of the measurement instruments.

Data Analysis. The collected data was analyzed using JASP and Microsoft Excel. First, descriptive statistics were calculated for all variables. Spearman correlation analysis was used to examine the relationship between relevance to academic learning, perceived enjoyment, perceived ease of use and perceived usefulness. To determine the individual contribution of each factor to perceived usefulness, a multiple regression analysis was conducted using the Enter method, with perceived usefulness as the dependent variable. The statistical significance level was set at $p < 0.05$. To determine whether the experience with LLMs influences the perception of the statements of the selected scales in this study, the difference between users and non-users of LLMs for academic learning was analyzed using the Mann-Whitney U test.

Results of Research

Table 1 shows the distribution of students' responses to the items measuring the perceived usefulness of LLMs (such as ChatGPT, Copilot, Gemini) for academic learning. The mean scores of all items within the construct of perceived usefulness ranged from 3.28 to 3.48, indicating a moderately positive attitude towards the usefulness of LLMs for academic learning.

Table 1
Distribution of respondents' answers (N = 102) to the items measuring the perceived usefulness of LLMs

Scale items	Frequency (%)					M	SD
	1	2	3	4	5		
Improves academic performance	7 (6.9)	18 (17.6)	37 (36.3)	19 (18.6)	21 (20.6)	3.28	1.18
Increases productivity	10 (9.8)	17 (16.7)	26 (25.5)	30 (29.4)	19 (18.6)	3.30	1.23
Improves efficiency in learning	8 (7.8)	12 (11.8)	30 (29.4)	27 (26.5)	25 (24.5)	3.48	1.21
Improves the quality of studies	12 (11.8)	15 (14.7)	24 (23.5)	34 (33.3)	17 (16.7)	3.28	1.25

Note. Responses were given on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). M = mean, SD = standard deviation.

S o u r c e: Own work.

The results of the descriptive analysis (Table 1) show that the respondents' opinion that the use of LLMs (such as ChatGPT) "Improves efficiency in learning" had the highest mean (M = 3.48, SD = 1.21), with 51% of the students expressing their agreement with this statement. Similar results were obtained for the statements "increases productivity" (M = 3.30, SD = 1.23) and "improves academic performance" (M = 3.28, SD = 1.18), with 48% of respondents agreeing with this statement. Respondents' opinion that the use of LLMs in learning "improves the quality of studies" had the same mean score (M = 3.28, SD = 1.25), with 50% of students agreeing with the above statement, but with slightly greater variability in answers, indicating more pronounced individual differences in the assessment of the contribution of LLMs to improving the quality of study. The results of the Mann-Whitney test (Appendix Table 1) consistently showed statistically significant differences between LLM users and non-users in their perceptions of the usefulness of LLMs. As shown in Appendix, Table 1, LLM users indicated a significantly higher level of perceived usefulness of LLMs for all items examined. The mean ratings of users were consistently higher (56.28–57.85) compared to the mean ratings of non-users (30.88–35.98). All differences were statistically significant ($p < .01$), with moderate to strong effects ($r = -.398$ to $-.529$). These findings clearly indicate that direct experience of using LLMs leads to a significantly positive perceptions of their usefulness in an academic context.

In order to investigate the perceived relevance for academic learning, the respondents' answers to the three statements listed in Table 2 were analyzed.

Table 2
Distribution of respondents' answers (N=102) to the items measuring the perceived relevance of LLMs for academic learning

Scale items	Frequency (%)					M	SD
	1	2	3	4	5		
Important for academic success	23 (22.5)	28 (27.5)	23 (22.5)	20 (19.6)	8 (7.8)	2.63	1.25
Relevant for educational goals	12 (11.8)	19 (18.6)	35 (34.3)	26 (25.5)	10 (9.8)	3.03	1.15
Important for educational tasks	11 (10.8)	26 (25.5)	30 (29.4)	26 (25.5)	9 (8.8)	2.96	1.14

Note. Responses were given on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). M = mean, SD = standard deviation.

S o u r c e: Own work.

The results of the descriptive analysis (Table 2) show that the mean values of the students' responses to all statements on the evaluation of the LLMs were predominantly neutral (M = 2.63–3.03) and only about one third of the respondents agreed with the statements (from 27.4% to 35.3%). The lowest level of agreement was with the statement that the use of LLMs is "important for academic success" (27.4%), indicating divided opinions on the value of LLMs for academic learning. The results of the Mann-Whitney test (Appendix, Table 1) consistently showed statistically significant differences between LLM users and non-users in their perceptions of the relevance of LLMs to academic learning. Statistically significant differences were found for all three statements analyzed regarding the evaluation of LLM relevance of LLMs for academic learning. The mean scores of users were significantly higher (54.92–55.46) than those of non-users (38.65–40.38). The differences were significant for the statements on relevance to academic success ($p = .013$), relevance to educational goals ($p = .024$), and relevance to educational tasks ($p = .030$), with medium effects ($r = -.285$ to $-.330$). These results indicate that users of LLMs recognize their educational relevance more clearly.

To investigate the emotional dimension of using LLMs in learning, students' perceptions of their enjoyment of working with them were analyzed (Table 3).

Table 3
Distribution of respondents' answers (N=102) to questions measuring perceived enjoyment of using LLM for academic learning

Scale items	Frequency (%) 1	2	3	4	5	M	SD
Using LLMs for learning is…							
Fun	7 (6.9)	7 (6.9)	40 (39.2)	23 (22.5)	25 (24.5)	3.51	1.14
Pleasant	2 (2.0)	11 (10.8)	31 (30.4)	36 (35.3)	22 (21.6)	3.64	1.00
Very interesting	5 (4.9)	13 (12.7)	29 (28.4)	33 (32.4)	21 (20.6)	3.51	1.11

Note. Responses were given on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). M = mean, SD = standard deviation.

Source: Own work.

The results of the descriptive analysis (Table 3) show that the perception of the use of LLMs in learning is predominantly positive in terms of the fun factor. They agreed most with the statement that using LLMs is "fun" (M = 3.64; SD = 1.00), with more than half of the respondents (56.9%) agreeing with this statement.

Similar mean scores were obtained for the statement that using LLMs is "fun" (M = 3.51; SD = 1.14) and "very interesting" (M = 3.51; SD = 1.11), with approximately 48% to 53% of respondents agreeing with this statement (Table 3). These results suggest that students generally find using LLMs an enjoyable and interesting experience. The results of the Mann-Whitney test (Appendix Table 1) consistently showed statistically significant differences between LLM users and non-users in the perception of enjoyment. The data in Appendix, Table 1, show that LLM users reported significantly higher mean scores for enjoyment of working with LLMs compared to non-users. All three statements were statistically significant ($p < .01$). Users found working with LLMs more enjoyable (MR = 57.56 vs. 31.81), more pleasant (MR = 55.94 vs. 37.06) and very interesting (MR = 56.01 vs. 34.00). The largest effect was expected for the statement about fun ($r = -.505$), which further confirms that the use of direct LLMs has a positive effect on perceived fun.

The results of the descriptive analysis (Table 4) show that the majority of students perceive the use of LLMs in learning as easy. The highest mean score was for the item "easy to use" (M = 3.99; SD = 0.87), with 72% of respondents agreeing or strongly agreeing. This was followed by the item "The interaction is clear and understandable" (M = 3.69; SD = 0.99) with 65% positive responses. Lower mean values and a lower proportion of agreement were recorded for the items "easy to achieve the desired result" (M = 3.50; SD = 0.95; 51% agreement) and "requires no mental effort" (M = 3.38; SD = 1.10; 47% agreement). A large proportion of neutral responses (score 3) was also recorded for these items, particularly for "easy to achieve the desired result", suggesting that some students do not have a clear

opinion on this dimension. Although the majority of students expressed a positive attitude towards the ease of use of LLMs, the majority of neutral responses for individual items indicate different experiences and perceptions within the student population.

Table 4
Distribution of respondents' answers (N=102) to questions measuring the perceived ease of use of LLMs for academic learning

Items	Frequency (%)					M	SD
	1	2	3	4	5		
Interaction is clear and understandable	3 (2.9)	10 (9.8)	23 (22.5)	46 (45.1)	20 (19.6)	3.69	0.99
Requires no mental effort	6 (5.9)	14 (13.7)	34 (33.3)	31 (30.4)	17 (16.7)	3.38	1.10
Easy to use	1 (1.0)	3 (2.9)	24 (23.5)	42 (41.2)	32 (31.4)	3.99	0.87
Easy to achieve the desired result	2 (2.0)	12 (11.8)	36 (35.3)	37 (36.3)	15 (14.7)	3.50	0.95

Note. Responses were given on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). M = mean, SD = standard deviation.

S o u r c e: Own work.

Regarding the perception of the ease of use of LLMs, the results of the Mann-Whitney U test (Appendix Table 1) showed that the only statistically significant difference was estimated for the statement "The interaction with the LLM is clear and understandable", where users had a higher average rank (55.04) than non-users (40.00), with statistical significance ($p = .021$) and measured ($r = -.295$). No statistically significant differences were found for the other statements (on mental effort, ease of use and goal achievement) ($p > .05$). It is assumed that the groups of respondents perceive the user-friendliness of LLMs similarly, although the users emphasize the clear interaction slightly more.

The results of the Spearman correlation analysis (see Table 5) showed that all three constructs analysed were statistically significantly positively associated with the perception of the usefulness of LLMs. The strongest correlation was found between relevance and perceived usefulness ($\rho = 0.774$; $p < .001$), suggesting that students perceive LLM users as particularly important and applicable to their academic goals. Perceived enjoyment (hedonism) showed a moderately positive relationship with usefulness ($\rho = 0.730$; $p < .001$), while perceived ease of use showed a weaker-moderate but significantly positive relationship ($\rho = 0.384$; $p < .001$) of the selected scales in the research.

Table 5
Results of Spearman's correlation of selected scales in the research (N=102)

Scale	Spearman's ρ	p-value	Interpretation of the strength of association
Relevance for academic learning	0.774	< .001	strong
Perceived enjoyment	0.730	< .001	strong
Perceived ease of use	0.384	< .001	weak to moderate

S o u r c e: Own work.

The results of the regression analysis showed that the group of predictors significantly explained the perceived usefulness of LLMs, $F(3,98) = 83.08$, $p < .001$, with the model explaining 71.8% of the variance. The strongest predictor was relevance ($\beta = .55$, $p < .001$), with perceived enjoyment also contributing significantly ($\beta = .41$, $p < .001$). Perceived ease of use ($\beta = –.02$, $p = .784$) was not significant when the other constructs were included in the model. These results suggest that students perceive LLMs as useful primarily when they perceive them as relevant to their academic needs and when they elicit a sense of enjoyment, whereas ease of use has no independent influence on the presence of other factors.

Table 6
Results of the multiple regression analysis based on the answers of the respondents (N=102)

Scale	B	SE B	β	t	p
Relevance for academic learning	0.578	0.069	0.553	8.424	< .001
Perceived ease of use	-0.026	0.095	-0.018	-0.275	.784
Perceived enjoyment	0.458	0.086	0.408	5.343	< .001

Note. B = unstandardized regression coefficient; SE B = standard error of B; β = standardized regression coefficient; t = t-statistic; p = significance level.

S o u r c e: Own work.

Discussion

This study found that the largest proportion of respondents (94.1%) used LLMs in their daily lives, with most preferring ChatGPT. However, 24% of respondents do not use LLMs for the purpose of academic learning. These findings indicate that the students included in the study have already gained extensive experience with the use of LLMs, which is an important basis for a reliable assessment of their attitudes and perceptions in the educational context. The results of the Spearman

correlation analysis showed that all three variables analysed – relevance, enjoyment and simplicity – are statistically significantly positively associated with the perceived usefulness of LLMs, thus confirming all three hypotheses (H1, H2 and H3) at the association level. These results are consistent with the basic assumptions of the TAM (Davis, 1989) and its extensions (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008), according to which both cognitive (relevance, simplicity) and affective (enjoyment) factors contribute to the formation of attitudes about the usefulness of educational technology. However, the results of the multiple regression analysis showed that only relevance and perceived enjoyment were significant predictors of students' perceived usefulness, while perceived ease of use did not make a statistically significant contribution to the prediction. In other words, although all three variables were related to usefulness, only relevance and enjoyment made a clear contribution to the prediction of usefulness when they were included in the model simultaneously. Hypothesis H3 was thus partially rejected. This result suggests that although students associate ease of use with usefulness, it does not play a crucial role in assessing the educational value of LLMs when other variables are taken into account, probably because it is perceived as an expected feature of modern digital tools. Alshamy et al. (2025) also come to similar conclusions and emphasize that relevance and usefulness are the most important factors for the intention to use LLMs, while ease of use becomes less important as the usage experience increases. Diao et al. (2024) also confirm that perceived usefulness, rather than expected effort, is the strongest predictor of intention to use GenAI tools, while Singh & Paiva (2025) emphasize that the hedonic component of use increases satisfaction and positive attitude, which is consistent with the findings of this study on the importance of perceived enjoyment. The results are partially consistent with the findings of Gong et al. (2025), who showed that perceived simplicity only indirectly influences usefulness via attitudes and previous experiences, while it was not confirmed as a direct predictor in this study. Additional analysis showed that users of LLMs for academic learning had statistically significantly higher scores on all items of the construct of perceived enjoyment than non-users, suggesting that personal experience of use increases the experience of satisfaction and engagement when working with these tools. This finding supports the assumption of the TAM3 model (Venkatesh & Bala, 2008) that the hedonic component of usage promotes the emergence of positive attitude towards technology and may indirectly contribute to its perceived usefulness. It is possible that students in this sample, as digitally literate users, understand the ease of use of LLMs and therefore place greater importance on the extent to which the tool relates to their educational goals and the level of satisfaction and engagement it provides them when using it. This emphasizes that the successful integration of LLMs into the educational process requires that they are aligned with pedagogical goals and that the activities are designed to engage students and are meaningfully connected to the course content (Belkina et al., 2025; Giannakos et al., 2025). Future research should include larger and more

diverse samples, additional constructs and a longitudinal approach to investigate how students' attitudes towards LLMs change over time.

Conclusions

The aim of this study was to investigate the extent to which relevance to academic learning, perceived enjoyment and perceived ease of use contribute to students' perceptions of the usefulness of LLMs in higher education. The results showed that all three variables were significantly positively associated with perceived usefulness, but that only relevance and enjoyment had significant predictive value when considered together in a regression model. This confirmed the importance of cognitive and affective factors in shaping attitudes towards educational technologies, with ease of use being associated with usefulness but not contributing to its prediction when other variables were controlled. The main contribution of this study is that it provides empirical evidence of the factors that shape students' perceptions of the usefulness of LLMs, focusing on the importance of their pedagogical evaluation and their ability to promote enjoyment and engagement in learning. These findings suggest that the integration of LLMs into higher education must be based on the design of activities that are consistent with educational objectives while being motivating for students. The findings can also serve as a basis for developing extended theoretical models of LLM acceptance and as a starting point for future research, which should include additional constructs, larger and more diverse samples, and a longitudinal approach to monitor changes in student' attitudes over time.

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Appendix A.

Results of the Mann-Whitney U-test to compare LLMs users and non-users for the statements of all scales

Table 1

Differences between users and non-users of LLMs in the items of all scales in this study (Mann-Whitney U-test)

Items	The use of LLMs for academic learning				U	p	r (rank-biserial)
	Users (N=78)		Non-Users (N=24)				
	Mean Rank	Mean SD	Mean Rank	Mean SD			
Perceived usefulness of LLMs							
Improves academic performance	56.89	3.51(1.09)	33.98	2.54(1.18)	1.357**	0.00	–.449
Increases productivity	57.85	3.59(1.10)	30.88	2.38(1.21)	1.431**	0.00	–.529
Improves efficiency in learning	57.67	3.74(1.10)	31.44	2.63(1.17)	1.418**	0.00	–.514
Improves the quality of studies	56.28	3.51(1.11)	35.98	2.54(1.38)	1.309*	0.02	–.398
Perceived Ease of use							
Interaction is clear and understandable	55.04	3.83(0.87)	40.00	3.21(1.22)	1.212*	.021	–.295
Requires no mental effort	51.79	3.40(1.06)	50.56	3.33(1.24)	958.5	.857	–.024
Easy to use	53.92	4.08(0.82)	43.63	3.71(1.00)	1.125	.114	–.202
Easy to achieve the desired result	52.35	3.53(0.94)	48.75	3.42(1.02)	1.002	.587	–.071
Relevance for academic learning							
Important for academic success	55.46	2.80(1.22)	38.65	2.08(1.21)	1.245*	.013	–.330
Relevant for educational goals	55.05	3.18(1.07)	39.96	2.08(1.21)	1.213*	.024	–.300
Important for educational tasks	54.92	3.09(1.11)	40.38	2.54(1.18)	1.203*	.030	–.285
Perceived enjoyment							
Using LLMs for learning is…							
Fun	57.56	3.77(0.99)	31.81	2.67(1.20)	1.409**	.000	–.505
Pleasant	55.94	3.80(0.96)	37.06	3.13(0.99)	1.283**	.004	–.370
Very interesting	56.01	3.71(1.06)	34.00	2.87(1.06)	1.288**	.001	–.436

*Note. U – Mann–Whitney U statistic; p – significance level (**p<0.01, *p<0.05); r – rank-biserial correlation (effect size)*

S o u r c e: Own work.

Snježana Babić

Badanie empiryczne nad rolą trafności, przyjemności i łatwości użytkowania w kształtowaniu postrzeganej użyteczności LLM-ów przez studentów szkół wyższych

S t r e s z c z e n i e

Postrzegana użyteczność (PU) jest jednym z najważniejszych czynników akceptacji technologii, ponieważ silnie wpływa zarówno na intencję korzystania, jak i faktyczne wykorzystanie technologii. Ponieważ duże modele językowe (LLM), takie jak ChatGPT, są coraz częściej wykorzystywane w szkolnictwie wyższym, istotne jest zrozumienie, jakie czynniki wpływają na postrzeganie przez studentów użyteczności LLM w uczeniu się akademickim. Na podstawie Modelu Akceptacji Technologii (TAM) niniejsze badanie analizowało rolę relewancji dla uczenia się akademickiego, postrzeganej przyjemności oraz postrzeganej łatwości użycia (PEOU) w kształtowaniu postrzegania przez studentów użyteczności LLM. W badaniu uczestniczyło 102 studentów z uniwersytetu w Chorwacji. Dane przeanalizowano z wykorzystaniem korelacji rang Spearmana oraz analizy regresji wielorakiej. Analiza korelacyjna wykazała, że wszystkie trzy czynniki były istotnie statystycznie dodatnio skorelowane z postrzeganą użytecznością LLM. Jednak analiza regresji wykazała, że tylko relewancja dla uczenia się akademickiego oraz postrzegana przyjemność korzystania z LLM w procesie uczenia się były istotnymi pozytywnymi predyktorami, podczas gdy postrzegana łatwość użycia odgrywała mniejszą rolę. Razem te dwie zmienne wyjaśniły 71,8% wariancji w postrzeganiu przez studentów użyteczności LLM. Wyniki podkreślają znaczenie identyfikacji czynników kształtujących postrzeganie użyteczności LLM, ponieważ są one ważnym predyktorem intencji korzystania z technologii. Uzyskane wyniki sugerują, że istnieje potrzeba opracowania narzędzi opartych na LLM, które będą pedagogicznie relewantne i angażujące dla studentów oraz które mogą stanowić wytyczne dla ich skutecznej integracji w szkolnictwie wyższym.

S ł o w a k l u c z o w e: duże modele językowe (LLM); Model Akceptacji Technologii (TAM); postrzegana użyteczność; trafność dla uczenia się akademickiego; postrzegana przyjemność; szkolnictwo wyższe

Snježana Babić

Estudio empírico sobre el papel de la relevancia, el disfrute y la facilidad de uso en la configuración de la utilidad percibida de los LLM entre estudiantes de educación superior

R e s u m e n

La utilidad percibida (PU) es uno de los factores más importantes en la aceptación de las tecnologías, ya que influye fuertemente tanto en la intención de uso como en el uso real de la tecnología. Dado que los grandes modelos de lenguaje (LLM), como ChatGPT, se utilizan cada vez más en la educación superior, es fundamental comprender qué factores influyen en la percepción que tienen los estudiantes sobre la utilidad de los LLM en el aprendizaje académico. Basándose en el Modelo de Aceptación de la Tecnología (TAM), el presente estudio analizó el papel de la relevancia para el aprendizaje académico, del disfrute percibido y de la facilidad de uso percibida (PEOU) en la confi-

guración de la utilidad percibida de los LLM por parte de los estudiantes. En el estudio participaron 102 estudiantes de una universidad en Croacia. Los datos se analizaron utilizando la correlación de rangos de Spearman y el análisis de regresión múltiple. El análisis de correlación mostró que los tres factores estaban significativamente correlacionados de forma positiva con la utilidad percibida de los LLM. Sin embargo, el análisis de regresión indicó que solo la relevancia para el aprendizaje académico y el disfrute percibido del uso de los LLM en el proceso de aprendizaje eran predictores positivos significativos, mientras que la facilidad de uso percibida desempeñaba un papel menor. En conjunto, estas dos variables explicaron el 71,8 % de la varianza en la utilidad percibida de los LLM por parte de los estudiantes. Los resultados subrayan la importancia de identificar los factores que configuran la percepción de la utilidad de los LLM, dado que constituyen un importante predictor de la intención de uso de la tecnología. Los hallazgos sugieren la necesidad de desarrollar herramientas basadas en LLM que sean pedagógicamente relevantes y motivadoras para los estudiantes y que puedan servir como directrices para su integración eficaz en la educación superior.

P a l a b r a s c l a v e: grandes modelos de lenguaje (LLM); Modelo de Aceptación de la Tecnología (TAM); utilidad percibida; relevancia para el aprendizaje académico; disfrute percibido; educación superior

Снежана Бабич

Эмпирическое исследование роли релевантности, удовольствия и простоты использования в формировании воспринимаемой полезности LLM у студентов высших учебных заведений

А н н о т а ц и я

Воспринимаемая полезность (PU) является одним из важнейших факторов принятия технологий, поскольку она существенно влияет как на намерение пользоваться технологией, так и на её фактическое использование. Поскольку крупные языковые модели (LLM), такие как ChatGPT, всё чаще используются в высшем образовании, важно понять, какие факторы влияют на восприятие студентами полезности LLM в академическом обучении. Опираясь на модель принятия технологии (Technology Acceptance Model, TAM), в данном исследовании анализировалась роль релевантности академическому обучению, воспринимаемого удовольствия и воспринимаемой простоты использования (PEOU) в формировании воспринимаемой полезности LLM у студентов. В исследовании приняли участие 102 студента одного университета в Хорватии. Данные были проанализированы с использованием ранговой корреляции Спирмена и множественного регрессионного анализа. Корреляционный анализ показал, что все три фактора имеют статистически значимую положительную связь с воспринимаемой полезностью LLM. Однако регрессионный анализ продемонстрировал, что лишь релевантность академическому обучению и воспринимаемое удовольствие от использования LLM в процессе обучения являются значимыми положительными предикторами, тогда как воспринимаемая простота использования играет менее значимую роль. В совокупности эти две переменные объяснили 71,8 % дисперсии в воспринимаемой полезности LLM у студентов. Полученные результаты подчёркивают важность выявления факторов, формирующих восприятие полезности LLM, поскольку они являются важным предиктором намерения использовать технологию. Результаты исследования указывают на необходимость разработки основанных на LLM инструментов, которые были бы педагогически релевантными и вовлекающими для

студентов и могли бы служить руководством для их эффективной интеграции в систему высшего образования.

К л ю ч е в ы е с л о в а: крупные языковые модели (LLM); модель принятия технологии (TAM); воспринимаемая полезность; релевантность академическому обучению; воспринимаемое удовольствие; высшее образование

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The Use of Artificial Intelligence in Academic and Personal Life of Pedagogy Students

Abstract

This study presents a comparative analysis focused on the use of artificial intelligence (AI) among students of Pedagogy in the Czech Republic and Poland. The aim of the research is to compare how Czech and Polish students use AI in both their academic and personal lives.The research was conducted using a quantitative method through a structured questionnaire (25 closed-ended questions) distributed across five universities in both countries (a total of 275 pedagogy students participated in the research, 130 from Poland and 142 from the Czech Republic) during May and June 2025. Data analysis was carried out using the chi-square test of independence.

The research findings show that AI has already become a common part of academic life for pedagogy students in both countries. The majority of respondents reported using AI regularly, with Polish students showing a slightly higher frequency of use than Czech students. Students most commonly use AI for information retrieval, creating presentations, writing academic papers, translation, grammar checking, and understanding complex subject matter. Students perceive AI as beneficial for their future professional practice, and most express an interest in further education in this area. At the same time, they are aware of the risks associated with AI use-particularly ethical and informational risks – and in most cases, they verify AI-generated outputs through other sources.

The research also revealed differences between students in the two countries-for example, in the frequency of AI use in practical teaching, in the level of

perceived awareness, or in attitudes related to AI use (such as feelings of guilt). The conclusions of the study underscore the need for the systematic integration of AI into education, including training on its risks, and the support for developing students' digital competencies in an international context.

K e y w o r d s: Artificial Intelligence, Higher Education, Students of Pedagogy, Comparative Study, Digital Competence, AI in Education, Student Attitudes, Ethical Use of AI

Introduction

The dynamic development of modern technologies is fundamentally transforming contemporary educational systems. One of the most significant innovations is the application of artificial intelligence in teaching (Belgith et al., 2024). The field of artificial intelligence is developing continously and rapidly (Przybyła-Kasperek, Smyrnova & Kommers, 2023¸ Oprea, 2021; Mhlanga, 2022; Yu & Nazir, 2021). A major shift has occurred particularly with the emergence of tools such as ChatGPT, which provide substantial support in the educational process (Firdaus et al., 2023). In recent years, artificial intelligence (AI) technologies have been gradually entering the field of education, bringing with them new challenges as well as opportunities (Ziatdinov et. al., 2022; Pikkarainen & Tihinen, 2023; Ramírez, 2021). The advancement of AI technologies in the digital era holds the potential to significantly transform and redefine traditional teaching and learning methods, approaches, and tools. In school education, the opportunities offered by these technologies are increasingly being leveraged in areas such as assessing and analyzing learning outcomes, personalizing educational content and learning processes, providing instant feedback, and enhancing student engagement and motivation (Glushkova & Malinova, 2024; Glushkova, Gurba, Hug, Morze, Noskova & Smyrnova-Trybulska, 2022).

1. The Emergence of Artificial Intelligence Use in Schools in the Czech Republic

Czech teachers are beginning to adapt to these changes and are seeking ways to work effectively with artificial intelligence. Research conducted by the Faculty of Education at Palacký University in Olomouc (Kopecký et al., 2023) showed that 27.7% of Czech teachers use chatbots when preparing for lessons, and 15.82%

use them directly during instruction. The same study revealed that most Czech teachers view artificial intelligence as a tool that has its place in the educational process. Specifically, 45.5% of Czech teachers have a positive attitude toward the use of AI in education. This opinion likely relates to the fact that as many as 81.7% of teachers recognize the need to acquire the skills necessary to work with these technologies. Although a large percentage of educators hold a positive view of using AI in education, the same research also found that there is a significant level of concern among teachers regarding the use of this technology in the educational field. Approximately 47.6% of teachers believe that chat tools are being misused by students for cheating, and 34% of respondents have already encountered specific cases where students used ChatGPT to generate essays or other homework assignments in order to avoid doing the work themselves.

The introduction of AI into schools is also being addressed by the Ministry of Education, Youth and Sports of the Czech Republic (MŠMT), which has prepared a support plan for the use of artificial intelligence in education, as well as by the National Pedagogical Institute of the Czech Republic (NPI ČR), which offers teachers online webinars and in-person seminars focused on the use of AI tools and related ethical issues (NPI ČR, online). The topic of AI in education is also addressed by international institutions. In 2022, the European Commission published the document *Ethical Guidelines for the Use of Artificial Intelligence within the European Union*, created as part of the *Digital Education Action Plan (2021–2027)*. This document provides a set of thought-provoking questions that educators should consider when integrating AI into teaching, encouraging reflection and a responsible approach (European Commission, 2022). At the national policy level, AI is also addressed in the *National Artificial Intelligence Strategy of the Czech Republic*, published by the Ministry of Industry and Trade in 2019. This strategic document not only addresses the impact of AI on the labor market but also explores the legal, ethical, and social aspects of its use in the public sphere, including education.

Artificial intelligence is transforming the Czech educational system. At universities, AI has become a standard part of academic practice. Both students and instructors use AI tools for data processing, translation, syllabus creation, proofreading, programming, and analysis of scholarly articles (MUNI, online). In certain fields-such as computer science, education, psychology, or the humanities-AI is not only a tool but also a subject of teaching and research. Increasing emphasis is being placed on academic integrity. Some universities (e.g., Faculty of Arts at Charles University, Masaryk University, Palacký University) have already amended their internal regulations to clearly define when and how AI may be used and how to distinguish legitimate use from plagiarism (FF UK, online; UPOL, online). In addition, training for academic staff in this area is expanding, and recommendations for the responsible use of these technologies are being developed. AI is thus becoming a standard tool of scientific and academic work.

2. The Emergence of Artificial Intelligence Use in Schools in Poland

In Poland, the topic of artificial intelligence (AI) is becoming increasingly important and is gaining attention from educators, experts, and the general public (Przybyła-Kasperek, Smyrnova & Kommers, 2023). Teachers perceive its potential as a key driving force that may significantly transform not only the educational system itself in the near future, but also the way future teachers and other education-related professionals are trained. AI is seen as a tool that can support the individualization of teaching, streamline administrative tasks, and help better respond to students' needs.

At the same time, Polish teachers are well aware that the use of AI also entails certain risks, especially in the areas of personal data protection, cybersecurity, and the ethical use of digital technologies (PARP, online). Therefore, the Polish education system emphasizes adherence to the procedures outlined in the document titled *Ethical Guidelines for the Use of Artificial Intelligence within the Europe Union*, issued by the European Commission in 2022. These guidelines stress the importance of transparency, accountability, and the protection of the rights of all users, including teachers and students (European Commission, 2022).

In October 2023, a comprehensive research study was published focusing on the use of artificial intelligence tools in Polish education, with particular emphasis on the ChatGPT platform. The results showed that 51% of teachers and 40% of students use this tool at least once a week. Interestingly, teachers were found to be more frequent users of AI than their students, which may reflect their effort to understand the technology they aim to integrate effectively into the classroom. Support for the use of AI also comes directly from the school environment – 38% of teachers actively encourage their students to use AI tools, such as chatbots, in a meaningful and efficient way. The majority of respondents, both teachers (72%) and students (63%), agree that the rise of chatbots and other AI tools brings inevitable changes to the traditional concept of teaching. This change is generally perceived positively – as an opportunity to streamline the teaching process, increase student engagement, and adapt learning to individual needs (PARP, online).

Polish teachers recognize that the emergence of artificial intelligence is reshaping the role of the teacher. In their view, the teacher will become more of a mentor or guide – not someone who simply delivers information, but someone who teaches students how to search for information, analyze it, think critically, and work creatively and independently (Vavříková & Zormanová, 2025).

In 2024, a study was published that explored the use of AI among high school students. The study focused on how secondary school students use ChatGPT and other artificial intelligence tools in education. The research was conducted among

75 students aged 15–19 who study exclusively using tablets and iPads. The aim of the research was to determine whether there is a connection between the use of these technologies and factors such as gender, personality traits, and career interests. Approximately half of the students reported having used ChatGPT or other AI tools. Although there were no significant differences in usage between genders, boys more frequently reported higher levels of knowledge and interest in AI compared to girls. Most students rated their knowledge of AI as average, while one-third considered their knowledge to be high or very high. According to the students, ChatGPT is particularly useful for information retrieval, translation, and solving math problems. It is perceived as less useful in areas of creative production, such as writing poetry (Skop & Frania, 2024).

The majority of respondents believe that AI will become a standard part of education – similar to computers – and support the idea that these tools should be actively used in schools rather than banned (Skop & Frania, 2024). The research did not find any significant correlation between personality traits (e.g., openness, extraversion) and the level of AI use or attitudes toward AI. On the other hand, career interests did influence both AI usage and attitudes. Students interested in organization and management showed a greater interest in AI, while those with practical-aesthetic interests were more likely to feel that tools like ChatGPT limit creativity. The study highlighted the need to introduce media education focused on working with AI, specifically aimed at practical training in prompt formulation („prompt literacy“) and the ethical use of these technologies. It emphasizes that the use of AI in education is not a matter of the future, but of the presentand the education system must respond to this reality proactively(Skop & Frania, 2024).

3. Research Methodology

The aim of the research is to compare how Czech and Polish pedagogy students use artificial intelligence in both their academic and personal lives. The contrast between Polish and Czech students was deliberately chosen because both countries share certain historical, cultural, and educational similarities, yet their higher education systems and approaches to digital literacy and AI integration differ. Comparing these two groups allows for identifying both common trends and country-specific differences in AI use among pedagogy students, providing a more nuanced understanding of students' behaviors, attitudes, and awareness of ethical issues. The selection of these populations thus offers a relevant context for exploring how AI is adopted and perceived in similar but distinct educational environments.

The main research question, based on the stated research objective, was formulated as follows:

MRQ: „For what purposes and to what extent do Czech and Polish pedagogy students use artificial intelligence in their academic and personal lives?“

MH: There are statistically significant differences between Czech and Polish pedagogy students in the purposes and extent of artificial intelligence use in their academic and personal lives.

This research question covers both the comparative dimension (comparison between the Czech Republic and Poland) as well as both contexts of AI use (academic and personal). The main research question was further divided into several sub-research questions, each corresponding to a specific hypothesis.

RQ1: To what extent do Czech and Polish pedagogy students use artificial intelligence (AI) in their academic studies, and are there significant differences between them in terms of usage frequency and purpose?

H1: There are statistically significant differences between Czech and Polish pedagogy students in their use of AI in academic studies in terms of frequency and purpose.

The hypothesis is supported by existing research showing that students adopt AI differently based on their perceptions of its usefulness and complexity. Research indicates that in teacher education programs, perceptions of the usefulness and ease of use of AI influence its adoption and practical application, even within an academic context.

Relevant questionnaire items:

- Q1: Do you use AI in your studies?
- Q2: How often do you use AI?
- Q3: For which academic tasks do you use AI most frequently? *(note: creating presentations showed significant difference)*
- Q5: Do you use AI when writing final or seminar papers?
- Q6: Do you use AI to prepare for tests or exams?
- Q7: Do you use AI in practical classes (e.g., simulations, clinical information search, preparation of teaching activities)?

  Bećirović et al. (2025), in their multidimensional study of AI adoption among pedagogy students, found that perceptions of usefulness and ease of use positively affect the practical application of AI in academic studies – this explains why the frequency and purposes of AI use may vary across groups with differing perceptions.

RQ2: Do Czech and Polish pedagogy students use AI outside academic obligations, and is there a significant difference in this behavior between the two groups?

H2: There is a statistically significant difference between Czech and Polish pedagogy students in the use of AI for non-academic, personal purposes.

The hypothesis is supported by research showing that students use AI not only for academic purposes but also for personal and everyday tasks, with their motivations and the relevant context influencing the extent of this adoption.

Relevant questionnaire items:

- Q18: Do you use AI outside of your studies?
  Mazaheriyan & Nourbakhsh (2025) note that students primarily use AI tools to improve work quality and efficiency, but without clear guidance, "shadow pedagogy" can emerge, potentially leading to differences in personal usage and motivations.

RQ3: How do Czech and Polish pedagogy students perceive the usefulness of AI for their future professional careers, and do these perceptions differ significantly?

H3: There is a statistically significant difference between Czech and Polish pedagogy students in their perceptions of AI's usefulness for their future professional practice.

Relevant questionnaire items:

- Q8: Do you think using AI can be beneficial for your professional practice?
- Q12: Do you think AI can help you in your future professional work?
- Q17: Do you think AI could threaten jobs in your field in the future?
  The hypothesis that Czech and Polish pedagogy students may differ in how they perceive the usefulness of AI for their future professional careers is grounded in research showing that many students regard AI as an important factor in their future employability and professional development. Studies indicate that students generally recognize AI's potential to enhance learning efficiency and support career readiness, but at the same time express concerns about ethical issues and the need for targeted education on AI competencies. For example, Thomson et al. (2024) found that a majority of students feel that understanding AI tools and their ethical implications will be important in their future careers, with many reporting that they are likely to use AI in their degree programs and believing that AI skills will be valuable in the workforce. This suggests that students' perceptions of AI's usefulness for their future professional practice are well-established in the literature and can vary depending on educational context and individual attitudes toward AI.

RQ4: How do Czech and Polish pedagogy students assess their awareness of AI applications and risks in their field of study, and are there significant differences in this self-assessment?

H4: There are statistically significant differences between Czech and Polish pedagogy students in their self-assessed awareness of AI applications and associated risks.

Relevant questionnaire items:

- Q9: Do you feel sufficiently informed about AI possibilities in your field?
- Q13: Are you aware of risks associated with AI (inaccurate info, plagiarism, ethical issues)?

  There are studies that specifically examine the perception of risks and ethical aspects of AI. Research on the perception of risks associated with emerging AI technologies highlights that these topics are important in the scholarly discussion, and that students reflect on their perception of them, which supports the formulation of H4. Machleidt et al. (2023) in their work on the perception of AI-related risks show that exposure to risk aspects of AI influences both students and the general public and emphasizes the need for ethical and risk-oriented education.

RQ5: Are Czech and Polish pedagogy students interested in AI-related training or education, and do they differ in their desire to further develop AI-related and digital competencies?

H5: There is a statistically significant difference between Czech and Polish pedagogy students in their interest in AI-related training and further development of AI and digital skills.

Relevant questionnaire items:

- Q11: Would you like the school to offer training/courses on AI use in your field?
- Q19: Are you interested in further developing your AI and digital skills?
- Q10: Do teachers at your institution mention AI or actively involve it in teaching?

  Multidimensional research on AI use suggests that students benefit from training programs that emphasize both the practical application and ethical use of AI tools, which may account for differences in their interest in pursuing further AI-related education. Bećirović et al. (2025) point out that the ethical and practical aspects of AI positively influence its use, and that targeted training and support enhance effective AI utilization, which supports the hypothesis of interest in training.

RQ6: How do Czech and Polish pedagogy students perceive the ethical implications of using AI in their studies, particularly in relation to feelings of guilt and perceptions of cheating?

H6: There is a statistically significant difference between Czech and Polish pedagogy students in their ethical perceptions of AI use in academic contexts, particularly regarding feelings of guilt and whether AI use is seen as cheating.

Relevant questionnaire items:

- Q15: Do you consider using AI in your studies as a form of cheating?
- Q21: Do you sometimes feel guilty for using AI?
- Q16: Have you encountered a negative attitude from teachers toward using AI? *ethical context)*

The hypothesis that Czech and Polish pedagogy students differ in their ethical perceptions of AI use is supported by research on academic integrity in the context of emerging technologies. Study (Eaton, 2023) shows that students' feelings of guilt and perceptions of cheating depend on institutional norms, cultural context, and the clarity of rules regarding AI use. Where guidance is ambiguous, students rely on personal moral judgment, which can result in cross-national differences in ethical attitudes toward AI-assisted learning.

RQ7: How frequently do Czech and Polish pedagogy students verify the information obtained through AI, and are there significant differences between them in this regard?

H7: There is a statistically significant difference between Czech and Polish pedagogy students in the frequency with which they verify AI-generated information.

Relevant questionnaire items:

- Q14: Do you verify information obtained via AI using other sources?
  The hypothesis that students differ in how frequently they verify AI-generated information is supported by research on digital literacy and algorithmic trust. Study (Büchi, Festic, & Latzer, 2019) indicates that while many students are aware of AI inaccuracies, verification behavior varies depending on critical thinking skills and prior instruction. Differences in educational emphasis on source evaluation may therefore lead to variation in verification practices across student groups.

RQ8: Do Czech and Polish pedagogy students perceive AI as helpful in understanding specialized academic subjects, and are there significant differences in these perceptions?

H8: There is a statistically significant difference between Czech and Polish pedagogy students in their perception of AI's helpfulness in understanding specialized academic topics.

Relevant questionnaire items:

- Q4: Has AI ever helped you understand a specialized topic?
  The hypothesis that students differ in their perception of AI's usefulness for understanding specialized subjects is supported by research on technology-enhanced learning. Study shows (Zawacki-Richter, Marín, Bond, & Gouverneur, 2019) that AI can support comprehension of complex topics, but perceived usefulness depends on prior experience, learning preferences, and instructional context, which may vary across educational systems.

RQ9: Are Czech and Polish pedagogy students aware of the potential risks of AI dependency, and do their behaviors and perceptions regarding excessive or purposeless AI use differ significantly?

H9: There is a statistically significant difference between Czech and Polish pedagogy students in their awareness and perception of the risks associated with AI overuse or dependency.

Relevant questionnaire items:

- Q22: Do you feel that you spend a lot of time using AI?
- Q23: Do you use AI even when it is not necessary (habit, boredom, nervousness)?
- Q24: Should schools talk more about risks of AI dependency?
- Q20: What is your general attitude toward using AI in education?
  The hypothesis that students differ in their awareness of AI dependency risks is grounded in research on digital habits and self-regulation. Study indicates (Büchi, Just, & Latzer, 2016) that many students use AI intensively without reflecting on potential overreliance, while others are more aware of risks such as reduced autonomy or habitual use. Such awareness is influenced by educational discourse and cultural context.

The research objective was fulfilled through quantitative research in the form of a questionnaire survey, which was conducted during May and June 2025 at selected universities in the Czech Republic and Poland. The following Polish universities participated in the study: AHE in Łódź and the University of Silesia in Katowice. The Czech universities involved were Prigo College Ostrava (VOŠ Prigo) and the College of Entrepreneurship and Law in Frýdek-Místek, and Silesia University in Opava. The questionnaire did not include questions regarding the students' gender, age, type of previous secondary education, or current year of study, because the research sample consisted predominantly of women (there are very few men in teacher training programs) and students from all years of study, making age and year of study non-essential for the purposes of this study. The research focused on capturing general patterns of AI usage among teacher training students, rather than analyzing differences based on gender, age, or previous education. A total of 275 pedagogy students participated in the research, 130 from Poland and 145 from the Czech Republic. The Polish universities represented were AHE in Łódź (60 students) and the University of Silesia in Katowice (70 students). The Czech institutions included Prigo College Ostrava (39 students), the College of Entrepreneurship and Law in Frýdek-Místek (70 students), and Silesia University in Opava (36 students). The research focused on capturing general patterns of AI usage among teacher training students, rather than analyzing differences based on gender, age, or previous education.

For the purpose of the research, an original questionnaire titled *"Use of Artificial Intelligence among University Students"* was created. The questionnaire was distributed in two language versions – Czech and Polish – with the aim of investigating how pedagogy students use artificial intelligence (AI) in both academic and personal life. The survey research was conducted using the online platform Survio.cz. To ensure linguistic accessibility for respondents, two language versions of the questionnaire were prepared:

- Polish version of the questionnaire:
  https://www.survio.com/survey/d/K9P9Z4I2T1K1Y1R3M
- Czech version of the questionnaire:
  https://www.survio.com/survey/d/R8X4P8M6K7C6Y6I7C

The anonymous survey allowed for a comparison of attitudes, habits, and the extent of AI usage between Czech and Polish pedagogy students .

The questionnaire consisted of 25 closed-ended questions and was created in two language versions – Czech and Polish. Both versions were identical in content and structure, which allowed for direct comparison of responses between the two groups of respondents.

The questionnaire consisted of 25 closed-ended questions focusing on the following areas:

- use of AI in studying (e.g., writing seminar and thesis papers, searching for scientific information, preparing for exams),
- use of AI in practical classes and simulations,
- subjective evaluation of AI's benefits for future professional employment,
- level of awareness regarding AI's possibilities and risks,
- ethical aspects of AI usage (including feelings of guilt or perceptions of AI as cheating),
- use of AI beyond the academic context (e.g., for planning, creativity, or communication),
- interest in further education in AI and digital skills.

Respondents answered questions by selecting from predefined options. All respondents completed the questionnaire in full, so no responses had to be excluded. The questionnaire's structure enabled quantitative evaluation and comparison of answers between both respondent groups.

A total of 275 pedagogy students participated in the research, 130 from Poland and 145 from the Czech Republic. All were students in teacher training programs. To test the research hypotheses and assess differences in responses, the chi-square test of independence (χ^2 test) was employed. This non-parametric statistical method was chosen due to the categorical nature of the data collected through the closed-ended questions. The chi-square test made it possible to determine whether observed differences in frequencies between the two national groups – Czech and Polish students were statistically significant or occurred by chance. The comparisons focused on variables such as the frequency, purpose, and context of AI use (academic vs. personal), attitudes toward AI, perceptions of ethical implications, and interest in further AI-related education. Through these analyses, the study was able to identify both similarities and statistically significant differences between the two populations in relation to their engagement with artificial intelligence. The chi-square test is then consistently applied across all research questions and hypotheses (RQ1–RQ9, H1–H9) to assess whether the differences in categorical data (survey responses) between Czech and Polish students are statistically significant.

4. Results of the Research Survey

In response to the question of whether pedagogy students use artificial intelligence (e.g., ChatGPT, Grammarly, mobile AI, image/test generators, voice assistants, Google Translator, diagnostic tools, DALL·E, Perplexity, etc.) in their studies, 95.41% of students from the Czech Republic and 96.92% of students from Poland answered affirmatively. The remaining 4.59% of Czech and 3.28% of Polish students stated that they do not use AI in their studies.

The survey then focused on students who do use AI in their studies, asking them how frequently they use it. The majority of respondents reported using AI regularly. Daily use was reported by 13.77% of Czech students and 16.92% of Polish students. The largest group consisted of those who reported using AI several times a week-specifically, 39.86% of students from the Czech Republic and 46.15% from Poland. The option "once a week" was selected by 19.57% of Czech and 13.85% of Polish respondents. Another 25.36% of students from the Czech Republic and 21.54% from Poland reported using AI rarely.

Table 1
The Extent of artificial intelligence use among students of Pedagogy in Poland and the Czech Republic

Frequency of AI Use	Czech Republic (%)	Poland (%)
Use AI in studies (total)	95.41	96.92
Daily	13.77	16.92
Several times a week	39.86	46.15
Once a week	19.57	13.85
Rarely	25.36	21.54

S o u r c e: Own work.

The results indicate that artificial intelligence is becoming a common part of the academic life of most students, with Polish students showing a slightly higher frequency of use than their Czech counterparts. At the same time, it is clear that daily use of AI is not very common. These findings highlight the need to reflect this reality in educational practice and to guide students toward critical, effective, and ethical use of AI technologies in education.

When asked about the most common purposes for which pedagogy students use artificial intelligence, the respondents were able to select multiple options. The most frequent use of AI is for searching professional information, cited by 63.59% of Czech students and 58.46% of Polish students. A significant portion of students also use AI for writing seminar papers, with 28,28% of Czech and 21.54% of Polish respondents selecting this option. Regarding presentation creation, a notably higher share of Polish students (44.62%) use AI for this purpose compared to

Czech students (28,28%). Approximately the same proportion of students from both countries use AI for translating professional texts – 24.83% of Czech and 23.08% of Polish respondents. AI is used for grammar and stylistic checks by 28,97% of Czech and 33.85% of Polish students. The majority of students – 66.97% of Czech and 67.69% of Polish respondents – report using AI to generate ideas for practical application. A significant number of students also use AI to explain complex technical concepts: 44.54% of Czech and 49.23% of Polish students.

These results demonstrate that students use AI tools broadly and diversely, primarily to support understanding and the creation of study materials. Marked differences between Czech and Polish students are especially evident in the area of presentation creation, where Polish students utilize AI more frequently. This may reflect differing study strategies, pedagogical approaches, or the extent of AI integration in teaching within each country. Overall, AI serves students not only as a tool for information retrieval and text correction but, most importantly, as an aid in the practical application of knowledge and comprehension of complex topics, thereby supporting their educational process and professional preparation.

When asked whether artificial intelligence has ever helped them understand a specialized topic, 75.86% of Czech students and 75.38% of Polish students answered affirmatively. The opposite opinion – that AI did not help them – was expressed by 7.59% of Czech and 12.31% of Polish students. Another 16.55% of Czech and 12.31% of Polish respondents were unsure whether AI had been beneficial in this regard. These results suggest that the majority of students in both countries perceive artificial intelligence as a useful tool for better understanding complex specialized subjects.

When asked whether pedagogy students use artificial intelligence to prepare for tests, exams, or final state exams, 64.14% of Czech students and 70.77% of Polish students answered affirmatively. The opposite view – that they do not use AI for preparing for these exam activities – was expressed by 35.86% of Czech and 29.23% of Polish respondents. The results show that the majority of students in both countries perceive artificial intelligence as a useful aid in preparing for important academic exams.

When asked whether pedagogy students use artificial intelligence in practical teaching, for example in preparing teaching activities, 73,79% of Czech students and 76.92% of Polish students answered affirmatively. Conversely, 26.21% of Czech and 23.08% of Polish respondents stated that they do not use AI in practical teaching. The results suggest that artificial intelligence is an important part of practical teaching, especially among Polish students, who use it to a greater extent than their Czech peers.

Table 2
The use of artificial intelligence among Czech and Polish students of Pedagogy

	Czech students (%)	Polish students (%)
Information searching	63.59	58.46
Writing seminar papers	28.28	21.54
Creating presentations	28.28	44.62
Translating specialized texts	24.83	23.08
Grammar and stylistic checking	33.03	33.85
Generating practical ideas	66.97	67.69
Explaining specialized concepts	50.34	49.23
Preparing for tests/final exams	64.14	70.77
Ideas for practical teaching	73.79	76.92

S o u r c e: own work.

When asked whether students consider the use of artificial intelligence beneficial for their professional practice, 46.90% of Czech students and 36.92% of Polish students answered that AI is definitely beneficial for them. Another 40.69% of Czech and 49.23% of Polish respondents indicated that they think AI is rather beneficial. Meanwhile, 4.14% of Czech and 4.62% of Polish respondents stated that AI is not beneficial for their professional practice. Additionally, 4.14% of Czech and 3.08% of Polish students answered that they are unsure whether AI is beneficial for their practice.The results show that the majority of students from both countries perceive artificial intelligence as beneficial for their future professional practice, with a higher proportion of Czech students being fully confident in this regard. On the other hand, Polish students more often adopt a slightly more cautious attitude. A smaller group of students express doubts or negative opinions, which may be related to uncertainty about the real impact of AI on their professional opportunities or concerns about potential risks and limitations.

When asked whether pedagogy students feel sufficiently informed about the possibilities of using artificial intelligence in their field, 15.86% of Czech and 15.83% of Polish students answered positively, i.e., "yes." Another 38.62% of Czech and 38.46% of Polish respondents said they rather feel informed. On the other hand, 40.69% of Czech and 29.23% of Polish students reported that they rather do not feel sufficiently informed, while 4.83% of Czech and 16.92% of Polish respondents said they do not feel informed at all.These results suggest that a significant portion of students in both countries feel they lack sufficient information about the use of AI in their field. While most Polish students tend to feel somewhat informed, a larger share of Czech students report feeling a lack of information. This may indicate a need for increased education and awareness about the possibilities and applications of AI within the respective study programs.

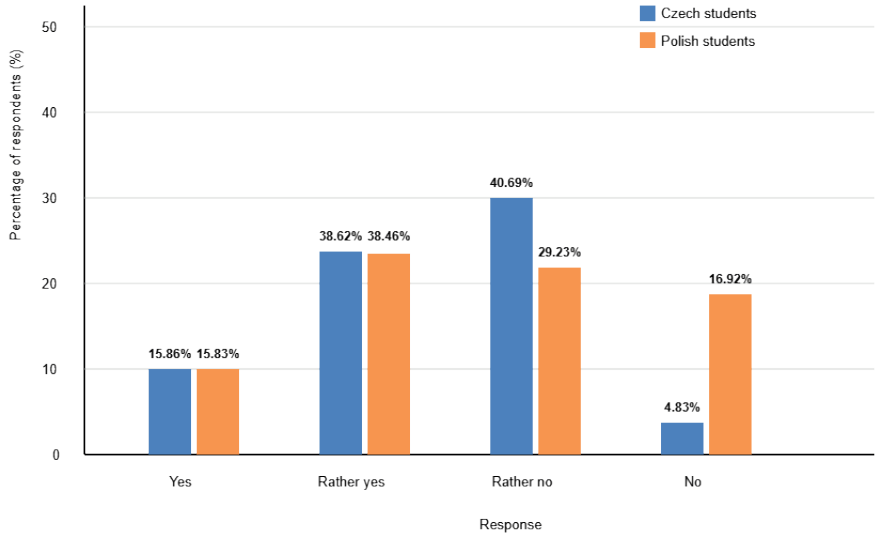

Figure 1. Studenst's Perceived Level of Information about AI Use in Pedagogy

S o u r c e: Own work.

When asked whether they would like their school to offer training or a course focused on the use of artificial intelligence in their field, 83.45% of Czech and 73.85% of Polish students answered affirmatively. The opposite opinion – that they would not need such training – was expressed by 7.59% of Czech and 13.85% of Polish respondents. The remaining students, specifically 8.97% of Czech and 12.31% of Polish students, were undecided and selected "I don't know." The results show that a significant majority of students from both countries are interested in further education and skill development in the area of artificial intelligence, confirming the need to introduce specialized courses or training programs within universities.

When asked whether pedagogy students believe that artificial intelligence can help them in their future professional work, 75.17% of Czech and 78.46% of Polish students answered affirmatively. The opposite opinion-that AI will not help them-was expressed by 7.59% of Czech and 7.69% of Polish respondents. The remaining 17.54% of Czech and 13.85% of Polish students were unsure and selected "I don't know." The results show that the vast majority of students in both countries perceive artificial intelligence as a significant support for their future professional careers.

When asked whether pedagogy students are aware of the risks associated with using artificial intelligence, such as inaccurate information, plagiarism, or ethical issues, 55.97% of Czech and 75.38% of Polish students answered that they are well aware of these risks. Partial awareness of these risks was reported by 35.77% of Czech and 21.54% of Polish respondents. On the other hand, 8.26% of Czech and 1.54% of Polish students said they rather do not know these risks, and a complete

lack of knowledge about the risks was reported by 0% of Czech and 1.54% of Polish students. The results show that the majority of students in both countries are aware of the possible risks associated with using AI, with Polish students demonstrating a higher level of awareness of these issues than Czech students.

When asked whether pedagogy students verify information obtained through artificial intelligence from other sources, 36.55% of Czech and 46.15% of Polish students answered that they always do so. The response "often" was chosen by 37.93% of Czech and 35.38% of Polish respondents, while "sometimes" was indicated by 16.55% of Czech and 16.92% of Polish students. Verifying information "rarely" was reported by 6.21% of Czech and 1.54% of Polish students, and only 3.67% of Czech students answered "never," whereas no Polish students gave this response. The results suggest that the majority of students in both countries approach knowledge gained through AI critically and actively verify it, with Polish students being slightly more cautious in this regard.

When asked whether pedagogy students consider the use of artificial intelligence during their studies a form of cheating, 5.52% of Czech students answered affirmatively, while no Polish students gave this response. The opposite opinion – that using AI is not cheating – was expressed by 22.76% of Czech and 18.46% of Polish students. The largest group of respondents, specifically 71.72% of Czech and 81.54% of Polish students, stated that the evaluation depends on how AI is used. The results show that the majority of students in both countries do not see the use of AI during studies as automatic cheating but rather emphasize the ethical aspects and the manner in which AI is utilized.

When asked whether they think artificial intelligence could threaten certain jobs in their field in the future, 37.93% of Czech and 35.38% of Polish students answered yes. Conversely, 40.0% of Czech and 49.23% of Polish respondents answered no. The response "I don't know" was given by 22.07% of Czech and 15.38% of Polish students. The results show that there are differing opinions among students regarding the impact of AI on the job market, with a slightly larger share of Polish students perceiving a lower risk of job displacement.

When asked if they are interested in further developing their skills in artificial intelligence and digital technologies, 82.07% of Czech and 47.69% of Polish students answered yes. The response "no" was chosen by 17.93% of Czech and 9.23% of Polish students, while "maybe" was selected by 0% of Czech and 43.08% of Polish students. The results indicate a significant difference between Czech and Polish students in their willingness to actively pursue further education in AI. While the majority of Czech students show a clear interest, Polish students are more divided on this issue.

When asked whether they use artificial intelligence outside of their studies, for example for writing emails, planning, or creative activities, 73.10% of Czech and 47.96% of Polish students answered "yes." The response "maybe" was given by 22.76% of Czech and 43.08% of Polish students, while "no" was chosen by 4.14%

of Czech and 9.23% of Polish respondents. The results show that Czech students use AI outside of academic purposes more frequently.

When asked about their general attitude towards the use of artificial intelligence in education, 26.90% of Czech and 4.62% of Polish students responded that they have a very positive attitude. A rather positive opinion was expressed by 41.38% of Czech and 53.85% of Polish respondents. A neutral attitude was reported by 27.59% of Czech and 32.31% of Polish students. AI in education is viewed somewhat negatively by 2.07% of Czech and 7.69% of Polish students, while a very negative attitude was expressed by 2.07% of Czech and 1.54% of Polish students. The results suggest that Czech students more often have a strongly positive attitude towards AI in education, whereas Polish students tend to lean towards a rather positive or neutral stance.

When asked whether they sometimes feel guilt or remorse when using artificial intelligence, 7.59% of Czech and 23.08% of Polish students answered "yes." The response "no" was chosen by 47.59% of Czech and 35.38% of Polish students. The option "yes, in academic matters, but no otherwise" was selected by 23.45% of Czech and 18.46% of Polish respondents, while "I never thought about it" was chosen by 21.38% of Czech and 23.08% of Polish students. The results show that feelings of guilt when using AI are more common among Polish students than Czech students, with a significant portion of students in both countries either feeling guilt only in an academic context or not considering the question at all.

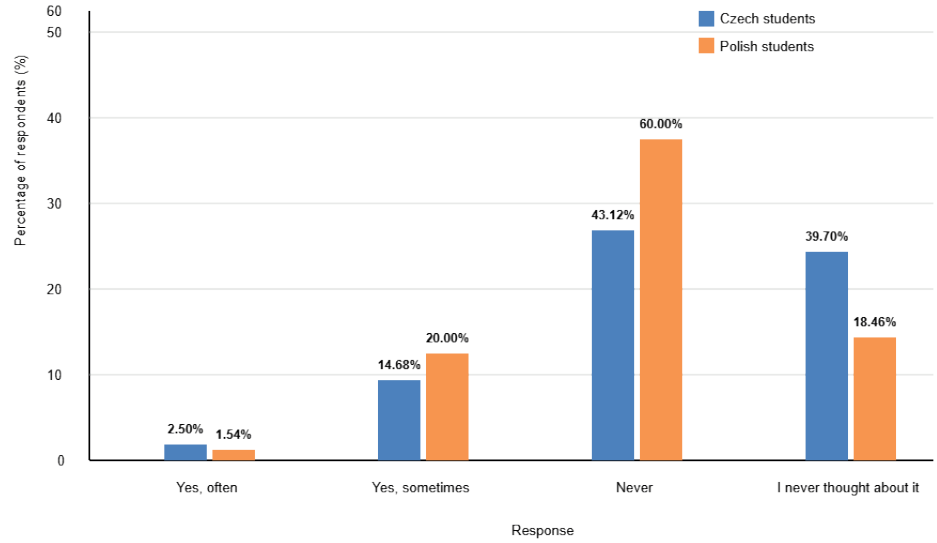

Figure 2. Studenst's Perceived Amount of Time Spent Using Artificial Intelligence

S o u r c e: Own work.

When asked whether they feel they spend a lot of time using artificial intelligence, only 2.50% of Czech and 1.54% of Polish students answered "yes, often." The option "yes, sometimes" was selected by 14.68% of Czech and 20% of Polish respondents. The response "never" was chosen by 43.12% of Czech and 60% of Polish students, while "I never thought about it" was indicated by 39.70% of Czech and 18.46% of Polish students. The results suggest that most students, especially in Poland, do not feel they spend excessive amounts of time using AI, with a significant portion of Czech students not even considering the question.

When asked whether they use artificial intelligence even in situations when they do not actually need it, for example out of habit or boredom, only 1.83% of Czech students and no Polish students answered "yes, all the time." The option "yes, out of habit" was chosen by 2.70% of Czech and 7.69% of Polish students, while "yes, when I'm bored" was selected by 8.11% of Czech and 9.23% of Polish respondents. The response "yes, when I'm nervous" was given by 2.75% of Czech and 3.08% of Polish students. On the other hand, the majority of students said they do not use AI without a specific need –this answer was chosen by 85.14% of Czech and 80% of Polish students. The results show that most students in both countries use AI primarily with purpose, while habitual or boredom-driven use of AI is rather rare, although Polish students report using AI out of habit or boredom more often than Czech students.

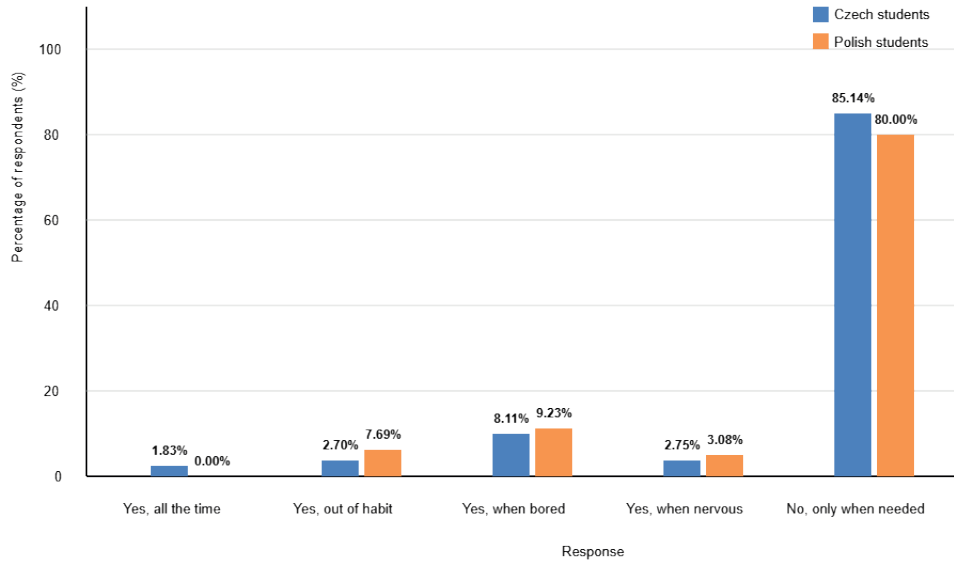

Figure 3. Use of Artificial Intelligence Without Actial Need

S o u r c e: Own work.

When asked whether schools should talk more about the possible risks of addiction to artificial intelligence, 86.21% of Czech and 80% of Polish students answered yes. Only 0.69% of Czech and 3.08% of Polish students stated that they do not see the need to discuss this topic. The option "I'm not sure whether the risks of addiction should be discussed more at school" was chosen by 13.10% of Czech and 16.92% of Polish students. The results suggest that a significant majority of students in both countries consider it important to discuss the risks of AI addiction more in schools.

5. Results of statistical data analysis

To verify the research hypotheses, the chi-square test of independence was used, which allowed for the identification of statistically significant differences between the responses of individual respondent groups.

The first research question (RQ1) and hypothesis (H1) focused on the use of artificial intelligence (AI) in the study environment revealed that the vast majority of Czech and Polish students use AI while studying. The difference between the two groups was not statistically significant ($\chi^2 = 0.37$; $p = 0.543$), indicating a similar level of AI adoption in both countries. Regarding the frequency of AI use, the differences in the frequency of use were also not statistically significant ($\chi^2 = 2.55$; $p = 0.638$).

Regarding the purpose of AI use, respondents most frequently reported using AI to generate ideas for practice, to search for specialized information, and to explain more complex concepts. A statistically significant difference was observed in only one area –creating presentations. While 44.62% of Polish students selected this option, only 28.28% of Czech students did ($\chi^2 = 8.31$; $p = 0.0039$). In the area of writing final and seminar papers, the majority of students indicated that they use AI at least occasionally. Differences between the groups were not statistically significant in this case either ($\chi^2 = 0.42$; $p = 0.81$). Similarly, for AI use in preparing for tests and exams, most of Czech and of Polish students responded affirmatively ($\chi^2 = 0.43$; $p = 0.51$). In the area of examining AI use in practical teaching statistical significance was not confirmed ($\chi^2 = 1.74$; $p = 0.19$).

The second research question (RQ2) and hypothesis (H2) focused on whether and how students use artificial intelligence outside their academic obligations,for example, when writing emails, planning, managing their time, or engaging in creative activities. Responses to this question revealed significant differences between Czech and Polish students, both in absolute numbers and in statistical significance. Statistical analysis ($\chi^2 = 13.88$; $df = 2$; $p \approx 0.001$) confirmed that these differences are statistically significant. Thus, hypothesis H2 was confirmed – there

is a statistically significant difference between Czech and Polish students in the extent of AI use in their personal lives. Czech students use artificial intelligence in a personal context significantly more often than their Polish peers.

The third research question (RQ3) and hypothesis (H3) focused on how Czech and Polish students assess the potential benefits of artificial intelligence for their future professional practice. Statistical analysis ($\chi^2 = 0.114$; $df = 2$; $p \approx 0.945$) again showed that there is no significant difference between the responses of Czech and Polish students.

An interesting addition to the previous questions was whether students believe that AI could threaten jobs in their field in the future. Statistical analysis ($\chi^2 = 1.29$, $df = 2$, $p \approx 0.53$) again showed that there is no significant difference between the responses of Czech and Polish students. Both groups have comparable perceptions of the risks that AI might bring to the labor market, although among Polish students there is a slightly higher proportion who completely reject the risk.

Research question RQ4 and hypothesis H4 investigated how Polish and Czech students evaluate their level of awareness regarding the possibilities of using artificial intelligence in their field. The responses indicate that there are slight differences between Czech and Polish students in their self-assessment of awareness. To verify whether a statistically significant difference exists between the groups, a chi-square test of independence was conducted, yielding a χ^2 value of approximately 7.8 with 3 degrees of freedom and a p-value around 0.05. This result suggests that the difference is on the borderline of statistical significance, meaning that a statistically significant difference in self-assessed awareness between Czech and Polish students cannot be conclusively demonstrated, but small differences do exist, particularly with Polish students more frequently reporting a feeling of insufficient awareness.

Another survey question related to research question RQ4 and hypothesis H4 focused on students' awareness of the risks associated with using AI, such as inaccurate information, plagiarism, or ethical issuesThis difference was confirmed by a chi-square test with a value of approximately $\chi^2 = 11.5$, 3 degrees of freedom, and a p-value of approximately 0.009, indicating that there is a statistically significant difference in awareness of AI-related risks between Czech and Polish students. Polish students demonstrate a significantly higher level of knowledge about the risks associated with using artificial intelligence than Czech students.

The fifth research question (RQ5) and hypothesis (H5) focused on whether students from the Czech Republic and Poland are interested in training or courses related to the use of artificial intelligence in their field, as well as their general interest in further developing their AI and digital skills. The chi-square test for these responses ($\chi^2 = 0.978$, $df = 2$, $p \approx 0.613$) showed that the difference between Czech and Polish students in interest in training is not statistically significant. This result suggests that the majority of students in both countries are interested in expanding their knowledge of AI through specialized courses or training.

Research question RQ6 and hypothesis H6 focused on how Czech and Polish students perceive ethical issues related to the use of artificial intelligence in their studies, specifically whether they consider AI to be a form of cheating.. The chi-square test calculation yielded a value of $\chi^2 = 11.67$ with three degrees of freedom (df = 3) and a p-value of approximately 0.009. This p-value is less than 0.05, indicating a statistically significant difference between Czech and Polish students in feelings of guilt associated with using AI. Polish students more frequently express a general feeling of guilt, while Czech students tend to perceive guilt more narrowly in the study context or do not consider guilt at all.

Another survey question related to RQ6 and H6 focused on whether students consider the use of AI in their studies to be a form of cheating. The chi-square test for this question yielded a value of $\chi^2 = 5.58$ with df = 2 and a p-value of 0.061, the difference between Czech and Polish students is not statistically significant but close to the significance threshold.

Research question RQ7 and hypothesis H7 focused on how frequently Czech and Polish students verify information obtained through artificial intelligence from other sources. To test the statistical significance of differences between the two groups, a chi-square test was conducted, yielding a value of $\chi^2 = 6.44$ with four degrees of freedom (df = 4) and a p-value of approximately 0.168. Since the p-value is greater than 0.05, the null hypothesis cannot be rejected, meaning that the difference in the frequency of verifying information between Czech and Polish students is not statistically significant.The results show that the majority of students in both countries approach knowledge gained through AI critically and actively verify it, with Polish students being slightly more cautious in this regard, as evidenced by the higher proportion of those who always verify the information.

Research question RQ8 and hypothesis H8 focused on whether Polish and Czech students use artificial intelligence to better understand their specialized subjects. To verify the statistical significance of the differences between the two groups, a chi-square test was conducted, yielding a value of $\chi^2 = 2.88$ with two degrees of freedom (df = 2) and a p-value of approximately 0.24. Since the p-value is greater than 0.05, the null hypothesis cannot be rejected, meaning that the difference between Czech and Polish students' responses is not statistically significant. The results show that the majority of students in both countries perceive artificial intelligence as a useful tool that helps them better understand complex specialized topics.

Research question RQ9 and hypothesis H9 examined whether there is a statistically significant difference in the percentage of students between Czech and Polish students who are aware of the risks of AI dependency. A chi-square test for this distribution yielded a value of $\chi^2 = 16.78$ with 3 degrees of freedom and a p-value of approximately 0.0008, indicating that the difference between Czech and Polish students is statistically significant. The results suggest that most students, especially in Poland, do not feel that they spend excessive time with AI, while a significant

portion of Czech students had not considered this question at all. Additionally, the study investigated whether students use AI without a specific need, for example out of habit, boredom, or nervousness. However, the majority of students stated that they do not use AI without need. The chi-square test result ($\chi^2 = 14.55$, df = 4, $p = 0.0057$) again showed a statistically significant difference between the two groups. The results thus indicate significant differences between Czech and Polish students in the perception of addictive AI use. Polish students more often report using AI out of habit or boredom, whereas Czech students are more likely not to consider this issue at all. Nevertheless, overall, the majority of students in both countries do not perceive the time spent with AI as problematic.

Conclusion

The study showed that artificial intelligence (AI) is currently an integral part of the study practices of most pedagogy students in both the Czech Republic and Poland, supporting H1. The majority of students actively use AI for inspiration, accessing specialized information, and understanding complex concepts. Czech students use AI more frequently in their personal lives ($\chi^2 = 13.88$; $p \approx 0.001$), confirming H2, and show a markedly higher interest in further developing their digital and AI skills ($\chi^2 = 38.98$; $p < 0.0001$), confirming H5, while Polish students are better informed about the risks associated with AI ($\chi^2 \approx 11.5$; $p \approx 0.009$), supporting H4, and more often experience ethical dilemmas or feelings of guilt when using AI ($\chi^2 = 11.67$; $p \approx 0.009$), confirming H6. Both groups similarly assessed the benefits of AI for their future professional practice, with differences not statistically significant ($\chi^2 = 4.02$; $p \approx 0.40$), which relates to H3.

The collected data indicate that artificial intelligence has become a common part of both the academic and professional lives of future educators in the Czech Republic and Poland, which carries significant social and educational implications. The high level of AI usage in studies, exam preparation, and practical teaching suggests that digital technologies are no longer peripheral tools but structural elements of the educational landscape. From a societal perspective, this implies a transformation in the way future teachers will manage information, plan instruction, and support student learning, which could have a long-term impact on the overall quality of the education system.

The educational significance of the findings lies primarily in the fact that students use artificial intelligence purposefully and reflectively – particularly for understanding specialized topics, generating teaching ideas, and applying knowledge in practice. This confirms AI's potential as a supportive learning tool, rather than merely a means to simplify academic tasks. At the same time, the fact that

a substantial portion of students do not feel sufficiently informed about the possibilities of AI in their field points to insufficient institutional support and a lack of systematic education in this area.

A socially significant finding is also the relatively high level of ethical reflection among students. Most respondents are aware of the risks associated with AI use, regularly verify the information they obtain, and do not regard AI use as an automatic form of cheating, but rather consider the situational context of its application. This attitude suggests the emergence of a new form of digital literacy based on critical thinking and responsibility, which is crucial for the sustainable integration of AI into both education and broader society.

Another important societal aspect is that most students do not feel excessively dependent on artificial intelligence, and they do not use AI unnecessarily out of boredom or habit. At the same time, it is evident that schools should pay greater attention to the risks of potential AI addiction. In this regard, a preventive dimension of education and an open discussion about the psychosocial impacts of digital technologies are needed. Therefore, educational institutions should not only develop technical skills but also promote healthy and balanced technology use.

Overall, the findings are of critical importance for the future direction of teacher education. They point to the necessity of systematically integrating AI-related topics into university curricula, addressing practical skills as well as ethical, critical, and social dimensions. Such an approach can help ensure that future educators are not only capable of using AI effectively, but also able to responsibly reflect on AI-generated outcomes and integrate them meaningfully into educational practice.

Based on the findings, the following recommendations can be made:

1. Integration of AI into teacher training programs: Since students actively and regularly use AI for study purposes, AI should be incorporated into teacher education curricula. Courses should include not only technical skills but also the ability to evaluate the reliability of AI-generated information and use AI ethically.
2. Promotion of ethical and responsible AI use: Polish students more frequently experience ethical dilemmas or feelings of guilt when using AI. Educational institutions should provide clear guidelines and recommendations on when AI constitutes assistance and when its use may be considered unethical, helping students use AI with confidence and responsibility.
3. Encouragement of critical verification of information: While most students verify information obtained from AI, Polish students are more cautious than Czechs. Teachers should actively promote the habit of consistently cross-checking AI outputs with reliable sources.
4. Balanced and purposeful use of AI: Data show that students use AI both for specific tasks and as a general study assistant. AI should be used as a tool to support independent thinking – generating ideas, analyzing data, or understanding specialized topics – without replacing active engagement in learning.

5. Development of digital competencies: A high proportion of Czech students expressed interest in further developing AI and digital skills (84.4% positive responses), while Polish students were more divided. Structured courses or workshops should be offered to enhance these competencies in both groups and build confidence in effective AI use.
6. Awareness of AI's potential for habitual use: Polish students more frequently reported using AI out of habit or boredom ($\chi^2 = 16.78$; $p \approx 0.0008$). Students should be guided toward intentional and goal-oriented use of AI to prevent overreliance or unconscious usage.

Overall, AI represents a significant tool supporting both study and professional preparation for pedagogy students. Its effective and ethical use requires structured guidance, educational support, and development of digital competencies to maximize positive outcomes while minimizing risks such as dependency, misinformation, or unethical use. Despite cultural and educational differences between the Czech Republic and Poland, pedagogy students in both countries share similar attitudes toward AI and its role in education.

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Lucie Zormanová, Šárka Čípová

Wykorzystanie sztucznej inteligencji w życiu akademickim i prywatnym studentów pedagogiki

S t r e s z c z e n i e

Niniejsze badanie przedstawia analizę porównawczą dotyczącą wykorzystania sztucznej inteligencji (SI) wśród studentów pedagogiki w Czechach i Polsce. Celem badania jest porównanie, w jaki sposób czescy i polscy studenci korzystają z SI zarówno w życiu akademickim, jak i prywatnym.

Badanie przeprowadzono metodą ilościową za pomocą ustrukturyzowanego kwestionariusza (25 pytań zamkniętych) dystrybuowanego na pięciu uczelniach w obu krajach (łącznie w badaniu wzięło udział 275 studentów pedagogiki: 130 z Polski i 142 z Czech) w maju i czerwcu 2025 roku. Analizę danych przeprowadzono przy użyciu testu chi-kwadrat niezależności.

Wyniki badania wykazały, że SI stała się już powszechną częścią życia akademickiego studentów pedagogiki w obu krajach. Większość respondentów zadeklarowała regularne korzystanie z AI, przy czym studenci polscy wykazywali nieco częstsze wykorzystanie niż studenci czescy. Studenci najczęściej korzystają z SI w celu pozyskiwania informacji, tworzenia prezentacji, pisania prac naukowych, tłumaczenia, sprawdzania gramatyki oraz rozumienia złożonych zagadnień. Studenci postrzegają SI jako korzystną dla swojej przyszłej praktyki zawodowej i większość z nich wykazuje zainteresowanie dalszą edukacją w tym zakresie. Jednocześnie są świadomi ryzyk związanych z korzystaniem z SI – szczególnie ryzyk etycznych i informacyjnych – i w większości przypadków weryfikują wyniki generowane przez SI za pomocą innych źródeł.

Badanie ujawniło również różnice między studentami w obu krajach – na przykład w częstotliwości wykorzystania SI w praktykach dydaktycznych, w poziomie postrzeganej świadomości lub w podejściu do korzystania z SI (np. odczuwanie poczucia winy). Wnioski z badania podkreślają potrzebę systematycznej integracji SI w edukacji, w tym szkoleń dotyczących jej ryzyk, oraz wsparcia w rozwijaniu kompetencji cyfrowych studentów w kontekście międzynarodowym.

S ł o w a k l u c z o w e: sztuczna inteligencja, szkolnictwo wyższe, studenci pedagogiki, badanie porównawcze, kompetencje cyfrowe, SI w edukacji, postawy studentów, etyczne wykorzystanie SI

The Use of Artificial Intelligence in Academic and Personal Life of Pedagogy Students

Lucie Zormanová, Šárka Čípová

Uso de la Inteligencia Artificial en la Vida Académica y Personal de los Estudiantes de Pedagogía

Resumen

Este estudio presenta un análisis comparativo centrado en el uso de la inteligencia artificial (IA) entre estudiantes de Pedagogía en la República Checa y Polonia. El objetivo de la investigación es comparar cómo los estudiantes checos y polacos utilizan la IA tanto en su vida académica como personal.

La investigación se llevó a cabo mediante un método cuantitativo a través de un cuestionario estructurado (25 preguntas cerradas) distribuido en cinco universidades de ambos países (participaron un total de 275 estudiantes de pedagogía: 130 de Polonia y 142 de la República Checa) durante mayo y junio de 2025. El análisis de los datos se realizó utilizando la prueba de independencia chi-cuadrado.

Los resultados muestran que la IA ya se ha convertido en una parte común de la vida académica de los estudiantes de Pedagogía en ambos países. La mayoría de los encuestados reportó usar la IA de manera regular, siendo los estudiantes polacos quienes mostraron una frecuencia ligeramente mayor que los checos. Los estudiantes utilizan la IA principalmente para la búsqueda de información, creación de presentaciones, redacción de trabajos académicos, traducción, corrección gramatical y comprensión de temas complejos. Los estudiantes perciben la IA como beneficiosa para su futura práctica profesional y la mayoría muestra interés en recibir más formación en este ámbito. Al mismo tiempo, son conscientes de los riesgos asociados al uso de la IA, especialmente los riesgos éticos e informativos, y en la mayoría de los casos verifican los resultados generados por la IA mediante otras fuentes.

La investigación también reveló diferencias entre los estudiantes de ambos países, por ejemplo, en la frecuencia de uso de la IA en la enseñanza práctica, en el nivel de conciencia percibida o en las actitudes relacionadas con el uso de la IA (como sentimientos de culpa). Las conclusiones del estudio subrayan la necesidad de integrar sistemáticamente la IA en la educación, incluyendo formación sobre sus riesgos y apoyo en el desarrollo de las competencias digitales de los estudiantes en un contexto internacional.

Palabras clave: Inteligencia Artificial, Educación Superior, Estudiantes de Pedagogía, Estudio Comparativo, Competencia Digital, IA en la Educación, Actitudes de los Estudiantes, Uso Ético de la IA

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Использование искусственного интеллекта в академической и личной жизни студентов педагогики

Аннотация

Данное исследование представляет собой сравнительный анализ использования искусственного интеллекта (ИИ) среди студентов педагогики в Чехии и Польше. Цель исследования – сравнить, как чешские и польские студенты используют ИИ как в академической, так и в личной жизни.

Исследование проводилось с использованием количественного метода через структурированную анкету (25 закрытых вопросов), распределённую среди пяти университетов в обеих странах (в исследовании приняли участие всего 275 студентов педагогики: 130 из Польши и 142 из Чехии) в мае и июне 2025 года. Анализ данных проводился с использованием критерия хи-квадрат для проверки независимости.

Результаты исследования показывают, что ИИ уже стал обычной частью академической жизни студентов педагогики в обеих странах. Большинство респондентов сообщили о регулярном использовании ИИ, при этом польские студенты демонстрировали немного более высокую частоту использования, чем чешские. Студенты чаще всего используют ИИ для поиска информации, создания презентаций, написания академических работ, перевода, проверки грамматики и понимания сложных тем. Студенты считают ИИ полезным для своей будущей профессиональной практики, и большинство выражает интерес к дальнейшему обучению в этой области. В то же время они осознают риски, связанные с использованием ИИ – особенно этические и информационные – и в большинстве случаев проверяют результаты, созданные ИИ, через другие источники.

Исследование также выявило различия между студентами двух стран – например, в частоте использования ИИ в практическом преподавании, в уровне осознанности или в отношении к использованию ИИ (например, чувство вины). Выводы исследования подчеркивают необходимость систематической интеграции ИИ в образование, включая обучение по его рискам, а также поддержку развития цифровых компетенций студентов в международном контексте.

К л ю ч е в ы е с л о в а: искусственный интеллект, высшее образование, студенты педагогики, сравнительное исследование, цифровая компетентность, ИИ в образовании, отношение студентов, этическое использование ИИ

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Low-Cognitive-Load Games as Attentional Support: A Scoping Review for Gen Z Learners

Abstract

In an era of constant digital multitasking, Generation Z learners struggle to maintain attention and memory during study and lecture-based learning. Although heavy social media use and technology-driven distractions are linked to poorer academic outcomes, emerging evidence suggests that low-cognitive-load digital activities – such as casual games, electronic fidgets, and brief micro-breaks – may help sustain engagement. This scoping review maps research published between 2010 and 2025 on digital micro-breaks, fidgeting tools, and other low-demand activities in learning and work contexts. Following PRISMA-ScR guidelines, 33 studies across 31 articles were identified through database searching and citation chaining. Evidence shows that short, low-effort, volitional activities can restore attentional resources, reduce fatigue, and improve affect without harming concurrent task performance, especially when compared with more demanding or externally imposed digital interruptions. Micro-break and recovery studies highlight

the benefits of brief restorative activities, while research on digital fidgets points to the self-regulatory value of rhythmic, repetitive interactions. Broader work on parallel digital activity emphasises that timing, context, and volition critically shape outcomes. Overall, findings suggest that purposefully designed low-cognitive-load games or tools may act as attentional supports, helping learners resist more disruptive cyberloafing. However, the literature remains fragmented, with inconsistent results for memory and limited research directly focused on educational settings. Future work should trial experimental prototypes of "mindless" mobile games for Gen Z learners, examining task type, timing, and individual differences to determine whether such interventions can enhance learning while mitigating distraction.

K e y w o r d s: attention and fatigue, digital micro-breaks, fidget tools, generation Z, low-cognitive-load activities

In an age of fragmented attention and information overload, maintaining focus and enhancing memory retention among younger learners has become a growing concern for educators, researchers, and designers of digital learning environments. This challenge is particularly salient for Generation Z – individuals born between the mid-1990s and early 2010s – who have grown up in a hyperconnected world of constant notifications, digital multitasking, and diverse media stimuli "from dusk to dawn" (Brosnan et al., 2025). The majority of students use electronic media either in class, while studying or while doing homework (Uncapher et al., 2017).

Research consistently shows that heavy social media use and digital multitasking are associated with poorer academic outcomes. Heavy social media use has been linked to lower academic performance among adolescents (Sampasa-Kanyinga et al., 2019), and multitasking behaviours such as texting in class (Ellis et al., 2010) or using multiple technologies while studying (Rosen et al., 2013) predict reduced task persistence and lower grades. Experimental work confirms that off-task technology use during lectures detracts from learning and cannot be offset by familiarity with such behaviours (Wood et al., 2012). Similarly, heavy media multitaskers tend to show reduced performance across a range of cognitive domains relative to light multitaskers (Uncapher et al., 2017).

Synthesising these findings, Van der Schuur et al. (2015) concluded that media multitasking is typically negatively related to academic outcomes, study behaviours, and perceived learning, though effects are often small to moderate and not always significant. They propose that multitasking may impair learning by displacing study time or taxing attentional resources. Extending this, Vedechkina and Borgonovi (2021) highlight that while cross-sectional studies often reveal negative associations, longitudinal evidence suggests weaker or absent effects, indicating that the relationship may be bidirectional and shaped by individual motivation and engagement rather than stable attentional deficits.

On the other hand, there is a tendency to integrate digital media use into formal education, a process globally fast-tracked by the Covid-19 pandemic in 2020-2022. Contemporary students seem to prefer learning through digital technologies, such as mobile applications, over more traditional methods (Szymkowiak et al., 2021). Besides technology integration, it is also important to include digital storytelling (Shorey et al., 2021). Game-based learning methods have gained increasing prominence. Generation Z prefers practical, career-focused, and personalized learning experiences that are structured, tech-integrated, and clearly connected to real-world outcomes. They value independence, mental health support, and social responsibility, but often need help with focus, digital literacy, and managing academic stress (Seemiller and Grace, 2016).

Research Problem

How to unite student preferences for digital media use with the need to minimize distractions for better academic performance as stipulated by cognitive load theory (Sweller et al., 1998)? Rigid application of the theory has been challenged by findings that affordances of digital learning such as detailed visuals or interactive responses induce some amount of "irrelevant cognitive load while still fostering learning outcomes" (Skulmowski & Xu, 2022). In this research we entertain the idea that certain types of low-cognitive-load digital activities – especially what we call "mindless" games – may paradoxically support sustained attention and improve the assimilation of auditory or passive learning content. Anecdotal evidence from educators and learners indicates that light interactivity during listening-based tasks – such as lectures or podcasts – can help prevent zoning out, reduce anxiety, and create subtle mnemonic anchors. However, formal research on this phenomenon is sparse and fragmented across multiple disciplines, including cognitive psychology, educational technology, human-computer interaction, and game studies.

In the present scoping literature review, we examine the potential cognitive and emotional functions of low-cognitive-load digital games and other digital activities when used in parallel with other tasks, such as passive learning, particularly in the context of Generation Z learners. By synthesizing cross-disciplinary evidence and identifying conceptual, methodological, and empirical gaps, this review serves as a foundation for the design of experimental pre-research and future intervention developments in the form of a low-cognitive-load ("mindless") mobile game that would replace other student cyberloafing activities and distractions during lectures, potentially anchoring their attention. To reiterate, this represents a distinct area of inquiry from the well-established research on the cognitive effects of video gaming, where strong evidence for broad skill enhancement beyond the specifically

trained tasks remains limited, suggesting a bidirectional link between gaming and cognition (Vedechkina & Borgonovi, 2021).

The scoping framework allows for a broad, exploratory investigation while enabling critical interpretation across multiple disciplines and media types. Following the structure proposed by Arksey and O'Malley (2005), updated by Peters et al., 2015) and adhering to PRISMA reporting standards (Tricco et al., 2018), the scoping review focuses on identifying, categorizing, and mapping existing literature and perspectives related to low-cognitive-load digital games or activities and their potential cognitive or emotional benefits in learning contexts. The research question guiding this review is: What types of digital games or activities with minimal cognitive demands have been associated with improved focus, memory retention, or sustained engagement during passive learning experiences – particularly among Generation Z?

Methodology of Research

Sources were included if they were published during 2010-2025, written in English, and with no limits on publication status. Given the limited volume of directly relevant empirical work, no exclusion was made based on study design or outcome reporting. The pilot search indicated that "low-cognitive-load" digital games or activities as an umbrella term needs to be specified. Therefore, sources that mentioned minimalist game designs, such as (hyper)casual, idle, incremental, background or ambient games (Alharthi et al., 2018) were included, together with electronic/digital fidgeting tools and micro-breaks with the use of technology.

Relevant documents were retrieved from Scopus, Web of Science, and Google Scholar, complemented by citation chaining (i.e., screening reference lists and forward citations) to capture studies not identified in the database search. The search strategy was drafted by one of the authors and refined through team discussion. The final search string combined terms for game types, related activities, and cognitive or behavioural outcomes using Boolean operators and truncation, as follows:

("idle game*" OR "incremental game*" OR "ambient game*" OR "ambient activit*" OR "hypercasual game*" OR "low-interactivity game*" OR "background play" OR "background game" OR "nonchallenging activit*" OR "low-cognitive-load" OR "low cognitive load" OR gameplay OR gaming OR "playing game*" OR fidget* OR "fidget device" OR micro-break* OR dual-tasking)

AND

(cognit* OR attention* OR behavior* OR focus OR memory OR engagement OR learning OR listening OR lecture OR "auditory learning" OR "lecture-based learning")

One reviewer screened the publications by sequentially evaluating the titles, abstracts and then the full texts of all publications identified by our searches for potentially relevant publications. All retrieved search results were exported and organised in a Google Sheet to facilitate screening and analysis. Challenging items were discussed with other reviewers. After discussion on the theme of fidgeting and fidget devices, results for fidgeting as (involuntary) body movement while not integrating with objects (Da Câmara et al., 2018) or non-electronic fidget devices were excluded from consideration due to the agreement that they bear only tangential relation to the research topic of digital low-cognitive activities. Instead, results of systematic reviews and metaanalyses of non-digital fidgeting are included in the introduction to the discussion of digital fidget results. In a similar manner, non-digital micro-break activities were excluded and digital interventions subjected to literature reviews were not considered eligible on their own. To further refine results, studies of micro-breaks with the use of technology outside of gaming or not explicitly regarded as low-cognitive load activity, such as attending to social media (Liu et al., 2021), were also excluded.

A data charting form was developed by one reviewer and subsequently evaluated by the team. The form was iteratively revised, primarily to include a category specifying the digital game or application used in the intervention – providing greater detail given the wide scope of digital media – and to remove the "setting" parameter, which was frequently unreported or ambiguously reported. One researcher performed the data charting, and the remaining team members verified the extracted data for accuracy. We extracted data on article characteristics (authors, year, location), research design, population, and sample size. We then charted the type of (digital) intervention, study purpose, outcome measures (where applicable), and key findings relevant to the review question. In cases where study aims were neither clearly nor concisely stated, we interpreted or simplified the information. Similarly, qualitative results were summarised to maintain clarity and brevity.

In Table 1, we categorised the studies into three groups according to their primary focus: (A) micro-breaks and recovery, (B) digital or electronic fidgets, and (C) other, e.g., the impact of interactive technology and video games on attention and learning outcomes. The qualitative text analysis was performed manually and with the assistance of ChatGPT-5 Pro. A descriptive format (Peters et al., 2015; Tricco et al., 2018) of narrative synthesis was used to summarise the types of settings, populations, and study designs for each group, along with the measures employed and the broad findings. This descriptive format was deemed most appropriate for the objectives of our review, particularly given the heterogeneity of study designs and the prevalence of non-quantitative or otherwise incompatible outcome measures. Finally, the results were integrated across all groups.

Results

A total of 2,776 records were identified through database searching, with an additional 26 records retrieved from citation chaining. After removing duplicates, 2,056 records were screened by title and abstract, resulting in the exclusion of 1,917 records. The full texts of 139 articles were assessed for eligibility, of which 108 were excluded for the following reasons: 11 articles were not retrievable, 93 did not address the research question, and four were part of literature reviews already included in the final dataset. This process resulted in 33 studies reported across 31 articles, as one article (Wu et al., 2025) included three relevant research studies (see Figure 1 for the PRISMA flow diagram).

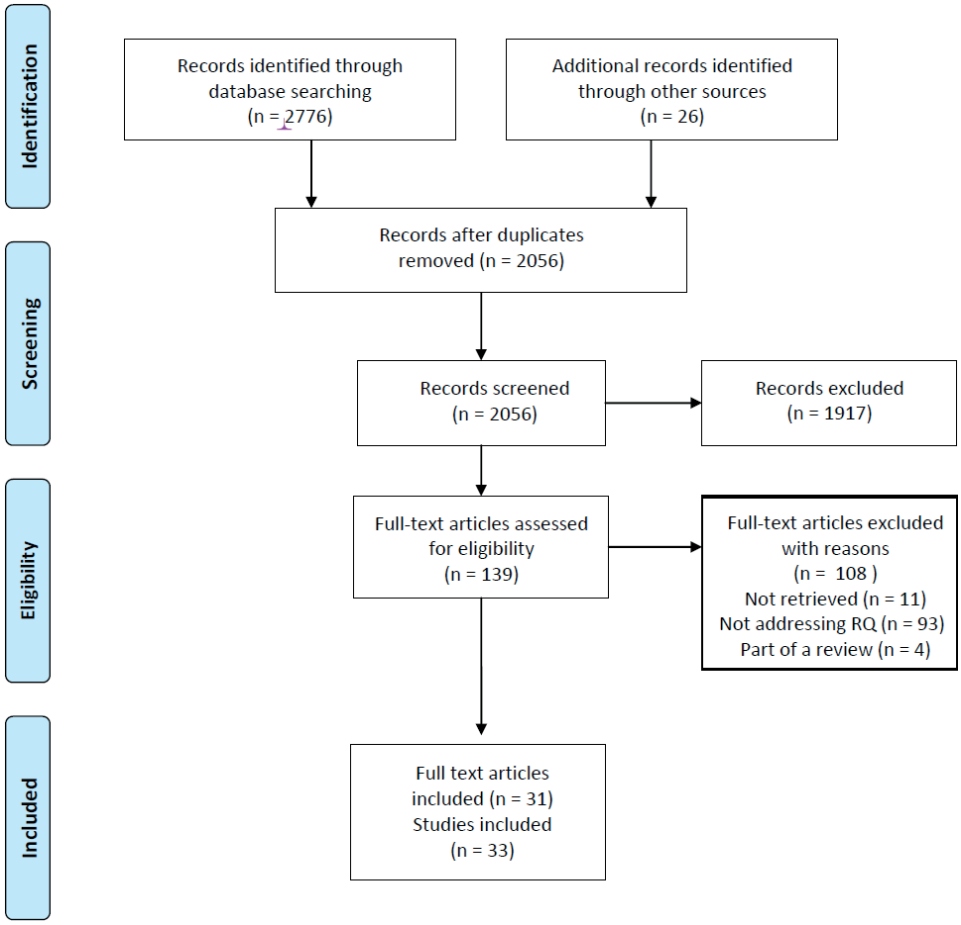

Figure 1. Flow diagram

S o u r c e: Own work.

The 33 studies included in this review were reported across 31 articles. Studies were conducted in multiple countries: eight in Europe (five in Germany), six in Asia (Japan and China), four in the USA, and one in New Zealand (Figure 2). A few intervention development studies and one experimental study did not specify a location. For literature reviews, this characteristic was considered not applicable. Most of the articles (24) have been published since 2020, demonstrating the growing interest in this topic. The included studies employed diverse designs (Figure 3), comprising 12 experimental studies (Burney & Sharp, 2025; Dianita et al., 2024; Dianita et al., 2025; Graben et al., 2022a, 2022b; Grobelny et al., 2024; Kitayama et al., 2023; Kuschpel et al., 2015; Liu et al., 2015; Liu et al., 2019; Wu et al., 2025), 10 intervention development studies (Da Câmara, 2022; Eichenlaub, 2022; Eichenlaub et al., 2023; Ji & Isbister, 2022; Karlesky & Isbister, 2014; Ross et al., 2023; Tancredi & Abrahamson, 2024; Torin, 2021; Williams et al., 2019; Zhang & Qin, 2021), seven literature reviews or meta-analyses (Albulescu et al., 2022; Barton et al., 2020; Gellmers & Yan, 2023; Jiang et al., 2023; Lyubykh et al., 2022; Perrigino et al., 2024; Sonnentag et al., 2022), two cross-sectional studies (Nalliah & Allareddy, 2014; Wu et al., 2025), one mixed-methods study (Rykard, 2020), and one qualitative study (Karlesky & Isbister, 2016). Sample sizes varied widely: experimental studies typically involved 30–100 participants, whereas intervention development studies often included fewer than 10 participants. Participants included university students (13 studies), office workers or working adults (four studies), high school students (one study), children (one study), and general adults with unspecified characteristics (six studies). One qualitative study did not report any demographic information.

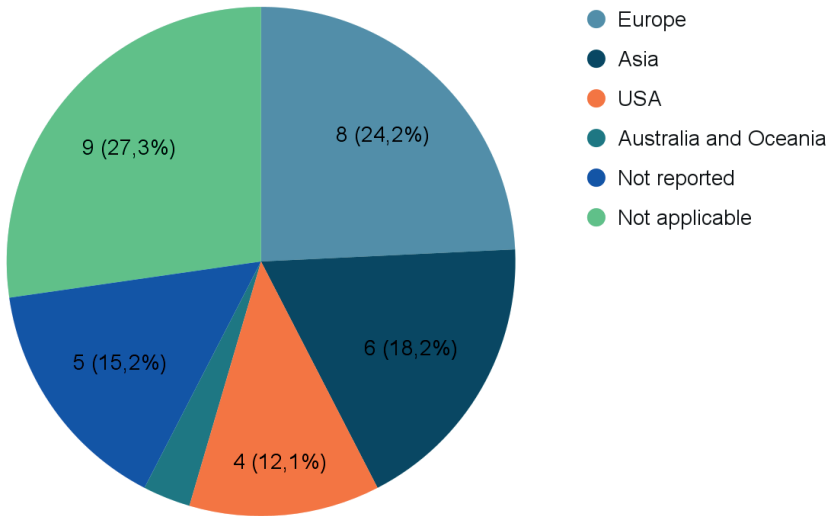

Figure 2. Study location distribution

S o u r c e: Own work.

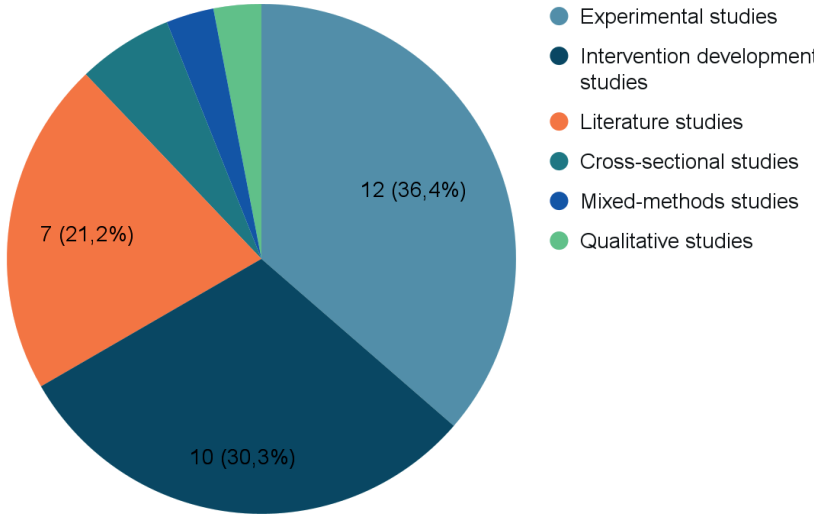

Figure 3. Study designs

S o u r c e: Own work.

The interventions and activities examined were diverse, encompassing casual video games (e.g., *Angry Birds*), screen-based micro-breaks, custom micro-games, fidgeting devices (e.g., *Fidget Widgets*, smart fidget prototypes), cyberloafing, and sensor-based interactive tools such as balance boards. Some studies focused on passive digital media consumption, while others involved active engagement with interactive applications or gamified tasks. The primary aim of most studies was to investigate the effects of brief digital or physical activities on attention, cognitive performance, engagement, well-being, or recovery. Literature reviews and meta-analyses sought to synthesise existing evidence on work breaks, recovery, and technology-mediated micro-interventions. Experimental studies predominantly combined behavioural tasks with self-report measures, with one including biological or physiological assessments, whereas intervention development studies primarily relied on self-reports. Overall, the included studies represented a wide methodological and intervention spectrum, offering insights into both experimental and applied contexts of micro-breaks, digital games, and fidgeting interventions across cognitive and behavioural outcomes. Key findings from each study are summarised separately in Table 1. The studies have been divided into three categories: micro-break and recovery studies, digital fidgeting studies and other technology use.

Table 1A
Micro-break and recovery studies

Authors (Year)	Important Results
S. Sonnentag, B. H. Cheng, S. L. Parker (2022)	Recovery activities like exercise, socialising, and low-effort tasks generally enhance well-being; high-duty tasks show opposite effects. Passive activities may be restorative depending on individual/work factors. Technology can support or hinder recovery; future work should explore application-based interventions.
Lyubykh et al. (2022)	Social media breaks have mixed effects; low-effort respite activities improve motivation, reduce exhaustion, and support well-being and task/contextual performance.
P. Albulescu et al. (2022)	Micro-breaks sustain vigour, reduce fatigue, and improve performance for clerical/creative tasks but not cognitively demanding ones; no negative effects reported; short breaks restore energy and focus, supporting learning.
J. Gellmers, N. Yan (2023)	Hedonic videos enhance positive affect and relaxation; eudaimonic videos foster gratitude and mastery; smartphone breaks increase vigour and reduce exhaustion; computer games promote detachment, relaxation, mastery, and control.
M. S. Kuschpel et al. (2015)	Active gaming during breaks negatively impacts working memory, increases mind wandering, and reduces concentration, taxing executive resources.
S. Liu et al. (2015)	Post-learning break activities affect memory retention differently; *Angry Birds* reduced auditory memory but improved visual memory compared to passive breaks.
S. Liu et al. (2019)	Video gaming decreased relaxation, increased heart rate, impaired working memory, and reduced SMA activation; different games affect cognitive functions differently.
K. Kitayama et al. (2023)	Micro-refresh (MR) is unlikely to reduce concentration; unclear if effects are due to MR or spontaneous breaks.
O. Dianita et al. (2024)	MB intervention stabilised performance across blocks; minor differences in subjective workload; three 20-second breaks had little effect on perceived symptoms.
O. Dianita et al. (2025)	Visual stimuli improved late-task performance, reduced fatigue, and enhanced detachment and relaxation; accuracy largely unaffected; productivity benefits observed.
Z. Zhang, L. Qin (2021)	Micro-games integrated into workflows reduce disruptions, act as rewards, gameplay should be low cognitive/physical effort, and support workflow without distraction.
Xuyao Wu, Qinghong Chen, Ye Li (2025)	Cyberloafing can reduce ego depletion variably; low-cognitive-load activities (music) are more restorative than high-load (shopping); benefits depend on prior ego depletion and timing.
J. Grobelny et al. (2024)	Social media breaks partially restore fatigue and vigour; nature-based breaks more effective; brief SM engagement aids detachment but limited relaxation/mastery benefits.
V. Burney, R. A. Sharp (2025)	Micro-breaks improve engagement, focus, enjoyment, and reduce stress/fatigue; preference for short, frequent breaks.

S o u r c e: Own work.

Table 1B
Digital fidgeting

Authors (Year)	Important Results
M. Karlesky, K. Isbister (2014)	*Fidget Widgets* support mindless and playful engagement; provide tactile, programmable, and bodily interaction; support daydreaming and overcoming mental blocks.
M. Karlesky, K. Isbister (2016)	Fidgeting supports self-regulation of creativity, focus, and calm; repetition and tactile movement central; short, mindless activities recommended around computing devices.
C. Ji, K. Isbister (2022)	Prototyped dynamic visualizations with audio to guide fidget gestures; aim to regulate undesired affective states via tapping interactions.
S. B. da Câmara (2022)	*Fidgetato* did not impair memory test performance; had no effect on metacognitive estimates; positive correlation between reports of attentional lapses and fidgeting frequency; design and selection matter.
J. A. Eichenlaub (2022)	Reflexive Focus Bounding (RFB) theory: fidgeting limits mind wandering and distraction; fidgeting reportedly regulates affect, anxiety, supports focus, attention, well-being; mindless fidgeting as an immediate, task-compatible intervention.
J. A. Eichenlaub, G. Huisman, H. Xue (2023)	*Fidget Knob* can replace distracting fidgeting; supports constructive mind wandering; interactive fidgets have both benefits and drawbacks; potential applications beyond HCI.
T. Torin (2021)	Fidgeting used during passive tasks supports emotion regulation without disrupting tasks; excessive focus can undermine regulation.
A. Williams et al. (2019)	Fidget conditions did not impair visual search; participants preferred fidgets, particularly the mobile haptic version; perceived and actual performance aligned.
S. Ross, N. Sullivan, J. Yoon (2023)	Virtual fidgets prevented 62.5% from switching to other sites; effectiveness varied; context-aware, interactive, visually appealing, but not distracting and easy to adopt designs recommended for lecture settings.
S. Tancredi, D. Abrahamson (2024)	Stimming is regulatory, cognitive, social, and pedagogically valuable; intentional stimming supports problem-solving and interaction; design heuristics proposed for learning environments.

S o u r c e: Own work.

Table 1C
Other technology use

Authors (Year)	Important Results
A. C. Barton et al. (2020)	Certain video games and exergames can boost attention temporarily; casual games show limited restorative effects; short, practical sessions recommended; longitudinal studies needed.
H. Jiang, M. Siponen, A. Tsohou (2023)	PUTW effects on executive attention depend on cognitive load, arousal, timing, and frequency; low-load, low-arousal, between-task, appropriately-timed activities are optimal.

M. B. Perrigino et al. (2024)	Non-work technology use occurs for varied reasons; short, positive, distributed episodes enhance engagement; excessive use may be harmful; policy design recommended.
R. P. Nalliah, V. Allareddy (2014)	Distraction by devices did not affect learning outcomes; performance similar between “distracted” and “non-distracted” groups.
K. Graben, B. K. Doering, A. Barke (2022a)	Gaming app use did not reduce reading speed, test performance, or time; push notifications had no effect; cognitive similarity may explain lack of impact.
K. Graben, B. K. Doering, A. Barke (2022b)	Push notifications reduced learning performance; parallel game play without notifications did not impair performance; source of interruption matters.
K. S. Rykard (2020)	44% reported no negative impact from cyberslacking; some noted reduced concentration; others reported stress relief, reduced worry, or improved peer relations.

S o u r c e: Own work.

Discussion

This review explored what types of digital games or low-cognitive-demand activities are associated with improved focus, memory retention, or sustained engagement when performed in parallel with passive learning or work tasks, particularly among Generation Z. Across the three result groups – digital micro-breaks, digital fidgets, and other parallel technology use – findings point to nuanced effects that depend on activity design, cognitive load, and contextual factors such as timing, duration, and task similarity.

Micro-breaks and Recovery Activities

Evidence from micro-breaks research highlights their potential to sustain vigour, reduce fatigue, and restore attentional resources during cognitively lighter tasks, with generally positive effects on well-being and task performance (Albulescu et al., 2022; Lyubykh et al., 2022; Gellmers & Yan, 2023). Importantly, micro-breaks rarely impair performance, even if they do not enhance it (Albulescu et al., 2022; Kitayama et al., 2023). Yet, the nature of the break matters: leisure or nature-based breaks appear more restorative than smartphone or social media use (Grobelny et al., 2024; Sonnentag et al., 2022; Wu et al., 2025), while short humorous or meaningful video clips can improve affective states and support recovery (Gellmers & Yan, 2023). Untaxing digital visual stimuli were shown to stabilise work performance over time, reduce fatigue, and enhance detachment

and relaxation (Dianita et al., 2024, 2025). Experimental studies suggest a double edge to gaming as a break activity. While minimalist game designs may promote detachment and relaxation (Zhang & Qin, 2021), casual games can also tax executive resources, impairing working memory or long-term recall when cognitively demanding or arousing features are present (Liu et al., 2015; Kuschpel et al., 2015; Liu et al., 2019). These findings underscore the importance of low cognitive demand and low arousal in selecting micro-break activities, aligning with cognitive load and resource allocation theories (Kuschpel et al., 2015; Wu et al., 2025). From an educational perspective, programmed short breaks during online lectures appear particularly beneficial, enhancing concentration, reducing fatigue, and sustaining engagement (Burney & Sharp, 2025).

Digital Fidgets and Stimming-Inspired Interventions

Reviews of fidgeting and use of fidget toys generally do not support their implementation in the classroom (Kriescher et al., 2023), concluding that their benefits for improving academic results and behaviour are negligible, if not negative overall (Schoenen et al., 2025). Different fidget devices may have wildly different effects (Schoenen et al., 2024). Research on digital fidgets such as *Fidgetato* indicates that repetitive, low-effort interactions – whether tactile, haptic, or visual – can support self-regulation, attention, and emotional balance without impairing concurrent task performance (Da Câmara, 2022; Eichenlaub, 2022; Karlesky & Isbister, 2014; 2016; Torin, 2021; Williams et al., 2019). Unlike social media or gaming breaks, fidgets are not designed to capture prolonged attention, but instead provide mindless, rhythmic, or sensory input that helps regulate arousal. This has been observed both in physical fidgets (e.g., *Fidget Knob*, Eichenlaub et al., 2023) and in virtual ones (Ross et al., 2023), which can act as intermediary distractions that prevent more disruptive task-switching (e.g., to social media). Da Câmara et al. (2018) found that fidgeting through pressing, clicking, or tapping was linked to engagement in cognitive tasks, including studying, homework, and focused learning in children. Building on this, Ji & Isbister (2022) prototyped swiping and tapping interactions with AR glasses to guide users from undesired affective states. If similar effects really extend to the student age cohort, a mobile game incorporating simple, repetitive tapping inputs could serve precisely this regulatory function, providing brief, low-effort engagement that mitigates more disruptive task-switching. Importantly, design plays a critical role: purpose-built fidgets that are context-aware, minimally intrusive, and integrated with the learning environment show promise in sustaining focus (Ross et al., 2023). Emerging stimming-inspired interventions (Tancredi & Abrahamson, 2024) expand this logic, positioning sensorimotor activity not merely as distraction management but as an epistemic and regulatory tool. This reframing suggests that digital fidgets may

not only preserve attentional resources but actively enrich cognitive engagement, especially when legitimised as part of learning or work practices.

Other Parallel Digital(ised) Activities

The broader literature on parallel digital activities paints a mixed picture. On one hand, low-demand, passive activities such as browsing or watching short videos can restore attentional resources, relieve stress, and prevent overload (Jiang et al., 2023; Rykard, 2020; Perrigino et al., 2024). Even certain video games as an off-task activity were shown to restore attention temporarily (Barton et al., 2020). On the other, externally triggered interruptions, such as push notifications, consistently impair learning outcomes – even when the associated activity is simple or low in cognitive load (Graben et al., 2022b). This distinction highlights the importance of volitional vs. imposed activity: self-initiated micro-engagements may replenish resources, while involuntary disruptions undermine attentional control. Notably, some studies report no measurable performance loss despite self-reported distraction (Nalliah & Allareddy, 2014; Graben et al., 2022a), suggesting that subjective perceptions of distraction do not always align with learning outcomes. Together, these findings suggest that parallel activities are most adaptive when self-chosen, brief, and low in both cognitive load and arousal.

Integrating Across Groups

Taken together, the three strands of evidence converge on several design-relevant insights. First, low cognitive demand and rhythmic or repetitive qualities appear central to maintaining or restoring attentional resources. Digital fidgets and certain micro-breaks (e.g., brief visual stimuli, simple casual games) embody these features, whereas arousing or cognitively heavy activities (e.g., competitive gaming, online shopping) may hinder recovery. Students could use short, intermittent bursts of low-cognitive-load gameplay as a form of recovery from cognitively demanding lecture content with or without their teacher's approval. Second, context and timing matter: micro-breaks scheduled between tasks or during pauses support recovery more effectively than within-task diversions (Jiang et al., 2023), suggesting that unstructured playing would have a negative effect on the comprehension and retention of the material. Similarly, fidgets are most effective when designed to integrate with, rather than intrude upon, the primary task (Ross et al., 2023). Third, volition and intentionality play a crucial role. Self-initiated fidgeting or micro-breaks often aid regulation, while externally imposed interruptions (e.g., push notifications) disrupt attention and memory (Graben et al., 2022b). Finally, there is emerging evidence that these interventions may hold particular promise

for younger cohorts such as Generation Z, who both expect and navigate high levels of digital multitasking. However, the literature remains fragmented, with experimental findings on memory effects (e.g., Liu et al., 2015; Liu et al., 2019) suggesting caution in assuming universally positive outcomes.

Implications and Future Directions

For designers and educators, the findings suggest prioritising digital fidgets and micro-break activities that are low in cognitive load, minimally intrusive, and context-aware. Future work should systematically compare digital fidgets, micro-breaks, and other parallel activities across different learning settings, particularly in Generation Z populations who frequently combine media and study. Longitudinal and mixed-method approaches are needed to clarify whether benefits are immediate, sustained, or contingent on task type (Barton et al., 2020), and to explore the role of individual differences (e.g., susceptibility to distraction, preference for multimodal engagement).

Design Principles for Mindless Games

These findings can also guide the formulation of specific design principles for creating experimental "mindless" games in our subsequent study. The following design implications are particularly relevant for learning contexts:

- Use continuous, rhythmic loops that run without player choices; avoid goals, scores, timers, streaks, levels, or branching. Keep loops incomplete to avoid triggering executive control.
- Treat the interaction as background cadence rather than as a secondary task.
- Ambient visuals; tactile if possible. Favour tactile over visual interaction during listening; if visual, keep muted, slow, predictable, minimal text/motion cues.
- Provide sound-off by default to avoid auditory masking, and keep haptics subtle and adjustable.
- Target low-to-moderate arousal: no competitive pressure, avoid abrupt salience (flashes, notifications, reward pops).
- Offer very short micro-doses (in the order of tens of seconds to ~1–2 min) to restore vigour and reduce fatigue without harming performance.
- Accessibility for Gen Z contexts: make the anchor instantly available; keep controls immediate and one-handed; enable quick start, pause/resume; maintain device-agnostic access, no sign-ups.

Conclusion

This review highlights that low-cognitive-load digital activities, particularly micro-breaks and digital fidgets, can support attentional recovery, reduce fatigue, and sustain engagement when paired with learning or work tasks. Evidence suggests that restorative effects depend on activity design, timing, and user volition, with self-initiated, brief, and minimally intrusive activities proving most beneficial. Digital fidgets and simple, rhythmic interactions appear especially promising compared to cognitively demanding or externally imposed activities such as competitive gaming or push notifications. While these strategies may be particularly well suited to Generation Z learners, findings remain fragmented, and caution is warranted regarding potential memory costs. Importantly, the review results also provide design implications for developing low-cognitive-load ("mindless") games as interventions to support focus and recovery in learning contexts, which will be further examined in future research.

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Gry o niskim obciążeniu poznawczym w kontekście uwagi: przeglądowe badanie w pokoleniu Z

Streszczenie

W erze ciągłego cyfrowego wielozadaniowości studenci pokolenia Z stoją przed wyjątkowymi wyzwaniami związanymi z utrzymaniem uwagi i pamięci podczas nauki i wykładów. Chociaż intensywne korzystanie z mediów społecznościowych i rozpraszające czynniki technologiczne wiążą się z gorszymi wynikami w nauce, nowe dowody wskazują, że cyfrowe działania o niskim obciążeniu poznawczym, takie jak tzw. gry casualowe, elektroniczne gadżety i krótkie mikroprzerwy, mogą paradoksalnie pomóc w utrzymaniu uwagi. Niniejszy przegląd mapuje i syntetyzuje badania opublikowane w latach 2010–2025 dotyczące cyfrowych mikroprzerw, gadżetów i innych czynności o niskim poziomie trudności w kontekście nauki i pracy. Zgodnie z wytycznymi PRISMA-ScR, na podstawie wyszukiwania w bazach danych i łańcuchowania cytowań zidentyfikowano 33 badania w 31 artykułach. Dowody wskazują, że krótkie, mało wymagające i dobrowolne czynności mogą sprzyjać przywróceniu uwagi, zmniejszeniu zmęczenia i poprawie nastroju bez wpływu na wykonywanie zadań równoległych, zwłaszcza w porównaniu z bardziej wymagającymi poznawczo lub wymuszonymi z zewnątrz cyfrowymi przerwami. Wyniki badań dotyczących mikroprzerw i regeneracji podkreślają korzyści płynące z krótkich czynności regeneracyjnych, natomiast badania dotyczące cyfrowych fidgetów wskazują na potencjał rytmicznych, powtarzających się interakcji w zakresie samoregulacji. Szersza literatura dotycząca równoległych działań cyfrowych podkreśla znaczenie czasu, kontekstu i wysiłku woli w określaniu wyników. Podsumowując, wyniki te sugerują, że celowo zaprojektowane gry lub narzędzia o niskim obciążeniu poznawczym mogą wspierać koncentrację uwagi i pomagać studentom opierać się bardziej rozpraszającym formom cyber-lenistwa.. Literatura

pozostaje jednak fragmentaryczna, z niespójnymi wynikami dotyczącymi pamięci i ograniczonymi badaniami skupiającymi się bezpośrednio na kontekstach edukacyjnych. W przyszłych pracach należy przetestować eksperymentalne prototypy „bezmyślnych" gier mobilnych dla uczniów z pokolenia Z, kładąc nacisk na rodzaj zadania, czas i indywidualne różnice, aby ustalić, czy takie interwencje mogą poprawić naukę, a jednocześnie zmniejszyć rozproszenie uwagi.

S ł o w a k l u c z o w e: uwaga i zmęczenie, cyfrowe mikroprzerwy, narzędzia rozpraszające uwagę, pokolenie Z, czynności o niskim obciążeniu poznawczym

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Juegos con baja carga cognitiva en el contexto de la atención: estudio general en la generación Z

R e s u m e n

En la era de la multitarea digital constante, los estudiantes de la generación Z se enfrentan a retos únicos para mantener la atención y la memoria durante el estudio y la enseñanza magistral. Aunque el uso intensivo de las redes sociales y las distracciones tecnológicas se asocian con peores resultados académicos, nuevas pruebas sugieren que las actividades digitales con baja carga cognitiva, como los juegos casuales, los fidgets electrónicos y los microdescansos breves, pueden, paradójicamente, ayudar a mantener la atención. Esta revisión recopila y sintetiza las investigaciones publicadas entre 2010 y 2025 sobre microdescansos digitales, juguetes electrónicos y otras actividades de baja exigencia en el contexto del estudio y el trabajo. De acuerdo con las directrices PRISMA-ScR, se identificaron 33 estudios en 31 artículos a partir de búsquedas en bases de datos y encadenamientos de citas. Las pruebas sugieren que las actividades breves, de baja intensidad y voluntarias pueden favorecer la recuperación de la atención, reducir la fatiga y mejorar el estado de ánimo sin afectar al rendimiento de las tareas simultáneas, especialmente en comparación con las interrupciones digitales más exigentes desde el punto de vista cognitivo o impuestas externamente. Los resultados de los estudios sobre microdescansos y recuperación destacan las ventajas de las actividades regenerativas breves, mientras que la investigación sobre los fidgets digitales señala el potencial de las interacciones rítmicas y repetitivas para la autorregulación. La bibliografía más amplia sobre actividades digitales paralelas destaca la importancia del momento, el contexto y el esfuerzo voluntario a la hora de determinar los resultados. En resumen, estos resultados sugieren que los juegos o herramientas diseñados intencionalmente con una baja carga cognitiva pueden servir para fomentar la atención y ayudar a los estudiantes a resistir formas más distractoras de cyberloafing. Sin embargo, la bibliografía sigue siendo fragmentada, con hallazgos inconsistentes sobre los resultados de la memoria y una investigación limitada centrada directamente en los contextos educativos. El trabajo futuro debería poner a prueba prototipos experimentales de juegos móviles «sin pensar» para los estudiantes de la generación Z, haciendo hincapié en el tipo de tarea, la sincronización y las diferencias individuales, con el fin de determinar si este tipo de intervenciones pueden mejorar el aprendizaje y, al mismo tiempo, mitigar las distracciones.

P a l a b r a s c l a v e: atención y fatiga, microdescansos digitales, herramientas de distracción, generación Z, actividades de baja carga cognitiva

Low-Cognitive-Load Games as Attentional Support:A Scoping Review for Gen Z Learners

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Игры с низкой когнитивной нагрузкой в контексте внимания: обзорное исследование поколения Z

Аннотация

В эпоху постоянной цифровой многозадачности студенты поколения Z сталкиваются с уникальными вызовами в сохранении внимания и памяти в процессе обучения и лекционных занятий. Хотя интенсивное использование социальных медиа и технологические отвлекающие факторы связаны с более низкими академическими результатами, новые данные свидетельствуют о том, что цифровые активности с низкой когнитивной нагрузкой – такие как так называемые казуальные игры, электронные фиджеты и короткие микроперерывы – парадоксальным образом могут способствовать удержанию внимания. Данный обзор отражает и обобщает исследования, опубликованные в период с 2010 по 2025 год, посвящённые цифровым микроперерывам, фиджетам и другим видам деятельности низкой сложности в контексте обучения и работы. В соответствии с рекомендациями PRISMA-ScR на основе поиска в базах данных и анализа цепочек цитирования были идентифицированы 33 исследования в 31 публикации. Полученные данные указывают на то, что краткие, малозатратные и добровольные активности могут способствовать восстановлению внимания, снижению утомляемости и улучшению настроения, не ухудшая выполнение параллельных задач, особенно по сравнению с когнитивно более требовательными или внешне навязанными цифровыми перерывами. Результаты исследований микроперерывов и восстановления подчёркивают преимущества кратких регенеративных активностей, тогда как работы, посвящённые цифровым фиджетам, указывают на потенциал ритмичных, повторяющихся взаимодействий для саморегуляции. Более широкая литература о параллельных цифровых активностях подчёркивает важность времени, контекста и волевых усилий в определении исходов. В совокупности эти результаты свидетельствуют о том, что специально разработанные игры или инструменты с низкой когнитивной нагрузкой могут служить «якорями внимания», помогая студентам противостоять более отвлекающим формам киберлофинга. В то же время литература остаётся фрагментированной, с непоследовательными выводами относительно эффектов на память и ограниченным числом исследований, непосредственно ориентированных на образовательные контексты. Будущие исследования должны протестировать экспериментальные прототипы «бездумных» мобильных игр для студентов поколения Z с акцентом на тип задания, тайминг и индивидуальные различия, чтобы определить, способны ли такие вмешательства улучшать обучение, одновременно снижая уровень отвлечения.

Ключевые слова: внимание и утомляемость, цифровые микроперерывы, инструменты отвлечения внимания, поколение Z, активности с низкой когнитивной нагрузкой

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Decoding User Experience in Instructional Design for E-learning Project

Abstract

In the rapidly evolving field of education, e-learning has become an essential tool for sharing knowledge and skills. However, the success of e-learning solutions mainly depends on how effectively they meet users' needs and expectations. Designing the User Experience (UX) is a crucial aspect of developing e-learning products. To incorporate UX strategies into projects, clear understanding and communication are vital among Instructional Designers (IDs), stakeholders, and Subject Matter Experts (SMEs). This article explores this relationship, focusing on the connection between UX and Instructional Design (ID) in e-learning projects. By examining the principles and practices that create effective UX in ID, we aim to recommend strategies that boost learner engagement, satisfaction, and overall educational outcomes. Through detailed analysis of current trends, case studies, and expert insights, a tool has been developed to help interpret UX elements during e-learning project development. The goal of this article is to create a roadmap for educators, designers, and developers committed to producing impactful, user-centered e-learning experiences. Additionally, it seeks to develop and validate a tool to assess Instructional Designers' approach to stakeholder discussions when beginning an e-learning project. It also aims to propose a model to evaluate how much project planning emphasizes UX design.

K e y w o r d s: User Experience (UX), Instructional Design (ID), User-Centered Design (UCD), Learner-Centered Design (LCD), e-Learning project, ADDIE Framework, Stakeholder Engagement, Workshop Methodology

Well-designed interfaces greatly enhance learners' engagement and satisfaction (Miya & Govender, 2022). Incorporating User-Centered Design (UCD) principles into the development of e-learning solutions results in a highly usable and effective learning tool (Gray et al., 2019).

Understanding the UX elements in initial interactions with project stakeholders and SMEs is essential for successful project outcomes (Sedio, 2024). To introduce effective UX practices early on, it is crucial to build trust during these first interactions through clear, concise, and transparent communication. This approach helps to develop a better understanding of the project goals (Adebayo et al., 2023). Engagement strategies like active listening are vital for understanding stakeholders' needs and expectations (Ślósarz, 2024).

The importance of collaboration between IDs and SMEs in digital transformation projects, particularly in education, has been emphasized in the literature, e.g., (Gottler, 2023; Drysdale, 2019). The role of teamwork is seen as crucial for creating effective digital learning content. IDs bring their expertise in teaching methods and design, while SMEs contribute their specialized knowledge. To ensure successful design and implementation, instructional designers must collaborate closely with subject matter experts who have extensive knowledge in specific fields. This partnership is vital for producing engaging and effective educational content (Smelkowska et al., 2023). IDs' expertise includes not only technical aspects and e-learning trends but also the ability to develop a learning strategy tailored to particular groups of learners. With this knowledge, IDs can design appropriate learning processes, proposing multiple tools for strategies such as paraphrasing, summarizing, categorizing information, and creating analogies (Zormanova, 2021). This enables the drafting of learners' profiles and the preparation of both content and the instructional layer of the e-learning project. However, collaboration between IDs, SMEs, and stakeholders is not always smooth. Common challenges include communication issues and power struggles. To improve project outcomes, clear understanding and well-defined roles are essential (Gottler, 2023). Regular feedback loops and mutual respect within the team foster a productive environment (Mokwa-Tarnowska et al., 2020). Research highlights that clearly defined roles and early engagement are crucial to prevent conflicts and ensure smooth collaboration (Drysdale, 2019). This can be achieved by organizing workshops at the start of the partnership. Afterward, regular brief meetings and consistent information sharing are critical. The following sections of this article present a series of specific steps to accomplish these goals.

Problem of Research

Despite the rapid growth of e-learning solutions, the application of effective UX principles in ID remains insufficiently explored. This gap often leads to poor learning results and user dissatisfaction, emphasizing the need for a thorough analysis of UX strategies customized for ID. By exploring the connection between UX and ID, we can identify key elements that boost learner engagement, retention, and overall satisfaction. Tackling this research issue is essential for creating e-learning solutions that are not only educationally effective but also user-friendly and enjoyable.

Methodology of Research

Building on the conceptual foundation outlined above, the following section details the methodological approach adopted to investigate the intersection of UX and instructional design in e-learning projects. This transition from theory to practice is essential for grounding our analysis in both empirical evidence and established frameworks. The collaboration between UX and ID is crucial for creating e-learning solutions that are both effective and enjoyable. Achieving this depends on strong cooperation among UX professionals, Instructional Designers, SMEs, and project stakeholders. To identify key areas, a thorough understanding of expectations and a solid theoretical foundation are needed. For IDs, the starting point of the design process typically involves a framework that provides a strong basis for integrating different parts of the project into a unified solution. In this article, the ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation) will be used to organize the investigation. This approach will support a systematic review of how UX strategies can be effectively incorporated into ID to enhance e-learning experiences.

To explore how UX principles can enhance the analysis phase of instructional design, we developed and facilitated a hands-on workshop for professionals in the e-learning field, including instructional designers, learning technologists, and UX practitioners.

The methodology was structured to serve both diagnostic and development purposes. Participants were engaged in a series of practical, scenario-based activities designed to simulate real-world instructional design challenges. These activities were interspersed with guided reflection sessions, allowing participants to critically evaluate their design decisions through the lens of UX principles such as usability, accessibility, learner empathy, and iterative feedback.

Data was collected through the workshop surveys, participant observation, and facilitated group discussions. These sources provided mainly qualitative insights into participants' evolving understanding of UX and its practical implications for instructional design. This can also be a good starting point to introduce some quantitative research methods based on the qualitative findings.

This methodology section outlines the workshop's structure, flow, and tools, providing context for the insights presented later in the article. By combining practical activities with structured reflection, the workshop served as both a diagnostic and developmental tool to assess learner-centered practices and promote deeper integration of UX within instructional design processes.

Having various project experience the participants linked the steps differently.

The methodology outlined above provides a robust foundation for analyzing the practical integration of UX principles within instructional design. The subsequent sections present the findings from the workshop and discuss their implications for learner-centered e-learning development.

ADDIE Framework in E-learning Development

To systematically examine the integration of UX principles within instructional design, we employ the ADDIE framework as an organizing structure. This model enables a comprehensive review of each phase of e-learning development, ensuring that both theoretical and practical considerations are addressed.

The framework that will be used as far as e-learning creation end-to-end is ADDIE. The ADDIE model is a systematic instructional design framework widely employed in educational and training contexts. Its acronym stands for Analysis, Design, Development, Implementation, and Evaluation. Each phase encapsulates distinct processes aimed at facilitating effective learning experiences.

Analysis

This initial phase involves a comprehensive examination of the learning needs and goals. It encompasses assessing the learners' characteristics, identifying performance gaps, and delineating the instructional objectives. The analysis phase serves as the foundation for subsequent design decisions.

Design

In this phase, instructional designers formulate strategies to address the identified learning needs. This entails crafting learning objectives, selecting appropriate instructional methods and media, and structuring the overall instructional approach.

Development

The development phase involves the actual creation of instructional materials based on the design specifications. Content is developed, multimedia elements are integrated, and interactive components are constructed. This phase typically involves collaboration among instructional designers, subject matter experts, and multimedia developers to ensure the alignment of content with instructional goals.

Implementation

Implementation marks the deployment of the instructional materials in the learning environment. This stage encompasses instructor training, learner orientation, and logistical arrangements for delivering the instruction. Whether in traditional classroom settings or online platforms, the implementation phase ensures that learners have access to the designed instruction and necessary support mechanisms.

Evaluation

Evaluation is an ongoing process throughout the ADDIE model and culminates in a comprehensive assessment of the instructional effectiveness. Formative evaluation occurs during the development and implementation phases to gather feedback and refine the instruction iteratively. Summative evaluation, conducted after the completion of instruction, assesses the attainment of learning objectives and the overall impact of the instructional intervention. Evaluation findings inform revisions and improvements for future iterations of the instructional design.

To illustrate the big picture of the intersection between UX and ID in a model-like environment, we have placed eleven UX/UI elements on top of ADDIE's development phases (see Figure 1). The UX/UI elements are as follows: research (an overarching element), analysis: scenarios, personas, user interviews, design: wireframes, prototypes, interaction design, information architecture, development: user interface (UI), UX writing, implementation: usability testing, quality assurance (QA), evaluation: usability testing, UAT (user acceptance test). The arrows indicate

that the phases of ADDIE are fluid and can overlap in an agile fashion to serve the effective project progression as needed. The same applies to UX/UI elements. It is up to the project's needs and context to inform the instructional designer's decision on which elements to use in what sequence.

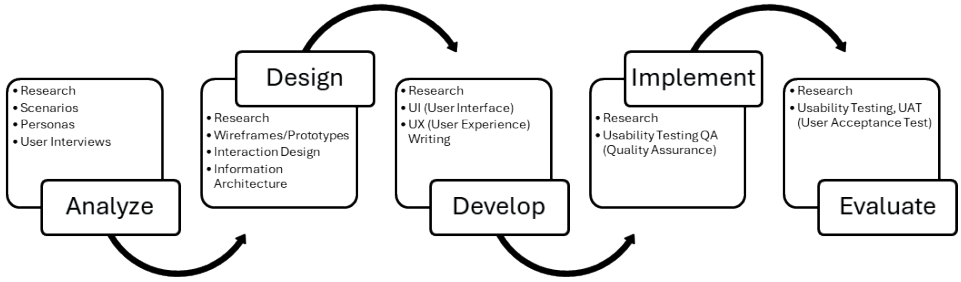

Figure 1. ADDIE framework including UX elements.

Source: Own work based on Branch (2009)

To answer the question of how much of what we are doing is learner-centered, we must be mindful that in the project work of e-learning designers, there are project management and instructional elements that do not refer to the learner directly, or even at all. This is very objective and depends a lot on the nature of the project and what challenges the learning intervention is addressing.

UX/ID Workshop

The Aim

In this article, we aim to explore insights from a workshop focused on the analysis phase of the ADDIE model, specifically emphasizing the initial interaction between e-learning managers and project stakeholders. The workshop was designed to raise awareness about integrating User Experience (UX) elements into Instructional Design (ID) processes. By examining this first meeting, the workshop aimed to assess how learner-centered these interactions are and identify areas for improvement.

The workshop gathered a diverse group of e-learning experts and consultants, including content developers, instructional designers, learning architects, strategists, and leaders dedicated to ensuring project success. This diverse attendance enriched the discussions, as both junior and senior participants shared their perspectives, experiences, and insights. The collaborative environment encouraged an

exchange of ideas, enabling participants to gain new insights into the intersection of instructional design (ID) and UX.

Participants participated in activities that emphasized the importance of identifying learner needs, developing detailed personas, and including stakeholder insights to shape the instructional approach. This collaborative environment enabled a thorough evaluation of current practices and the identification of UX elements that naturally align with learner-focused strategies.

Through structured discussions and interactive sessions, the workshop aimed to measure the level of learner-centeredness in these early interactions. Participants were encouraged to reflect on their current practices and consider how much they prioritize the learner's experience. By assessing the impact of UX elements in the initial stakeholder meeting, the workshop offered valuable insights into how much of the instructional design process is naturally learner-focused and where improvements could be made.

The workshop outcomes highlighted the potential for behavioral change among instructional designers. By increasing awareness of the importance of UX during the analysis phase, participants were encouraged to take more mindful and proactive steps to prioritize the learner. This includes strategies such as intentionally designing scenarios and negotiating for time to develop detailed learner personas and conduct interviews, ensuring that design decisions are based on a thorough understanding of the learner's context and needs.

Ultimately, the workshop emphasized the important role that UX principles play in improving the effectiveness of e-learning projects. By promoting a culture of reflection and ongoing improvement, instructional designers can develop more engaging and impactful learning experiences. The insights from this workshop form the basis of this article, providing a detailed look at the current state of learner-centeredness and suggesting ways to advance e-learning practices further.

The Flow

The UX Case Study Workshop is designed to engage participants in understanding UX elements within instructional design through a structured flow. The workshop begins with an introduction to the agenda and its goals, focusing on helping participants identify UX elements in initial interactions with stakeholders and SMEs (Subject Matter Experts).

The ADDIE framework (Analyze, Design, Develop, Implement, Evaluate) is incorporated as a foundational structure for instructional design, emphasizing its application in UX/UI design for e-learning. Participants are introduced to a case study involving a client request from Silicon Software, a tech company, which outlines the scenario, roles, and audience involved in the project.

Before the meeting, participants are encouraged to conduct thorough research on the product and client. This includes reviewing demos, user stories, and existing educational content to prepare adequately. A brief onboarding call is suggested to introduce the agenda and build excitement for the collaborative workshop. The meeting goals include conducting a performance needs analysis and a "Know, Do, Feel" workshop to align stakeholders on project objectives.

Participants engage in a series of deep-dive rapid-fire questions designed to uncover the problem, business reasons, stakeholder roles, and project scope. This section emphasizes understanding the target audience and technical requirements. The interactive "Know, Do, Feel" workshop segment focuses on what the target audience should know, do, and feel after completing the curriculum, aiming to align learning outcomes with business objectives.

The meeting structure and process are outlined in the agenda, covering performance needs analysis, the "Know, Do, Feel" workshop, and defining roles and processes for collaboration. The workshop zooms in on UX by analyzing how learner-centered the interview and first meeting are, comparing UX/UI elements with discovery meeting elements.

Finally, the workshop concludes with a summary of key insights and a call to action, encouraging participants to create their own case study versions and reflect on their approach for future meetings

The High-level View on Tools

The workshop utilized several tools to facilitate participant engagement and understanding of UX/UI elements within the ADDIE framework. One of the primary tools was a Mural exercise, which was used to assign UX/UI elements on top of the ADDIE framework. This interactive activity allowed participants to visually map and integrate UX principles with instructional design processes.

The case study, an invented scenario by the workshop creators, served as a practical application of the concepts discussed. This scenario provided a realistic context for participants to apply their knowledge and skills. To gauge participants' understanding, rapid-fire questions were employed to check the audience's pulse on how well they grasped certain elements of the meeting. These questions helped determine whether the elements belonged to instructional design, UX, project management, or a combination of these areas.

Additionally, a calculation tool exercise was conducted where participants worked in groups. This exercise involved calculating, based on assumptions and individual inputs, the percentage of UX-centeredness in the first interaction with stakeholders. This collaborative activity provided insights into how much focus on UX was already present in initial stakeholder interactions.

Throughout the workshop, open questions and concerns from the audience were encouraged, allowing for a dynamic exchange of ideas and addressing any uncertainties participants might have had

The Detailed View on the Tools

To bring theory into practice, the workshop incorporated a series of interactive tools and exercises designed to deepen participants' understanding of UX integration within instructional design. These tools were not only intended to facilitate engagement but also to surface assumptions, challenge habits, and encourage a more structured reflection on current practices. From mapping UX elements onto the ADDIE framework to simulating stakeholder meetings, each activity was crafted to illustrate how user-centered thinking can be embedded at different stages of learning design. In the sections that follow, we provide a closer look at each tool, its purpose, and how it contributed to the overall workshop experience.

The Miro Sorting Exercise

This exercise is a key interactive activity within the workshop, designed to help participants connect UX/UI elements with the ADDIE framework. By visually mapping these elements, participants gain a deeper understanding of how UX principles integrate with instructional design.

The exercise begins with the framework preparation. A digital Miro (or Mural) board is set up, with distinct sections representing each phase of the ADDIE model: Analyze, Design, Develop, Implement, and Evaluate. This structure serves as the foundation for participants to systematically organize UX/UI components.

Participants are then introduced to a diverse pool of UX/UI elements. These include essential concepts such as personas, user interviews, wireframes and prototypes, information architecture, UI design, UX writing, usability testing (QA & UAT), interaction design, and research. Each of these elements plays a crucial role in shaping effective learning experiences, and their placement within ADDIE allows participants to see the depth of their impact on instructional design.

As the central task of the exercise, participants are asked to sort and assign UX/UI elements into the appropriate ADDIE phase. They must analyze where each element best fits within the instructional design process, facilitating connections between UX methodologies and traditional learning design strategies. This hands-on activity encourages critical thinking and meaningful discussions on when and how UX/UI considerations influence learning solutions.

Following the sorting process, participants engage in an open discussion and justification of their placements. This phase often sparks debate, as some elements can fit into multiple ADDIE stages. Through these discussions, participants refine

their understanding, challenge assumptions, and recognize the flexibility of UX applications in instructional design.

Guided by the facilitator's insights, the group reviews their placements, addressing any potential misalignments and reinforcing key takeaways. The facilitator may introduce real-world examples or best practices to illustrate how UX methodologies enhance instructional design at every stage.

To conclude the activity, participants reflect on their own work and share how they currently – or plan to – integrate UX thinking into their projects. This final discussion helps bridge workshop concepts with their practical applications, ensuring that participants leave with actionable insights for future instructional design initiatives.

The Miro Sorting Exercise effectively immerses participants in the intersections of UX and instructional design, providing them with a structured yet flexible approach to incorporating user-centered thinking into their learning development processes (Smyrnova-Trybulska et al.; 2020).

Case Study Brief

The Case Study Brief presented in the workshop is a carefully constructed, invented scenario designed to provide participants with a realistic, hands-on application of UX and instructional design principles. By working through this scenario, participants gain experience navigating stakeholder interactions, defining project scope, and ensuring a learner-centered approach within instructional design.

The case study revolves around a client request from Silicon Software, a fictional American fintech software company based in San Francisco, California. Silicon Software specializes in developing software for searching, monitoring, and analyzing machine-generated data via a web-style interface. In the scenario, the company's ENTERPRISE team has developed a new product demo showcasing its latest capabilities. However, they require the final curriculum to be designed, developed, and published within a six-week timeframe, without providing additional information upfront.

Participants assume the role of new joiner instructional designers embedded within an established team. Their task is to support Silicon Software in creating educational materials tailored for a specific audience: the company's sales representatives. These individuals need training on the ENTERPRISE product's new capabilities to enhance their product knowledge and client interactions.

As part of the case study, participants are guided through a structured process of analyzing and preparing for the initial meeting with stakeholders. This involves researching the product, reviewing existing training materials, and understanding the audience's learning needs. They are expected to anticipate challenges and plan for effective stakeholder engagement.

A key component of this process is preparing for the stakeholder onboarding call and crafting a strategy for the first formal meeting. The workshop provides

a framework for planning this discussion, prompting participants to consider several critical aspects: What preliminary work should be done before the meeting? What should the meeting goals be? What key questions need to be asked? How should the meeting be structured to maximize efficiency and clarity? Participants also work on drafting a timeline outlining crucial handoff points, reviews, and content development deadlines.

The exercise encourages participants to identify and assess UX elements within stakeholder interactions, applying user-centered design principles to instructional material development. The case study also includes an interactive element where participants estimate how much UX is embedded in the first interaction with stakeholders, providing a quantifiable measure of the learner-centered approach.

By simulating a real-world instructional design challenge, the Case Study Brief enables participants to practice problem-solving, stakeholder collaboration, and UX integration in a controlled environment. This experience not only reinforces theoretical concepts but also equips participants with actionable insights for applying UX methodologies to instructional design in their professional roles.

Deep-dive Rapid Fire Questions

This segment of the workshop serves as an interactive method to gauge participants' understanding of key concepts related to UX, instructional design, and project management. This activity acts as a real-time pulse check, ensuring that attendees can accurately categorize different meeting elements and understand their role within the broader instructional design and UX framework.

To conduct this activity, participants are presented with a series of quick, targeted questions related to various aspects of the workshop content. These questions prompt them to identify whether a given element belongs to instructional design, UX, project management, or a combination of these fields. By requiring immediate responses, the exercise encourages reflexive thinking and rapid knowledge application, reinforcing core concepts in an engaging format.

The questions cover a range of topics, reflecting the content discussed throughout the workshop. Participants might be asked to classify elements such as stakeholder engagement strategies, user interviews, wireframing, usability testing, curriculum planning, or performance needs analysis. Each question is designed to provoke thought and challenge assumptions, pushing participants to discern where UX overlaps with instructional design and where project management plays a role in structuring effective learning experiences.

The facilitator guides the discussion following each response, offering explanations, corrections, and context to clarify any misunderstandings. This ensures that even when participants answer incorrectly, they gain insights into why a particular element falls under UX rather than instructional design, or why certain aspects of project management are integral to stakeholder collaboration.

By the end of the Rapid Fire Questions session, participants not only reinforce their knowledge of UX and instructional design but also develop a clearer framework for recognizing how these disciplines intersect in real-world learning projects. This exercise fosters engagement, active participation, and dynamic discussion, making it a crucial part of the workshop's knowledge validation strategy.

Zoom-in on UX

The Zoom-in on UX session is a critical component of the workshop, designed to help participants analyze and quantify how learner-centered their first interactions with stakeholders are. This segment goes beyond theoretical discussion by incorporating a calculation tool exercise, allowing participants to assess the UX focus within stakeholder engagements through a structured, data-driven approach.

The session begins with an exploration of UX-centeredness in instructional design interactions, where participants reflect on the elements that contribute to a learner-focused approach. They examine aspects such as learner research, user interviews, experience mapping, and usability considerations, identifying where and how these factors emerge in their first meetings and onboarding calls with stakeholders.

At the core of this session is the calculation tool exercise, in which participants work collaboratively in groups. Each group is tasked with assigning values and percentages to different UX factors, based on their individual experiences and workshop-provided assumptions. By doing so, they collectively determine how much UX is already embedded into their stakeholder engagements. This hands-on approach enables them to quantify the extent to which the interaction prioritizes end-user learning needs.

Throughout the activity, participants engage in discussions about how assumptions, biases, and organizational processes impact UX inclusion. The facilitator encourages reflection on how to enhance UX-centeredness in future stakeholder meetings, ensuring instructional design decisions are informed by user needs rather than rigid business constraints alone.

To conclude the session, the groups compare their calculated results, discussing differences in perceptions and interpretations of UX presence. Open-ended questions allow participants to voice concerns, observations, and strategies for improving user-centered engagement in their professional contexts.

By the end of the Zoom-in on UX session, participants have not only measured the importance of UX in their stakeholder interactions but also developed concrete strategies for embedding a stronger learner-focused approach in future projects. This session reinforces the idea that UX is not incidental – it must be intentionally designed into every aspect of stakeholder engagement and instructional development.

The following table presents a curated selection of these questions, along with sample answers that illustrate varying degrees of learner-centeredness.

Table 1
List of selected questions with sample answers indicating to what degree the questions refer to the learner

	Interview Question	*Low*	*Moderate*	*High*
1	What is the problem/challenge you are trying to address?			x
2	What is the business reason for this request?		x	
3	What changes will we see in the organization when we implement this solution (What does success look like)?		x	
4	How can we measure the impact of the solution (with existing means)?		x	
5	What are the risks/challenges we need to consider?			x
6	Why six weeks from now is your desired timeline? Any important event or milestone?		x	
7	What does the Target audience look like?			x
8	How many people in the target audience? Different roles? New starters? Existing? Access to digital? Mandatory? Language requirements? When will they take this training? Where would they look for information/support?		x	
9	What should the target audience know, do, and feel after they have completed the curriculum?			x
10	What does the end-user of the Enterprise product look like?		x	
11	Which sales reps (3-5) can I talk to that will be exposed to this education material?			x
12	Which technical requirements and limitations do we need to take into account?	x		
	Weight	0.1	0.3	0.6
	Number of indications	1	6	5
	Calculated value of the reference to the learner		1.8	3
	How learner-centered is the interview?	40%		

S o u r c e: Own work.

As shown, Table 1 focused on analyzing the learner-centeredness of commonly used design questions. The workshop also included a quantitative component aimed at assessing how much attention is actually allocated to learner-centered considerations during the analysis phase. Table 2 presents a breakdown of time distribution across different categories of design questions, highlighting the amount of time spent on learner-focused aspects.

This data-driven perspective provided participants with a clearer picture of their current design priorities and served as a catalyst for rebalancing their approach toward more user-centered practices.

Table 2
Summary of time spent in the meeting, with focus on UX.

First meeting elements	Time *[min]*	UX *involvement*	UX time
Research	240	0.5	120.00
Onboarding Call	15	0	–
Meeting Goals	5	0	–
Discovery questions	70	0.40	28.00
Meeting Structure	5	0	–
How We Will Work Together	10	0	–
Sum of time	345		148
How learner-centered is the first meeting?	43%		

S o u r c e: Own work.

Reflection on Participants' Insights

The data gathered during the workshop revealed several recurring themes that highlight both the challenges and opportunities in integrating UX principles into Instructional Design. It was noticeable that the perception of adherence of certain analysis steps was fluid depending on the project size, context and the size and scale of the organization facilitating it.

Some participants acknowledged a gap between their current practices and the ideal of user-centered design, citing institutional constraints, time pressures, and limited UX training as barriers. However, the reflective nature of the workshop encouraged open dialogue and peer learning, which participants described as both validating and eye-opening. Several attendees reported that the session helped them identify specific areas for improvement in their own workflows, particularly in how they gather and interpret learner feedback during the early stages of course development.

These insights underscore the value of reflective, collaborative spaces for professional development and suggest that even brief interventions can catalyze meaningful shifts in mindset and practice.

Limitations and Future Research

While this study provides valuable insights into the integration of UX principles within instructional design, its findings are based on a single workshop and may not be universal to all e-learning contexts. Future research should explore the application of these strategies across diverse educational settings and investigate the long-term impact of UX-focused interventions on learning outcomes.

Conclusions

This study highlights the critical role of UX principles in enhancing Instructional Design practices within e-learning environments. Through a structured workshop, participants gained practical insights into integrating UX elements during the analysis phase of the ADDIE model. The findings underscore the need for intentional learner-centered strategies, particularly in early stakeholder interactions. By quantifying UX involvement and reflecting on current practices, instructional designers can better align their work with user needs, ultimately improving learning outcomes. Future research should explore extended impacts of UX integration and develop standardized tools for assessing learner-centeredness in instructional design.

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Kamila Szwed, Anna Bąkała

Odkrywanie doświadczeń użytkownika w projektowaniu dydaktycznym dla projektu e-learningowego

S t r e s z c z e n i e

W dynamicznie rozwijającym się środowisku edukacyjnym e-learning odgrywa kluczową rolę w upowszechnianiu wiedzy i umiejętności. Sukces rozwiązań e-learningowych w dużej mierze zależy od ich dopasowania do potrzeb i oczekiwań użytkowników. Projektowanie doświadczenia użytkownika (User Experience - UX) staje się zatem istotnym elementem procesu tworzenia produktów e-learningowych. Artykuł analizuje relację pomiędzy UX a obszarem Instructional Design (ID) w kontekście projektów e-learningowych. Na podstawie analizy trendów, studiów przypadków i warsztatów z udziałem ekspertów zaproponowano narzędzie wspierające identyfikację elementów UX w procesie projektowania. Celem artykułu jest opracowanie modelu wspierającego projektantów dydaktycznych w prowadzeniu rozmów ze interesariuszami na etapie przygotowania projektu oraz ocena, w jakim stopniu działania te są skoncentrowane na użytkowniku końcowym.

S ł o w a k l u c z o w e: doświadczenie użytkownika (User Experience – UX), Instructional Design, projekt e-learningowy, model ADDIE, projektowanie zorientowane na użytkownika, współpraca z interesariuszami

Decoding User Experience in Instructional Design for E-learning Project

Kamila Szwed, Anna Bąkała

Descubriendo la experiencia del usuario en el diseño instruccional para el proyecto de e-learning

Resumen

En un entorno educativo en constante desarrollo, el e-learning desempeña un papel clave en la difusión del conocimiento y las habilidades. El éxito de las soluciones de e-learning depende en gran medida de su adecuación a las necesidades y expectativas de los usuarios. El diseño de la experiencia del usuario (User Experience – UX) se convierte, por lo tanto, en un elemento esencial del proceso de creación de productos de e-learning. El artículo analiza la relación entre UX y el área de Instructional Design (ID) en el contexto de los proyectos de e-learning. A partir del análisis de tendencias, estudios de caso y talleres con la participación de expertos, se propone una herramienta que apoye la identificación de elementos de UX en el proceso de diseño. El objetivo del artículo es desarrollar un modelo que respalde a los diseñadores instruccionales en la conducción de conversaciones con los interesados durante la etapa de preparación del proyecto, así como evaluar en qué medida estas acciones están centradas en el usuario final.

Palabras clave: Experiencia del usuario (User Experience – UX), Instructional Design, proyecto de e-learning, modelo ADDIE, diseño centrado en el usuario, colaboración con los interesados

Камила Швед, Анна Бакала

Открытие опыта пользователя в методическом дизайне для проекта электронного обучения

Аннотация

В стремительно развивающемся образовательном ландшафте электронное обучение стало важным инструментом передачи знаний и навыков. Однако успех решений в области e-learning во многом зависит от того, насколько они соответствуют потребностям и ожиданиям пользователя. Проектирование пользовательского опыта (UX) становится важной частью процесса создания продуктов электронного обучения. Для внедрения UX-стратегии в проект необходимо хорошее понимание и эффективная коммуникация между дизайнером учебных материалов (Instructional Designer, ID), заинтересованными сторонами и экспертами по предмету (SMEs). В данной статье рассматриваются эти взаимоотношения в контексте связей между UX и учебным дизайном (ID) в рамках инициатив по электронному обучению. Раскрывая принципы и практики, способствующие эффективному UX в учебном дизайне, мы предлагаем стратегии, повышающие вовлеченность учащихся, их удовлетворенность и общие образовательные результаты. На основе глубокого анализа текущих тенденций, кейсов и экспертных мнений предложен инструмент, позволяющий расшифровывать элементы UX в процессе создания проекта электронного обучения. Цель статьи – подготовить дорожную карту для преподавателей, дизайнеров и разработчиков, стремящихся создавать эффективные и ориентированные на пользователя e-learning-решения. Также статья направлена на разработку и валидацию инструмента для оценки подхода учебных дизайнеров к обсуждению с заинтересованными

сторонами на этапе запуска проекта e-learning. Кроме того, предлагается модель для изучения степени ориентации подготовки проекта на UX-дизайн.

К л ю ч е в ы е с л о в а: Пользовательский опыт (UX), Учебный дизайн (ID), Ориентированный на пользователя дизайн (UCD), Ориентированный на учащегося дизайн (LCD), проект e-learning, модель ADDIE, вовлечение заинтересованных сторон, методология воркшопов

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A Scratch-Based Simulation of Virus Spread as a Constructionist E-Learning Project

Abstract

This article presents a qualitative case study of a Scratch-based simulation project created by a primary school student during a period of remote learning. The study explores how designing a simple agent-based model in a visual programming environment can support the development of digital and computational competences. The analysis draws on three sources of data: the Scratch artefact, competition documentation, and a retrospective semi-structured interview with the project's author. The findings indicate that constructing the simulation helped the student develop key computational practices – such as decomposition, iterative refinement, and problem-solving – and enabled her to explore causal relationships within a simplified model. The project demonstrates how accessible programming environments can facilitate constructionist learning by engaging learners in designing and testing executable artefacts. The results further suggest that simulation-based projects can enrich remote and hybrid education by providing opportunities for active experimentation and reflective analysis. The study's main limitation is its single-case design, which narrows the scope for generalisation. Further comparative and longitudinal research is needed to assess wider educational impact of student-created simulations.

K e y w o r d s: constructionism, Scratch, remote learning, computational thinking, digital competences, civic competences

Introduction

The period of remote education in 2020–2021 rapidly accelerated the integration of digital technologies into everyday school practice, and created fertile ground for projects built around programming and computer-based simulations. One example of such initiatives was a nationwide IT competition organized by Lodz University of Technology, in which students prepared applications or presentations in Scratch that addressed contemporary social issues. The competition task combined elements of computational thinking, problem-solving, and social reflection, offering a particularly clear illustration of constructionist, project-based learning.

Within this context, the project examined in this case study emerged – a simulation illustrating the spread of a virus in a self-service store, created by the article's co-author, then a fourteen-year-old student participating in remote schooling. She chose to develop the project in the form of a simulation-game, blending agent-based modeling, interactivity, and randomness. This design allowed users to test various scenarios and observe how changes in model parameters affected infection dynamics.

The purpose of this article is to analyze the project from pedagogical and technological perspectives, with particular attention to how designing a simulation in a visual programming environment can foster computational thinking, digital competences, and an inquiry-oriented approach to learning. The case study also contributes to the broader discussion on the role of simulation-based projects in e-learning and on how simple programming environments can support the exploration of complex social phenomena.

The presented case offers not only a view of the final artefact but also a detailed look at how a student constructs a simulation, what decisions she makes along the way, and which features of the visual programming environment support her computational and project-based practices. This case study introduces three elements that distinguish it from Scratch-based pandemic projects typically described in the literature: (1) it documents the entire process of simulation design – from the initial concept, through iterative refinements, to sharing the artefact with other users; (2) it represents an independently developed, simplified agent-based model of a social phenomenon, whereas most educational Scratch projects focus on animations, simple games, or introductory programming tasks; and (3) it draws on three complementary data sources – the programming artefact, competition documentation, and a retrospective interview – allowing the code structure to be linked directly with the student's narrative and the institutional context. Such triangulation is rarely discussed in studies of student-created Scratch projects.

1. Theoretical Background

The COVID-19 pandemic accelerated the adoption of digital technologies in education, drawing renewed attention to learning models that foreground student activity, independent experimentation, and the creation of digital artefacts. In this context, three interrelated perspectives have gained particular relevance: constructionism, computational thinking, and learning through simulations and project-based activities.

Constructionism and Learning Through Making

Constructionism (Papert, 1991, 1993) posits that learners develop knowledge most effectively when they create tangible artefacts – programs, models, animations – that externalize and refine their understanding of a phenomenon. The act of making becomes a cognitive process in itself, involving hypothesis building, testing, and reflection. Within the setting of remote education, constructionism provides a framework that supports autonomy, creativity, and self-regulation, enabling learners to explore and create artefacts in digital environments such as Scratch (Levin et al., 2025; Hodges et al., 2020; Bozkurt & Sharma, 2020).

Computational Thinking as a Design-Supporting Competence

Computational thinking (Wing, 2006) encompasses the ability to decompose problems, identify patterns, design algorithms, and engage in abstract reasoning. In the framework proposed by Brennan and Resnick (2012), it consists of three components: programming practices (e.g., iteration, testing), programming concepts (such as variables, loops, and conditionals), and cognitive dispositions including persistence and curiosity. Designing simulations in Scratch naturally develops these elements, as it requires learners to blend system logic with experimentation, iterative refinement, and independent problem-solving.

Simulations and Project-Based Learning as Tools for Inquiry

Using simulations as educational tools allows learners to explore phenomena by manipulating parameters and observing resulting patterns. Following the inquiry learning model (de Jong & van Joolingen, 1998), students formulate hypotheses, test them in a simulated environment, and interpret the outcomes. Even simplified agent-based simulations allow learners to examine causal relationships and observe emergent behaviors. When combined with constructionist principles, designing a simulation becomes a form of learning through inquiry and project-based exploration.

Visual Technologies and Learning in Digital Environments

Visual programming environments such as Scratch lower the entry threshold for programming and modeling, enabling students to translate intuitive ideas into executable code. In educational practice, they are recognized as tools that foster creativity, iterative work, and the sharing of results (Resnick, 2017). In the context of remote learning, these environments gain additional importance – they allow students to undertake projects that integrate social, technical, and civic themes while maintaining the practical dimension of experimentation.

In the case discussed here, Scratch served as a natural environment for developing such skills: the student designed, tested, and shared her work with others. The DigCompEdu framework (Punie, 2017) underscores the value of creative and critical uses of technology in teaching, emphasizing autonomy and collaboration – the elements clearly visible in this project.

Integrating the Three Perspectives

This article adopts an interpretative framework that brings together the three areas described above:

- constructionism, understood as the philosophy and method of "learning through making";
- computational thinking, viewed as the set of competences employed in designing the model;
- simulation-based learning, understood as a means of exploring social and epidemiological phenomena.

This integrated perspective makes it possible to analyze the project both as a technical artefact and as an educational tool that fosters reflection, digital competences, and inquiry-based practices.

2. Case Study Context

In the 2020/2021 school year, when the education system operated almost entirely in a remote mode, students worked with limited contact with teachers and peers, which required greater independence in planning and completing learning tasks. Research shows that the pandemic acted as a catalyst for the rapid digital transformation of schools and stimulated interest in pedagogical models emphasizing learner activity, creativity, and the construction of digital artefacts (Hodges et al., 2020; Bozkurt & Sharma, 2020). In many countries, project-based work and technology-supported initiatives were among the few elements that positively influenced students' motivation and engagement during remote learning (European Schoolnet, 2021; Konin.pl, 2020).

Against this backdrop, the nationwide InfoSukces IT competition organized by Lodz University of Technology created an opportunity for students to develop independent digital projects. The competition task – designing a Scratch presentation or application related to pandemic-specific phenomena – aligned with constructionist principles that promote learning through the creation of artefacts (Papert, 1991; Ackermann, 2001). The evaluation criteria, which included originality, logical coherence, and educational value, reflected broader trends in combining creativity, reflective activity, and computational thinking in school-based projects (Brennan & Resnick, 2012; Levin et al., 2025).

The aim of the student's project was to enable users to explore the relationships between human behavior and the dynamics of virus transmission in a self-service store. This was achieved by designing an interactive simulation that allowed users to modify social conditions within the store environment and observe how these changes influenced the spread of the virus. The author of the analyzed project was a fourteen-year-old student attending school remotely, which meant that the work had to be planned and carried out independently – a pattern consistent with research emphasizing the increased importance of self-regulation during remote learning (Dumont et al., 2021; Długosz, 2022). Working in Scratch enabled her to combine programming knowledge with intuitive insights about social behaviors observed during the pandemic. The process of translating personal experiences into an educational model aligns with constructionist approaches that view artefacts as externalizations of learners' understanding of the world (Papert, 1993; Resnick, 2017).

The project received second place in the competition, confirming both its technical quality and conceptual strength. The student published the simulation on the Scratch platform, allowing other users to experiment with variables and explore the outcomes of different scenarios – a practice aligned with the constructionist idea of learning by sharing artefacts (Resnick, 2017) and with inquiry learning, which emphasizes experimentation and hypothesis testing in simulated environments (de Jong & van Joolingen, 1998; Fukuda et al., 2022).

3. Research Methodology

This study was conducted within a qualitative paradigm using a case study design, which makes it possible to examine a complex educational phenomenon within its natural context (Crowe et al., 2011). A single-case approach was selected, with embedded units of analysis comprising the Scratch application, the competition documentation, and the retrospective interview data. Given that, the boundaries between the phenomenon under study (the simulator project) and its

context (the pandemic and remote learning) were inherently blurred, this method was particularly appropriate (Yin, 2014).

Data Sources and Their Role in the Analysis

Three categories of data were used in the analysis, as summarized in Table 1. Their triangulated use allowed for the comparison of information from multiple sources and strengthened the credibility of the findings (Yin, 2014).

Table 1.
Data sources and their role in the analysis

Type of data	Description	Role in the analysis
Artefact – Scratch project	Program code, system logic, sprite structure, simulation mechanics	Reconstruction of the model design process; identification of design decisions and elements of computational thinking
Competition documents	InfoSukces regulations, evaluation criteria, submission requirements	Situating the project within its institutional context; analysing constraints and expectations shaping design choices
Retrospective semi-structured interview	A 30-minute recorded and transcribed interview with the project author	Eliciting information about motivations, strategies, project iterations, and reflections on the learning process

S o u r c e: Own work.

Artefact Analysis

The artefact analysis focused on the structure of the Scratch code, the relationships between modules, and the implementation of agent movement, interactions, and randomness. Particular attention was given to design decisions reflecting computational thinking practices such as decomposition, iteration, and the use of loops and conditionals (Brennan & Resnick, 2012). Key technical components of the program are presented in Appendix B.

Document Analysis

The competition documentation was examined with regard to its objectives, project requirements, and evaluation criteria. This analysis made it possible to understand the institutional expectations that may have influenced both the scope and form of the developed simulation.

Retrospective Interview

The interview with the project author followed a semi-structured format, enabling flexible exploration of themes related to motivation, conceptual development, and the progression of programming iterations (Kvale, 2007). The analysis was conducted using thematic coding, which helped identify key areas: motivations and project context, the workflow and creative process, strategies for coping with difficulties, an examination of design choices, and broader reflections on the

significance of the project. The full list of interview questions is provided in Appendix A.

Process Tracing

Elements of process tracing were also employed to reconstruct the sequence of design decisions – from the initial concept, through iterative coding and testing, to the final version of the simulation (Collier, 2011). This approach made it possible to capture the mechanisms underlying each stage of artefact creation and to understand how they contributed to the student's developing skills.

4. Results and Discussion

4.1. Analysis of the Artefact and Design Structures

An analysis of the Scratch application shows that the student designed a simulation in which agents (store customers) move autonomously, interact with one another, and generate events that lead to the spread of the virus. The logical layer of the model reveals the use of key computational thinking practices: decomposing the process into modules (movement, infections, interactions), employing loops and conditionals, operating with variables, and introducing randomness (Brennan & Resnick, 2012; Wing, 2006).

The project "Coronavirus in the Store" (Fig. 1) was developed in Scratch 3.0. The structure of the program is built around four main modules corresponding to the logic of the simulation: customer (agent) movement, infections and virus particles, interactions and infection conditions, and the user panel with result visualization. The key technical components of the program are presented in Appendix B.

The simplified agent-based simulation created by the student reflects characteristic features of emergent models, in which global outcomes (e.g., the number of infections) arise from the collective behaviour of individual agents operating according to simple rules (Railsback & Grimm, 2019; Ormazábal et al., 2021). The choice of such a structure suggests an intuitive recognition of the properties of complex social systems on the part of the student.

The program code embodies computational thinking through:

- the decomposition of the epidemiological phenomenon into agents, movement, and interactions;
- the use of loops, variables, conditionals, and randomness as tools for representing processes;
- iterative testing and refinement of the code consistent with engineering practices.

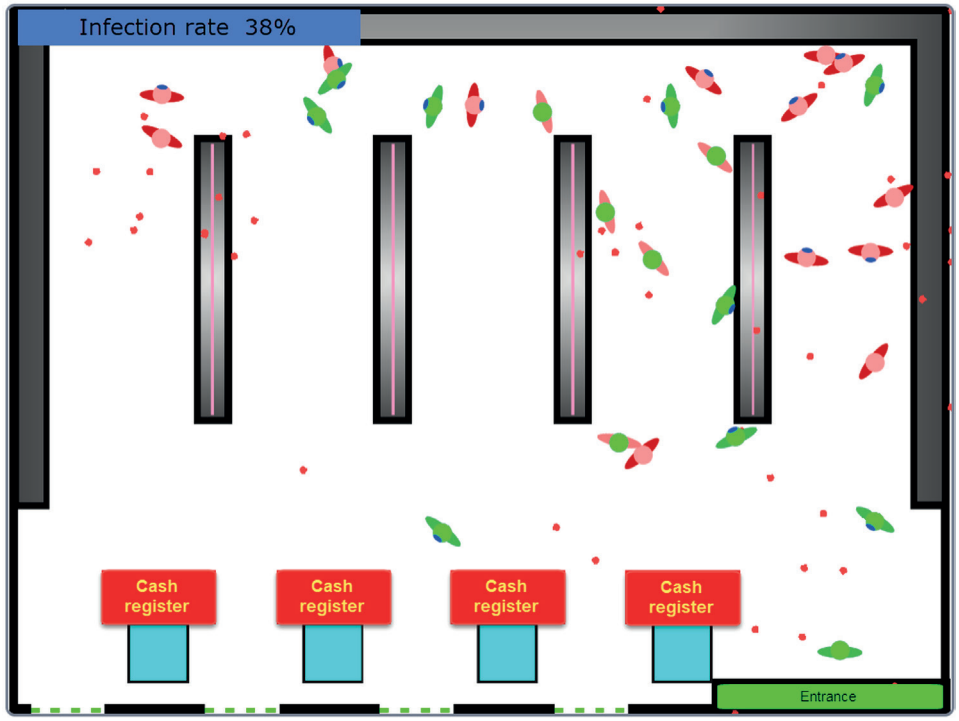

Figure 1. View of the simulation environment.

S o u r c e: Own work.

From a constructionist perspective, creating this program constituted a form of learning through action: the author explored epidemiological, computational, and social concepts by transforming them into a material artefact. Each block of code became a locus of reflection on reality, while choosing a parameter value was, in effect, a research decision.

From the standpoint of educational simulations, the program implements core principles of inquiry-based learning (de Jong & van Joolingen, 1998): the user can manipulate parameters, observe the outcomes, and draw inferences. An additional strength of the project is that it was conceived from the outset as a game, which elicits specific user behaviours and stimulates cognitive and exploratory engagement. The user independently observes causal relationships, confronting their own decisions (e.g., number of people in the store, assigning masks to healthy or infected customers) with the resulting epidemiological effects. This distinctive approach to the competition task aligns with inquiry-based simulation learning, in which hypothesis testing leads to conclusions grounded in model results (Zhang, 2025). The model itself functions as a constructionist artefact: in designing it, the student encoded her social and health-related intuitions into the logic of the simulation.

The artefact analysis thus confirms that the project is a coherent example of multi-agent modelling in an educationally friendly environment and is fully aligned with the ideas of digital constructionism.

4.2. Document Analysis

The analysis of the InfoSukces competition regulations, issued by Lodz University of Technology and the Regional Board of Education in Łódź, situates the project within a broader institutional and didactic context. The competition was national in scope and targeted students in grades 7–8 of primary school. Its aims included developing students' interest in computer science, promoting logical thinking, and encouraging creative use of information technologies. The document analysis highlighted several key aspects:

1. Aims and rationale of the competition: InfoSukces is consistent with educational constructionism in that it promotes the creation of original digital artefacts rather than the reproduction of content. The evaluation criteria (originality, aesthetics, functional logic, and use of Scratch) placed strong emphasis on creativity, independence, and the practical application of computing skills.
2. Theme and requirements: in the 2020/2021 edition, the pandemic theme granted the projects a social and emotional dimension. The task was to create a project that addressed the problem of the pandemic in the form of an educational program or presentation.
3. Evaluation system: projects were assessed according to three main criteria: programming effort, quality of visual design, and originality of the idea. This balanced focus on technical, visual, and conceptual aspects encouraged design thinking rather than merely checking for technical correctness.

4.3. Analysis of the Semi-Structured Interview Transcript

The interview had a retrospective character, was conducted in person, and lasted 30 minutes. Its analysis made it possible to reconstruct the student's learning process in alignment with the stages embedded in the research instrument. The author indicated that her main motivation for creating the simulator was the need for an intellectual challenge and the desire to apply skills acquired earlier in a programming course.

During the project, she employed practices consistent with the idea of learning by making. She described planning her actions independently, using loops and randomness in the code, and iteratively testing the program while adding new functionalities such as improved graphics and sound effects. The process was highly autonomous – she analysed errors on her own and searched for solutions. This

supports the claim that a constructionist approach can foster both computational thinking and persistence in problem-solving (Brennan & Resnick, 2012).

The student also reported that, although the pandemic period was emotionally difficult, the work on the project itself was not associated with negative emotions; on the contrary, it was a source of satisfaction and a sense of agency. She noted that programming demands concentration and solitary work, which meant that isolation did not hinder but rather naturally accompanied the creative process. This observation echoes Gee's (2003) contention that virtual environments can provide "safe spaces" for experimentation and knowledge construction under conditions of social distancing.

On the social level, the author acknowledged that the simulator had an educational purpose and reflected knowledge circulating in the media at the time – concerning masks, physical distancing, and group size. The goal was to illustrate that these factors have a tangible impact on the pace of infections. She also emphasised that she did not aim to achieve scientific fidelity to real epidemiological processes, but rather to build a "conceptual schematic". Despite this awareness, the project had a social dimension: it was shared with peers, enabling joint experimentation and conversations about the consequences of pandemic-related behaviours.

The choice of a self-service store as the simulation environment was motivated by its universality and the relative ease of modelling processes taking place there. The selection of parameters (number of people, distance, masks) reflected their prominence in public discourse, pointing to an intuitive transfer of social knowledge into programming logic.

4.4. Process Tracing

The retrospective interview showed that the project evolved in a cyclical manner, consistent with the iterative model described in constructionist literature: create–test–improve (Papert, 1991; Resnick, 2017). The student began with a sketch-like model and then systematically extended it by adding new mechanisms, such as masks, different types of customers, random events, and an infection counter.

Each iteration was driven by observing how the model behaved and identifying problems. For example:

- when infections spread too quickly, she introduced a mask protection coefficient;
- when agent movement appeared chaotic, she added direction planning and collision constraints;
- when interpreting the results proved difficult, she expanded the counters and simplified the user interface.

This iterative approach corresponds to constructionist practices in which learners test hypotheses by modifying an artefact and learning from errors (Harel &

Papert, 1991; Levin et al., 2025). At a certain point, the project reached a level of complexity that exceeded the technical capabilities of the environment, which the student interpreted as evidence of her own progress. This reflection suggests that technological limits can act as a learning milestone – a moment when learners become aware of both their competencies and the constraints of the tool (Wing, 2006).

Based on the analysis of the code and the student's narrative, a set of actions corresponding to the three dimensions of computational thinking (CT) proposed by Brennan and Resnick (2012) was identified:

Computational concepts

The student built a model based on variables, random functions, conditionals, and loops controlling agent behaviour. This not only allowed her to construct the logic of the simulation but also to understand parametric dependencies – such as the impact of the number of customers or mask usage on system behaviour.

Computational practices

The project involved typical practices such as iterative modification, debugging, scenario testing, and exploring edge cases. The test–refine cycle, central to constructionism, was particularly evident.

Computational perspectives

The student's statements indicate that the project enabled her to consciously connect social observations with model logic – what the literature describes as the development of model-based reasoning in simulation environments (de Jong & van Joolingen, 1998; Wen et al., 2020). She noted that she understood "why the model behaves in one way and not another" and could observe the consequences of parameter changes, which supported her understanding of causal relationships.

An examination of how empirical data were linked to the findings shows that:

The artefact (code and program logic)

- made it possible to determine which elements of the model required specific programming and logical practices;
- enabled the identification of structures that support CT, such as loops, variables, conditionals, and events.

The interview

- confirmed that code iterations were conscious educational decisions (e.g., "I changed the model because infections were rising too fast");
- revealed the student's motivations and her understanding of her own learning process.

The competition documents

- clarified why the student chose a simulation as the project format (criteria of originality and educational value);
- enriched the analysis with the institutional context.

Triangulation thus made it possible to compare what the student declared with what she actually encoded, thereby strengthening the credibility of the results (Yin, 2014).

4.5. Comparison with Previous Research

The findings of this case study are consistent with the literature indicating that project-based and constructionist approaches can be effective even under remote learning conditions. The student worked independently, demonstrating high levels of motivation and engagement, which aligns with studies showing that, during the pandemic, students perceived projects as one of the most engaging forms of work (Konin.pl, 2020; European Schoolnet, 2021). Similar conclusions have been drawn by teachers involved in eTwinning projects, who reported that project work improved the organization of teaching and increased the attractiveness of learning materials (Kaya & Bagçeci, 2025).

In line with research on remote programming education, the case shows that projects implemented in visual environments support the development of digital competences and computational thinking. The student developed both programming concepts and iterative design practices, in accordance with the theoretical framework proposed by Brennan and Resnick (2012). These results are consistent with experimental studies demonstrating that project-based approaches to teaching programming can be effective online, provided that students have access to appropriate tools and tasks (Amnouychokanant et al., 2021). European research reviews also indicate that distance teaching of computer science requires close collaboration among teachers and deliberate use of digital media (Skaraki & Kolokotronis, 2022).

The findings also resonate with broader observations on remote education, which emphasize that active, learner-centred methods can counteract declines in motivation and learning quality frequently reported during lockdowns (Konin. pl, 2020; Długosz, 2022). Projects grounded in real-world problems enhanced students' sense of agency, which has been identified as a key factor in mitigating typical challenges associated with distance learning. European initiatives such as eTwinning had already shown that digital projects can foster not only technical skills but also collaboration, creativity, and problem-solving (Saab et al., 2011; Kaya & Bagçeci, 2025). Our case confirms that visual environments such as Scratch can serve as effective tools for developing these competences even under conditions of full isolation.

At the same time, several differences between this case and previous studies should be noted. First, the project emerged from strong internal motivation and the structural support of a competition, whereas many pandemic-era studies highlight students' difficulties with autonomy and sustained engagement in online work, especially among younger learners (Czerniewicz et al., 2020; Dumont et al., 2021). Second, most existing research on educational projects is descriptive in nature, and there is a lack of experimental evidence demonstrating their superiority over traditional methods in school settings (Skaraki & Kolokotronis, 2022). Third, relatively few studies examine the role of post-project reflection, even though research from other domains – including medical education – suggests that debriefing may be crucial for the durability of learning outcomes.

In summary, the results of this study align with dominant trends pointing to the substantial value of project-based learning and constructionism in remote education. At the same time, they underscore the need for further research involving larger groups of students and diverse contexts, as well as longitudinal analyses, to determine the extent to which the observed effects are generalizable or are specific to the conditions of a single case (Długosz, 2022).

5. Synthesis of Findings and Key Conclusions

The analysis of the interview, competition documentation, and the programming artefact indicates that designing the simulation in Scratch functioned as an example of learning through making, fully aligned with constructionist principles. The student demonstrated the ability to independently plan subsequent stages of work, solve technical problems, and iteratively refine the model – skills reflected both in the structure of the code and in her descriptions of the project's development process. These practices correspond to core elements of computational thinking, such as decomposition, testing, and step-by-step improvement.

The findings also show that even simple programming environments can meaningfully support the development of digital and computational competences when the project presents learners with authentic challenges and enables them to explore phenomena through simulation (see also: Montiel & Gómez-Zermeño, 2021). Working with an agent-based model allowed the student to engage with causal and parametric relationships, encouraging analysis and reflection on how her design functioned – without attempting to replicate real epidemiological processes.

Practical Recommendations

In light of the evidence gathered, the study suggests that simulation-based projects can be a valuable component of remote and hybrid learning. The crea-

tion of a functioning artefact fostered technical, logical, and organisational skills, while also cultivating habits of iterative work. Such forms of activity may increase student engagement and participation in the learning process. Moreover, incorporating structured reflection and discussion after simulation-based experiments (debriefing) is advisable, as research in medical education shows that this phase strengthens learning outcomes (Elendu et al., 2024). These conclusions align with previous analyses emphasising the utility of project-based approaches in digital learning environments.

Limitations

The single-case nature of the study limits the generalisability of its findings. The project represents an individual example rather than a pattern that can be assumed to apply to all student-created simulations. The absence of quantitative data – such as user statistics or system logs – prevents a fuller assessment of how the project may have influenced learners' attitudes or behaviours. Additionally, the retrospective interview may be subject to memory bias, and the simulation itself, despite its didactic value, did not account for many real epidemiological factors, which constrains its scientific precision – though achieving scientific accuracy was not its intended purpose.

Directions for Future Research

The findings point to the need for expanding research to include a greater number of student-created simulations across diverse school and regional contexts, allowing for comparative analyses of design strategies and educational outcomes. Future work could incorporate quantitative studies, including experimental designs in which classes engaging in simulation tasks are compared with control groups – in order to assess the impact of such activities on digital competences and conceptual understanding. Longitudinal studies would also be valuable to determine whether experience with simulation design influences later achievement in STEM subjects. Another promising direction involves integrating emerging technologies – such as artificial intelligence, machine learning, or real-world datasets – to explore their potential impact on learner engagement and learning effectiveness.

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Appendix A.

Interview questions covering the main thematic areas

1. Motivations and the context of the project's creation
- What inspired you to create a simulator for the competition?
- How did you perceive the significance of the pandemic theme in the context of your own life and learning?
- What emotions accompanied you while working on the project during the period of social isolation?

2. Work process and creative development
- How did you plan the project – from the initial idea to its implementation?
- What sources did you use (materials, consultations, videos, online examples)?
- Which tools and elements of Scratch did you use most frequently?
- How did you cope with technical problems and bugs in the code?

3. Difficulties and problem-solving strategies
- What was the most challenging aspect of creating the simulator?
- What strategies did you use to overcome these challenges?
- Did anyone assist you in solving problems (teacher, peers, online forums)?

4. Analysis of design decisions (process tracing)
- Why did you choose a self-service store as the environment for the simulation?
- How did you decide which parameters (e.g., number of customers, masks, distancing) were most important?
- How did you test the effectiveness of the simulator?
- What changes or improvements did you introduce in successive iterations of the project?
- What led you to select the final version submitted to the competition?

5. Reflections and significance of the project
- What did you learn through creating this project – both technically and personally?
- In your view, how did the simulator affect other students or users?
- How do you assess the significance of this project for your own development today?

Appendix B.

Key Program Modules

1. Customer Movement Module

Each customer is an independent object (sprite) moving randomly within the store space (Fig. 1). Movement is implemented using a set of control blocks: forever, move X steps, and if on edge, bounce. The direction is periodically randomized – every few cycles, the program selects a new direction (point in direction (pick random 0–360)). Collision-avoidance conditions are included: if another customer is detected within a predefined distance, the agent adjusts its path. This module illustrates computational thinking through the decomposition of the problem into units (agents) and the implementation of algorithms and control loops (Brennan & Resnick, 2012).

2. Infection Module

A portion of the customers is designated as initial virus carriers according to a starting parameter chosen by the player (Fig. 2). Their behaviour includes random events: within a forever loop, the instruction if (random < probability of sneezing) → show virus particles is executed. Each virus particle is a separate sprite that moves for a defined period (repeat N times → move K steps), after which it disappears (hide). The particle's lifetime simulates the limited viability of the virus. Global variables (lifetime, number of infected) are used to update interface indicators. This module demonstrates the application of conditionals and randomness – key components of computational thinking – and a simplified representation of probabilistic processes.

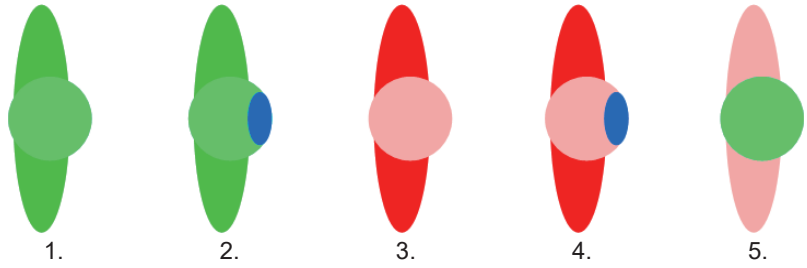

Figure 2. Types of agents (customers) in the simulation.

Note: **1** – healthy without a mask; **2** – healthy with a mask (added by the player); **3** – infected without a mask; **4** – infected with a mask (added by the player); **5** – healthy individual infected during the simulation.

S o u r c e: Own work.

3. Interaction and Infection Module

Infection occurs when a virus particle touches another agent without a mask. The module uses a collision-based condition (if touching [customer] and [mask = false] → set [infected = true]). The probability of infection is modified by mask usage (if mask = true → random < 10%, if mask = false → random < 40%). This module combines conditional event control with probabilistic reasoning and randomness. Interactions between agents form a simplified multi-agent model that illustrates principles of emergent modelling, in which global patterns arise from local rules (Railsback & Grimm, 2019).

4. User Panel and Results Module

The user panel contains variables and counters (number of infected individuals, number of healthy individuals, percentage of mask usage). Users may manipulate parameters through buttons or input variables (change number of customers, add masks). The simulation outcome (infection rate) is updated in real time and displayed at the top of the screen. Visual elements (colours, messages, animations) and auditory cues (recorded sneezing and coughing samples) reinforce the didactic effect and enhance user engagement with causal observation.

Figure 3. Overview of a fragment of the simulation code.

S o u r c e: Own work.

5. Logic and Dependencies in the Code

The entire program is built on the interaction of infinite loops and conditional statements, creating a dynamic system responsive to randomness and agent interactions (Fig. 3). The hierarchy of events unfolds as follows:

1. Starting the game triggers the creation of agents (when green flag clicked).
2. Each agent acts independently within a forever loop.
3. Unmasked infected agents generate virus particles at set intervals.
4. Virus particles check for collisions with unmasked customers and update their infection status.
5. A global variable tallies the total number of infections.
6. Results are presented to the user in real time.

The mechanics combine elements of determinism (movement modelling), randomness (sneezing events), and interaction (encounters within the store), enabling the user to observe correlations between simulation settings and outcomes (Wen et al., 2020).

Maria Wisniewska, Zbigniew Wisniewski

Symulacja rozprzestrzeniania się wirusa oparta na języku Scratch jako konstruktywistyczny projekt e-learningowy

S t r e s z c z e n i e

Artykuł przedstawia jakościowe studium przypadku projektu symulacyjnego stworzonego w środowisku Scratch przez uczennicę szkoły podstawowej w okresie nauczania zdalnego. Celem badania jest analiza, w jaki sposób projektowanie prostego modelu agentowego w wizualnym środowisku programowania może wspierać rozwój kompetencji cyfrowych i komputacyjnych. Analiza opiera się na trzech źródłach danych: artefakcie stworzonym w Scratch, dokumentacji konkursowej oraz retrospektywnym wywiadzie półustrukturyzowanym z autorką projektu.

Wyniki wskazują, że konstruowanie symulacji sprzyjało rozwijaniu kluczowych praktyk myślenia komputacyjnego – takich jak dekompozycja, iteracyjne udoskonalanie oraz rozwiązywanie problemów – a także umożliwiło uczennicy eksplorację zależności przyczynowo-skutkowych w ramach uproszczonego modelu. Projekt pokazuje, że dostępne środowiska programowania mogą skutecznie wspierać uczenie się konstrukcjonistyczne, angażując uczniów w projektowanie i testowanie działających artefaktów. Wyniki sugerują również, że projekty oparte na symulacjach mogą wzbogacać edukację zdalną i hybrydową, oferując możliwości aktywnego eksperymentowania i refleksyjnej analizy.

Głównym ograniczeniem badania jest jego jednostkowy charakter, który zawęża możliwość uogólniania wniosków. Wymagane są dalsze badania porównawcze i długofalowe, aby ocenić szerszy wpływ edukacyjny symulacji tworzonych przez uczniów.

S ł o w a k l u c z o w e: konstrukcjonizm, Scratch, nauczanie zdalne, myślenie komputacyjne, kompetencje cyfrowe, kompetencje obywatelskie

A Scratch-Based Simulation of Virus Spread as a Constructionist E-Learning Project

Maria Wisniewska, Zbigniew Wisniewski

Una simulación de la propagación de un virus en Scratch como proyecto e-learning construccionista

Resumen

Este artículo presenta un estudio de caso cualitativo sobre un proyecto de simulación desarrollado en Scratch por una estudiante de educación primaria durante el periodo de aprendizaje remoto. El objetivo del estudio es analizar cómo el diseño de un modelo basado en agentes en un entorno de programación visual puede favorecer el desarrollo de competencias digitales y de pensamiento computacional. El análisis se basa en tres fuentes de información: el artefacto creado en Scratch, la documentación del concurso y una entrevista retrospectiva semiestructurada realizada a la autora del proyecto.

Los resultados muestran que la construcción de la simulación permitió a la estudiante desarrollar prácticas clave del pensamiento computacional – como la descomposición, la mejora iterativa y la resolución de problemas – y explorar relaciones causales dentro de un modelo simplificado. El proyecto demuestra cómo los entornos de programación accesibles pueden facilitar el aprendizaje construccionista al involucrar al alumnado en el diseño y prueba de artefactos ejecutables. Asimismo, los resultados sugieren que los proyectos basados en simulaciones pueden enriquecer el aprendizaje remoto e híbrido, ofreciendo oportunidades para la experimentación activa y el análisis reflexivo.

La principal limitación del estudio es su naturaleza de caso único, lo que restringe la posibilidad de generalizar las conclusiones. Se requieren estudios comparativos y longitudinales adicionales para evaluar el impacto educativo más amplio de las simulaciones creadas por estudiantes.

Palabras clave: construccionismo, Scratch, enseñanza a distancia, pensamiento computacional, competencias digitales, competencias cívicas

Мария Вишневска, Збигнев Вишневски

Симуляция распространения вируса в среде Scratch как конструкционистский e-learning-проект

Аннотация

В статье представлен качественный кейс-стади проекта симуляции, созданного в среде Scratch ученицей начальной школы в период дистанционного обучения. Цель исследования – проанализировать, каким образом разработка простейшей агентной модели в визуальной программной среде может способствовать развитию цифровых компетенций и вычислительного мышления. Анализ опирается на три источника данных: созданный в Scratch артефакт, документацию конкурса и ретроспективное полуструктурированное интервью с автором проекта.

Полученные результаты показывают, что процесс конструирования симуляции помог учащейся развить ключевые практики вычислительного мышления – такие как декомпозиция, итеративное совершенствование и решение проблем – а также исследовать причинно-следственные связи внутри упрощённой модели. Проект демонстрирует, что доступные визуальные программные среды могут эффективно поддерживать конструкционистский подход, вовлекая учащихся в создание и тестирование работоспособных артефактов. Кроме того, результаты

свидетельствуют о том, что симуляционные проекты могут обогащать дистанционное и гибридное обучение, предоставляя возможности для активного экспериментирования и рефлексивного анализа.

Основным ограничением исследования является его характер единичного кейса, что сужает возможности обобщения выводов. Для оценки более широкого образовательного эффекта студенческих симуляций необходимы дальнейшие сравнительные и лонгитюдные исследования.

К л ю ч е в ы е с л о в а: конструкционизм, Scratch, дистанционное обучение, вычислительное мышление, цифровые компетенции, гражданские компетенции

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Through University Students' Headsets: To Immerse or Not to Immerse in New Learning Experiences

Abstract

Integrating technology-enhanced resources and activities into university curricula necessitates a restructuring of teaching programmes. To achieve a synergistic effect, conventional methods should be replaced with active learning approaches that provide students with innovative, engaging, and collaborative ways of building knowledge suited to contemporary society. Virtual reality (VR) is among the technological innovations expected to transform education into interactive and immersive learning environments. This paper investigates whether integrating VR into university courses can, in students' opinions, increase their interest in a deeper understanding of complex phenomena, and whether it may translate into greater engagement and improved achievement of learning outcomes. The challenges of implementing such instructional design are examined through an analysis of survey responses from bachelor's and master's students at Gdańsk University of Technology (Gdańsk Tech), collected in June and July 2025.

K e y w o r d s: virtual reality, VR, education, effectiveness, VR applications, educational outcomes

Introduction

Incorporating technology-enhanced resources and activities into a university curriculum involves restructuring the teaching programme to achieve a synergistic effect. Recent advances have enabled educators to move from instructivist approaches towards constructivist ones, fostering interactive, immersive, collaborative, and student-centred learning in contexts that were previously unavailable – now created through the affordances of the functionalities offered by digital environments. Technology alone will not change teachers' and students' perceptions of potential educational benefits. Its effective use to enhance learning opportunities requires understanding its added value and embracing novelty, which often involves attitude change and open-mindedness.

The paper aims to investigate whether redeveloping university curricula to include immersive experiences can increase students' interest in classes enhanced in this way, based on their perceptions of such changes. It further explores if their attitude can translate into greater engagement and improved achievement of intended learning outcomes. The challenges of such instructional design are examined through the analysis of responses from bachelor's and master's students of science and engineering at Gdańsk University of Technology (Gdańsk Tech), collected via a survey conducted in June and July 2025. The discussion is supported by both qualitative and quantitative research findings. The following research questions were addressed:

- To what extent are technically-minded students willing to embrace VR in their university courses? (RQ1)
- To what extent do technically-minded students believe that VR can help them retain knowledge and better understand complex issues? (RQ2)
- To what extent do technically-minded students believe that VR-enhanced classes can increase their engagement and motivation to learn? (RQ3)
- How do technically-minded students perceive the likelihood that VR will become a widely used teaching tool in university-level education over the next five years? (RQ4)
- To what extent does VR experience impact students' attitude to the adoption of VR-enhanced classes? (RQ5)

Virtual Reality in University Education

In the literature, various definitions of virtual reality (VR) can be found, with some emphasising either technical aspects or interactive experiences. To combine

both perspectives, VR can be understood as the use of computer modelling and simulation to create computer-generated environments that immerse the user by replicating certain aspects of the real world through multi-sensory and dynamic experiences, which enable lifelike encounters. VR applications typically employ devices such as headsets, goggles, gloves, or body suits that transmit and receive information, allowing users to view three-dimensional simulated environments and manipulate virtual objects through force-feedback technologies.

Lampropoulos et al. (2022) claim that the release of consumer devices such as Oculus Rift, HTC Vive, and PlayStation VR in 2016, along with the growth of gaming applications, boosted public interest in VR technology. They support their findings with an analysis of tweets in which they found a number of positive emotions such as anticipation, trust, and joy in relation to VR; however, they also saw many neutral remarks, suggesting that the potential benefits of these technologies were not yet widely recognised by the public at that time. Notwithstanding similar positive expectations shared by the university community, VR technology has not yet become a widely used educational environment (AlGerafi et al., 2023, p.7) – the reasons being different.

VR applications can be used in a variety of ways to support learning of different subjects. They can simplify the understanding of abstract concepts and intricate solutions in a physical environment, thus allowing students to engage in experiences that would be otherwise challenging or difficult to achieve in a traditional classroom (Tekindur & Kara, 2025, p. 221; Lebiedź, 2024; Anjos et al., 2024; Merchant et al., 2014). According to Tekindur and Kara (2025, p. 221), and following the research by Avcı and Taşdemir (2019), employing three-dimensional models of molecular structures or using virtual simulations to replicate chemical reactions has been shown to enhance students' understanding of complex concepts in chemistry. Similarly, such technologies have been found to have supported experiential learning of core principles in the physics courses they investigated, such as Newton's laws of motion.

In line with Lampropoulos et al. (2025), Anjos et al. (2024), Bodzin et al. (2021) and Lampropoulos et al. (2022) another important reason for adopting VR in science education is its ability to make learning more engaging and flexible. By interacting with visual environments, students are believed to retain knowledge more effectively, deepen their understanding of scientific processes, and develop cognitive and practical skills (Almulqu et al., 2025; Sung et al., 2024; AlGerafi et al., 2023, p. 16). Therefore, VR seems to have a potential to transform, e.g., medical education by providing immersive learning experiences that support anatomy visualisation, surgical training, diagnostic simulations and collaboration, resulting in students developing a range of professional skills faster and earlier. A study at the University of Dundee, where students of varying experience levels explored 3D anatomical models in VR, showed promising results, with relatively high acceptance levels of such environments and performance results (AlGerafi et al., 2023,

p. 17; Erolin et al., 2019). Similarly, Kowalski et al., (2024) found that immersive experiences not only provide engaging learning environments for students of architecture, but also deepen their understanding of spatial concepts.

In addition, Mazhar and Al Rifaee (2023) report that their students showed high levels of satisfaction with classes implementing virtual reality technology, finding them to be a more enjoyable and immersive learning experience than traditional settings.

It is expected that in engineering education, VR can enhance student engagement, motivation, and performance while fostering key soft skills such as creativity, problem-solving, decision-making, and communication, looked for by employers (Mokwa-Tarnowska & Tarnowska, 2019, pp. 218-219), preparing them for future career demands. Moreover, compared to physical laboratories, it provides operational benefits, including lower construction costs, scalability, easier maintenance, reduced running costs and flexibility for adaptation and replication.

Bibliometric studies show that VR technology, to varying degrees of frequency, accessibility and complexity, has been featured in teaching science and education research since 2002. The results reveal a yearly increase in interest among educators, with most applications employing the constructivist paradigm (Tekindur & Kara, 2025, p. 229; Lampropoulos & Kinshuk, 2024).

However, research has also indicated several limitations to the wider adoption of VR in academic education, a key one being the high cost of the technology. Additionally, the requirement for specialized hardware and software can make its implementation challenging and maintenance demanding (Mazhar & Al Rifaee, 2023). Furthermore, the advanced IT skills needed to develop VR applications can restrict their use to universities of technology, whose staff are qualified to manage the technical demands and may be willing to incorporate them for pedagogical gain. Lastly, VR simulations can consume up to ten times more energy, thus raising environmental concerns (Mohammadi et al., 2025, p. 6).

From the student perspective, incorporating VR into instructional design presents challenges, including communication difficulties – as students usually use the environment alone; problems with object manipulation – since they must learn how to use the interface, which is not necessarily intuitive and can be time-consuming; and technical issues such as bugs and crashes – for which they will need support to avoid disruptions in their learning experience (AlGerafi et al., 2023, p. 23). Furthermore, it can have side effects as a result of prolonged use; yet few studies have examined possible health risks associated with VR (AlGerafi et al., 2023, p. 18).

Research Methodology

Data for this study were gathered through an online questionnaire accessible only to students of Gdańsk Tech via its website. The questionnaire comprised three questions using a nominal scale about the respondent's specialisation, level of study and experience with VR technology, with categorical variables not possessing inherent order, and fourteen questions using a five-point Likert-style scale, where respondents were instructed to rate their responses, facilitating a nuanced understanding of their opinions. One question with a request to provide comments was intended to collect deeper insights into the rationale behind their quantitative ratings, thus enriching the data collection process qualitatively. The nominal-scale questions were supposed to support the analysis of responses in relation to differences in VR experience, the degree of advancement in university education and the field of specialisation. To address the paper's objectives in relation to the research questions, the analysis focuses on the first part of the survey, comprising the initial eight questions.

To maintain the integrity of the study, all participants received the same set of questions and were tested under identical conditions. This approach ensures that the findings remain unaffected by variations in question content or testing circumstances. Participation in the questionnaire was restricted to 1st and 2nd degree students, who were notified about it via the university's managed learning environment. This selection criterion was applied to maintain methodological consistency.

Importantly, the questionnaire was intentionally designed not to request sociodemographic information from participants. This measure was taken to ensure the privacy and anonymity of the study's participants in line with ethical standards for data collection.

Quantitative data are presented as percentages. Statistical analyses were conducted using the Chi-Square Test of Independence to examine the association between participants' VR experience and their perception of the likeliness of using VR in future academic settings. Due to the presence of small expected cell counts in several contingency tables, a Monte Carlo simulation with 10,000 replicates was employed to provide a more robust estimation of *p-values.* Additionally, Fisher's Exact Test was applied as it is more appropriate for sparse data. Some of the results were considered statistically significant at $p<.05$ and others not with $p>.05$. All of them provided valuable insights into the potential value of VR-enhanced curricula. The statistical analyses were performed with RStudio.

Survey Results and Discussion

Altogether 169 students completed the questionnaire – 129 on a bachelor's course and 40 on a master's one. Their responses are divided by specialisation to capture diverse academic perspectives – Architecture, Biomedical Engineering, Chemistry, Civil Engineering, Computer Science, Electrical Engineering, Environmental Science / Engineering, Geodesy, Management and Economics, Material Science, Mechanical Engineering, Mathematics, Offshore Engineering / Ship Industry, Physics, Robotics, Telecommunication and Transport.

The data presented in Figures 1–19 were collected and analysed by the authors without support from external parties. Statistical analyses were conducted using RStudio. As there was only one MSc respondent with some coding experience, they were excluded from the experience–attitude analysis, as their data were treated as an outlier, significantly differing from other observations in the dataset. However, this respondent was included in the data shown in Figures 1–18, and their opinions were also taken into account. For clarity in the visualisations, specialisations represented by only one or two respondents in the case of BSc students were grouped under the label *Other*; these included Geodesy or Management and Economics or Material Science. Within the much smaller MSc group, the students themselves selected this category.

The data presented in Figures 1–20 were collected and analysed solely by the authors, without support from any external parties.

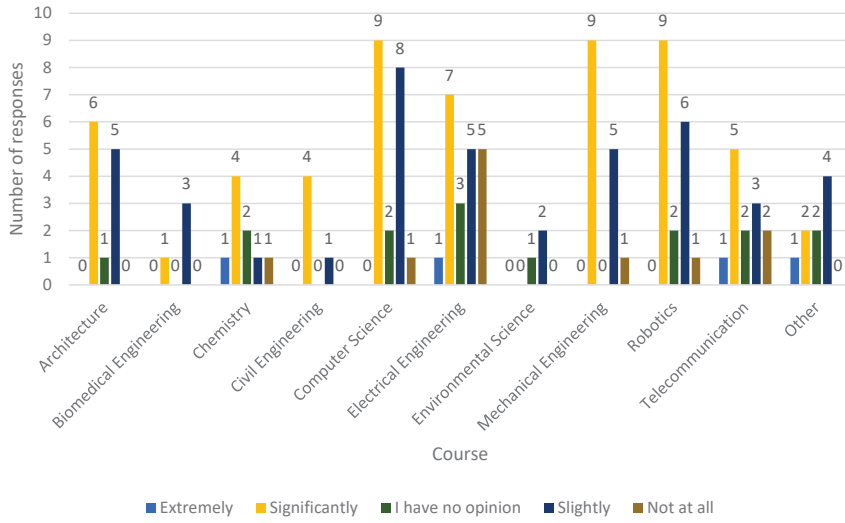

Figure 1. Bachelor's Students – VR and Understanding of Complex Academic Content

N o t e: Data collected and analysed by the authors.

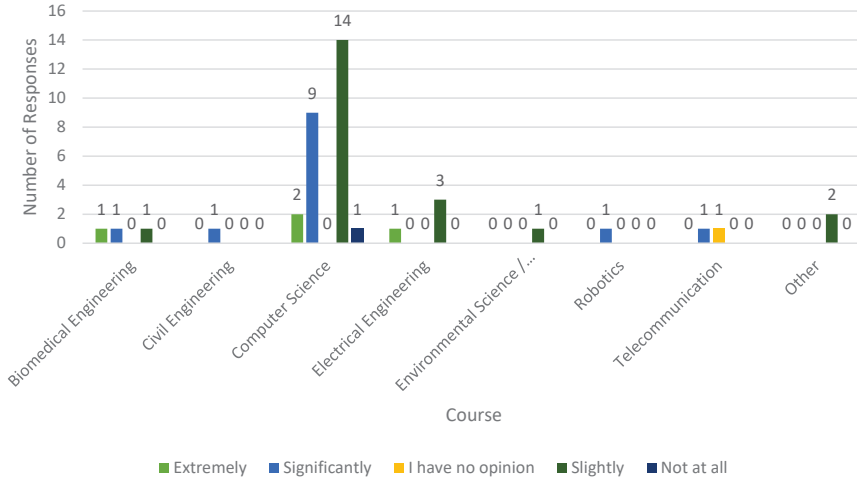

Figure 2. Master's Students – VR and Understanding of Complex Academic Content

N o t e: Data collected and analysed by the authors.

Figures 1 and 2 show how students perceive the potential of VR to enhance their understanding of complex academic content (RQ2). It appears that almost half of the respondents overall (45%), including both BSc and MSc students, believe that VR can help to a significant extent, with some variation across disciplines (e.g., BSc: 50% of Architecture, 56% of Chemistry, 80% of Civil Engineering, 45% of IT, 38% of Electrical Engineering, 60% of Mechanical Engineering, 50% of Robotics and 60% of Telecommunication; MSc: 42% of IT). Some students have no opinion (BSc: 11.6%, MSc: 2.5%), which means that almost the same proportion of bachelor's students (43.6%) and an even higher proportion of master's students (52.5%) think that the incorporation of VR will not contribute to them being able to gain a better understanding of complex issues related to their specialisation.

When it comes to retaining knowledge developed due to using VR-enhanced materials in class, addressed in RQ2, (Figs. 3 and 4), 55% of bachelor's students and 57.5% of master's students are of the opinion that using VR will be beneficial (e.g., BSc: 75% of Architecture, 67% of Chemistry, 60% of Civil Engineering, 45% of IT, 52% of Electrical Engineering, 67% of Mechanical Engineering, 50% of Robotics and 46% of Telecommunication; MSc: 61.5% of IT). Because slightly higher proportions of bachelor's and master's students do not have an opinion compared with the previous question – 18.6% and 7.5% respectively – a decrease in negative attitudes towards VR can be noticed (26.4% and 35%) if knowledge retention is taken into consideration.

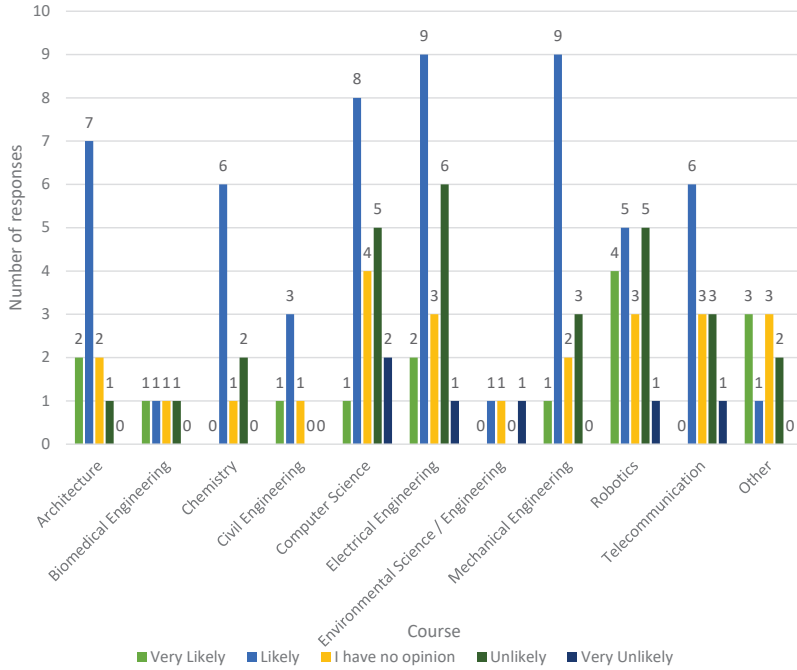

Figure 3. Bachelor's Students – VR and Knowledge Retention

N o t e: Data collected and analysed by the authors.

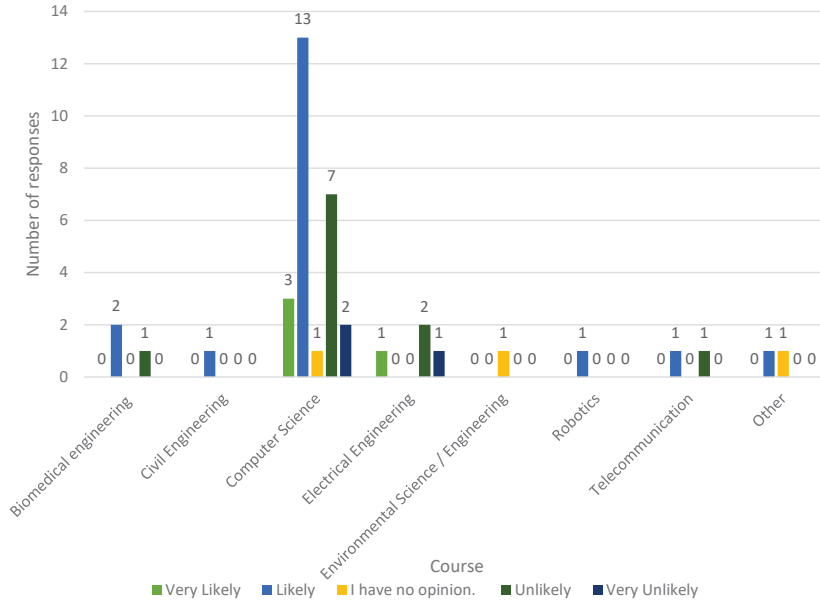

Figure 4. Master's Students – VR and Knowledge Retention

N o t e: Data collected and analysed by the authors.

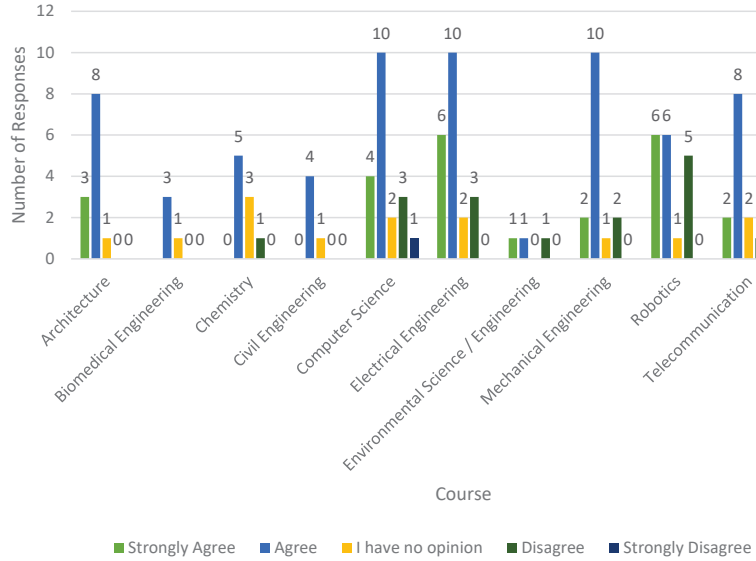

Figure 5. Bachelor's Students – Engaging Nature of VR

N o t e: Data collected and analysed by the authors.

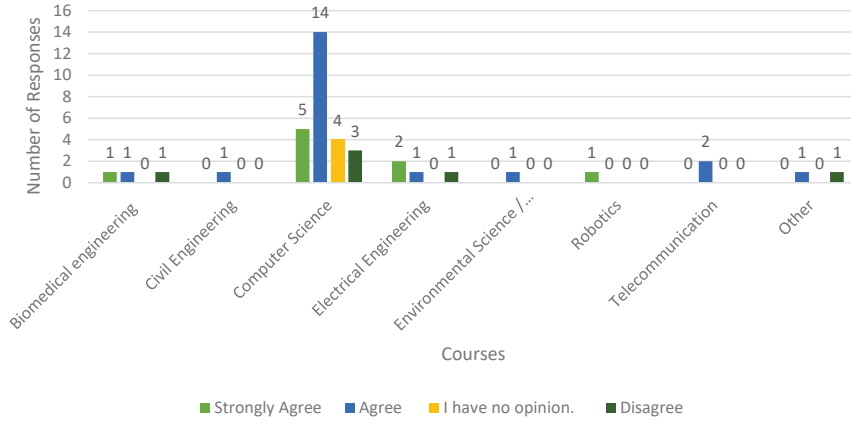

Figure 6. Master's Students – Engaging Nature of VR

N o t e: Data collected and analysed by the authors.

Figures 5 and 6 show students' high beliefs in the engaging nature of VR-based learning (RQ3). Unlike, the previous responses, which indicate a relatively low positive response towards VR, the answers about engagement, which are 74% and 75%, reflect more positive anticipation, with some variation across the sample (e.g., BSc: 92% of Architecture, 75% of Biomedical Engineering, 55.5% of Chemistry, 80% of Civil Engineering, 45% of IT, 76% of Electrical Engineering, 66.7% of

Environmental Engineering/Science, 80% of Mechanical Engineering, 66.7% of Robotics and 46% of Telecommunication; MSc: 73% of IT).

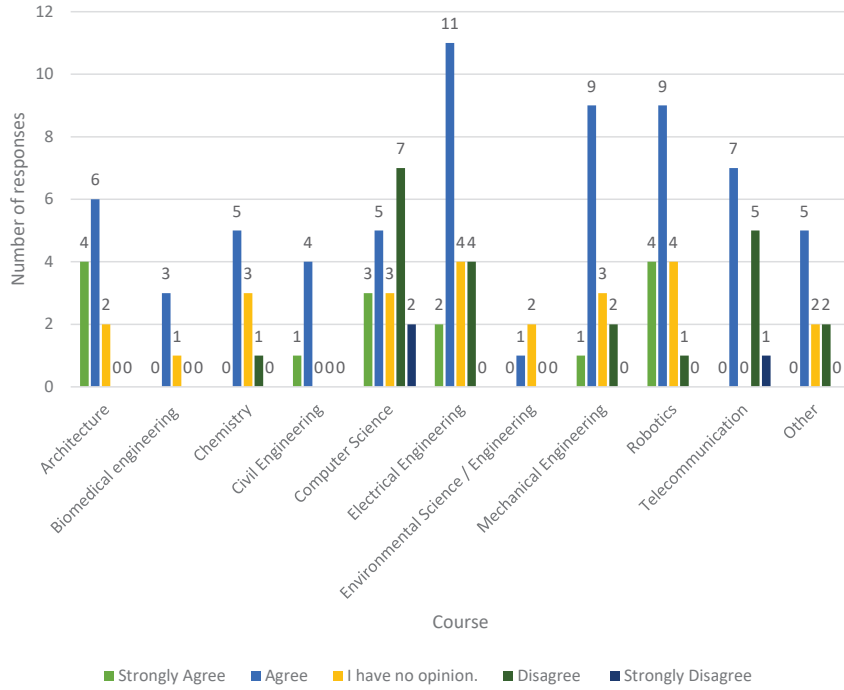

Figure 7. Bachelor's Students – VR and More Realistic and Immersive Experiences

N o t e: Data collected and analysed by the authors.

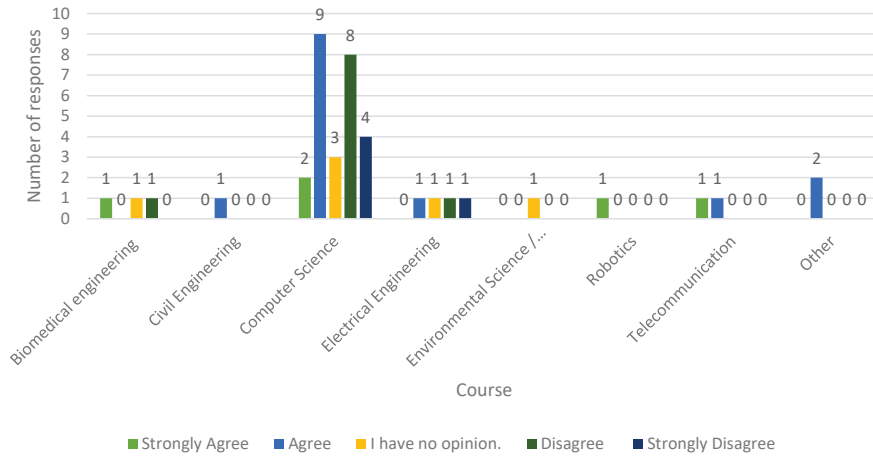

Figure 8. Master's Students – VR and More Realistic and Immersive Experiences

N o t e: Data collected and analysed by the authors.

As can be seen in Figures 7 and 8, overall bachelor's students expect VR-enhanced education to provide more realistic and immersive experiences than traditional classes – 62% and 47.5% respectively (RQ1). This can be explained by their earlier stage of professional development, which triggers high hopes, or their lower IT knowledge, which limits their understanding of VR possibilities (e.g., BSc: 83% of Architecture, 75% of Biomedical Engineering, 55.5% of Chemistry, 80% of Civil Engineering, 40% of IT, 62% of Electrical Engineering, 33.3% of Environmental Engineering/Science, 66.7% of Mechanical Engineering, 72% of Robotics and 54% of Telecommunication; MSc: 42% of IT). A relatively high number of BSc students (18.6%) and MSc students (12.5%) have no opinion. Twice as many master's students (40% and 19.4% respectively) do not perceive VR experiences as realistic or immersive.

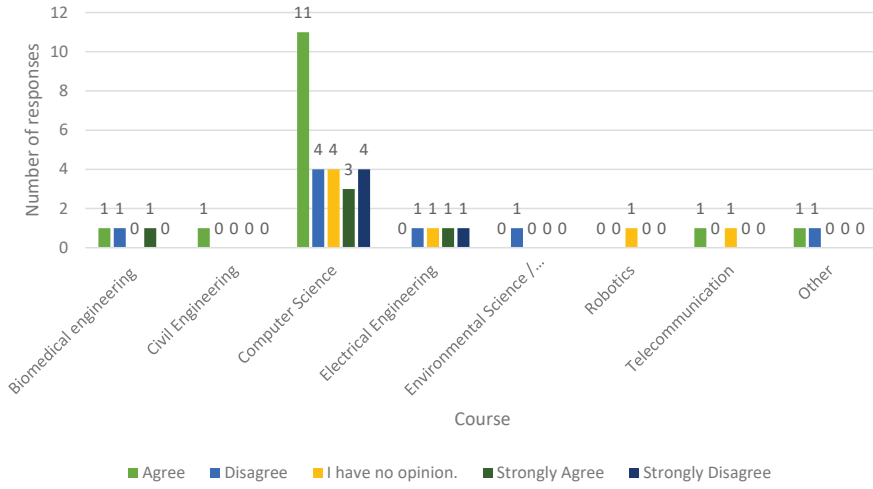

Figure 9. Bachelor's Students – VR and Motivation to Learn

N o t e: Data collected and analysed by the authors.

Generally speaking, as illustrated by the data in Figures 9 and 10, only about half of the respondents think that VR in academic settings can increase their motivation to learn (RQ3) – 51% of bachelor's students and 50% of master's students, showing minimal differences across specialisations (e.g., BSc: 50% of Architecture, 50% of Biomedical Engineering, 55.5% of Chemistry, 80% of Civil Engineering, 50% of IT, 43% of Electrical Engineering, 66.7% of Environmental Engineering/Science, 40% of Mechanical Engineering, 55.5% of Robotics and 54% of Telecommunication; MSc: 53.8% of IT). Almost a quarter of BSc students (24.2%) and nearly a third of MSc students (32.5%) are of the opinion that VR will not positively affect their motivation to learn.

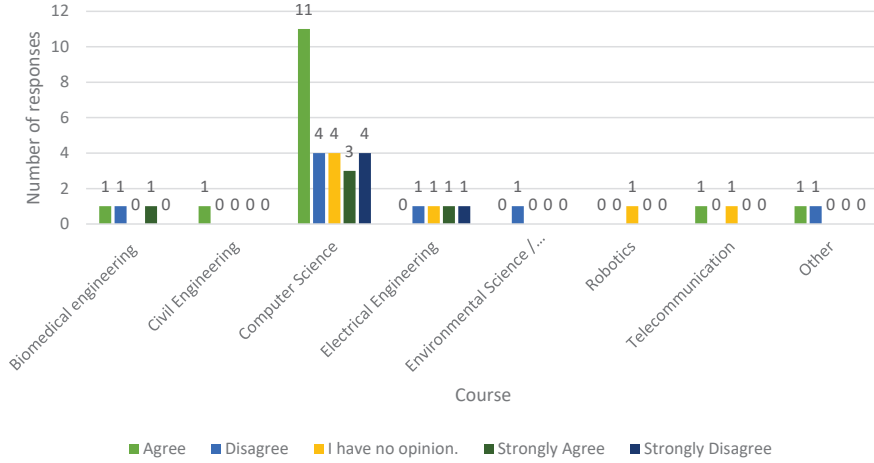

Figure 10. Master's Students – VR and Motivation to Learn

N o t e: Data collected and analysed by the authors.

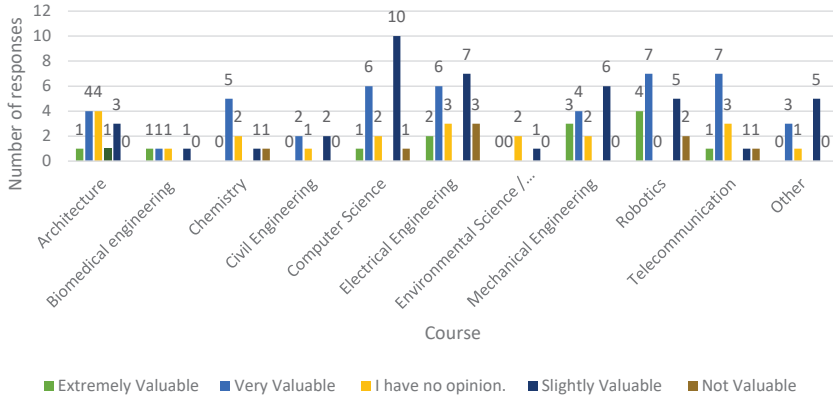

Figure 11. Bachelor's Students – VR and Real-World or Industry-Specific Tasks

N o t e: Data collected and analysed by the authors.

Fewer than half of the respondents – 45% of BSc students and 37.5% of MSc students – believe that VR can deliver experiences preparing them very well or even extremely well for real-world or industry-specific tasks (RQ1) (e.g., BSc: 42% of Architecture, 50% of Biomedical Engineering, 55.5% of Chemistry, 40% of Civil Engineering, 35% of IT, 38% of Electrical Engineering, 46.7% of Mechanical Engineering, 61% of Robotics and 61% of Telecommunication; MSc: 38.5% of IT), with 32.5% of bachelor's students and 45% of master's students seeing some advantages in this area (see Figures 11 and 12). This shows the most positive attitude altogether compared with the way the respondents perceive an increase in knowledge retention, understanding university subjects, engagement and motivation,

only as few as 6.2% and 5% respectively negate the educational usefulness of VR in preparation for workplace-relevant tasks.

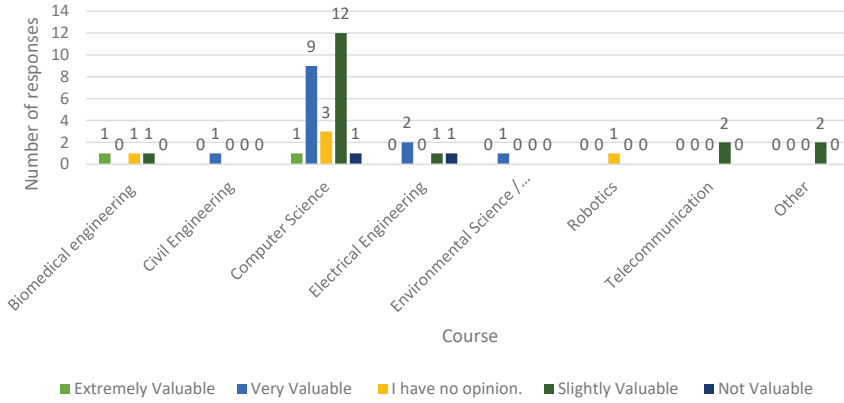

Figure 12. Master's Students – VR and Real-World or Industry-Specific Tasks

N o t e: Data collected and analysed by the authors.

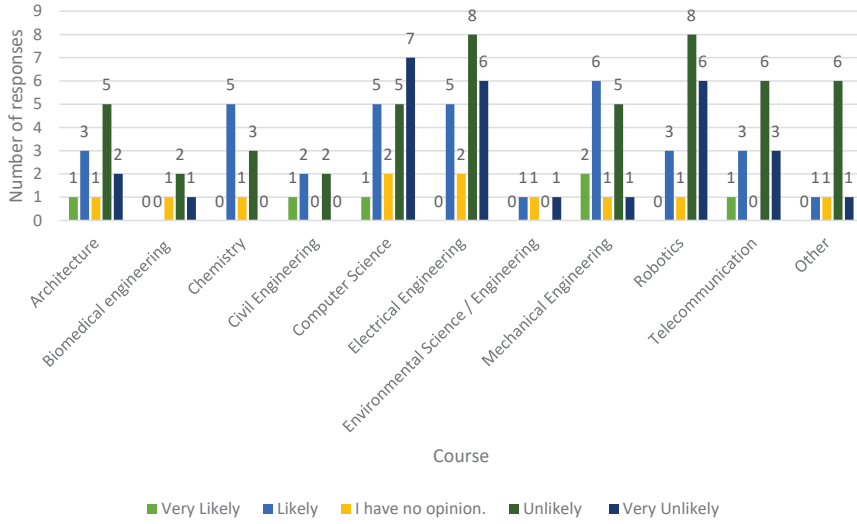

Figure 13. Bachelor's Students – VR as a More Widely Used Teaching Tool

N o t e: Data collected and analysed by the authors.

As Figures 13 and 14 indicate, almost the same number of respondents in both groups – 31% of BSc students and 32.5% of master's students – believe that VR will be incorporated into university curricula within the next five years – the issue addressed in RQ4, (e.g., BSc: 33.3% of Architecture, 55.5% of Chemistry, 60% of Civil Engineering, 30% of IT, 23.8% of Electrical Engineering, 33.3% of Environmental Engineering/Science, 53.3% of Mechanical Engineering, 16.7%

of Robotics and 30.7% of Telecommunication; MSc: 23% of IT), which does not reflect strong enthusiasm for this type of technological innovation in education. More than 60% (60.5% and 65% respectively) do not expect VR to have any impact on university teaching in the near future. The reasons the respondents chose are shown in Figures 15 and 16.

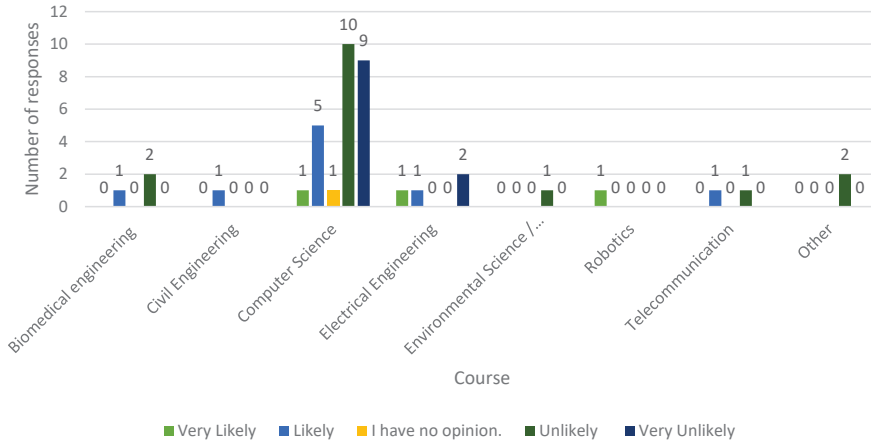

Figure 14. Master's Students – VR as a More Widely Used Teaching Tool

N o t e: Data collected and analysed by the authors.

As shown in Figures 15 and 16, BSc respondents identify motivation, engagement, personalisation, immersive experiences, and technological novelty as the main reasons why educators might be willing to enhance their classes with VR, with a total of 141 responses. Specifically, 32 BSc and 10 MSc students cited VR's potential to enhance engagement and motivation; 31 BSc and 10 MSc students mentioned technological advancements; 24 BSc and 6 MSc students highlighted support for personalised and immersive learning experiences (RQ1 and RQ4). Decreasing cost was also frequently noted (BSc 17, MSc 7).

Conversely, the most commonly selected reasons for why VR may not be incorporated into teaching reflect students' scepticism about its near-future adoption: high cost (BSc 65, MSc 19), educators' reluctance to implement major changes in teaching methods (BSc 51, MSc 14), and a preference for traditional approaches (BSc 44, MSc 14). Other factors mentioned include insufficient training and support for educators, and a perceived lack of added value. Negative reasons were chosen twice as often, totalling 287 responses. This may help explain why only about one third of the students predict the introduction of VR-enhanced education within the next five years.

Figure 15. Bachelor's Students – Likelihood of VR Being Used in University-Level Education

N o t e: Data collected and analysed by the authors.

The respondents seem to be quite appreciative of the possible incorporation of VR into university education (RQ4) (see Figures 17 and 18). Almost three thirds (73% of bachelor's Students and 72.5% of master's students) express their support for such an initiative (e.g., BSc: 91.7% of Architecture, 50% of Biomedical Engineering, 55.5% of Chemistry, 100% of Civil Engineering, 75% of IT, 81% of Electrical Engineering, 33.3% of Environmental Engineering/Science, 86.7% of Mechanical Engineering, 66.7% of Robotics and 69% of Telecommunication; MSc: 73% of IT). Only 7% of BSc students and 10% of master's students appear to be reluctant to see teaching methods enhanced with VR integrated into their courses.

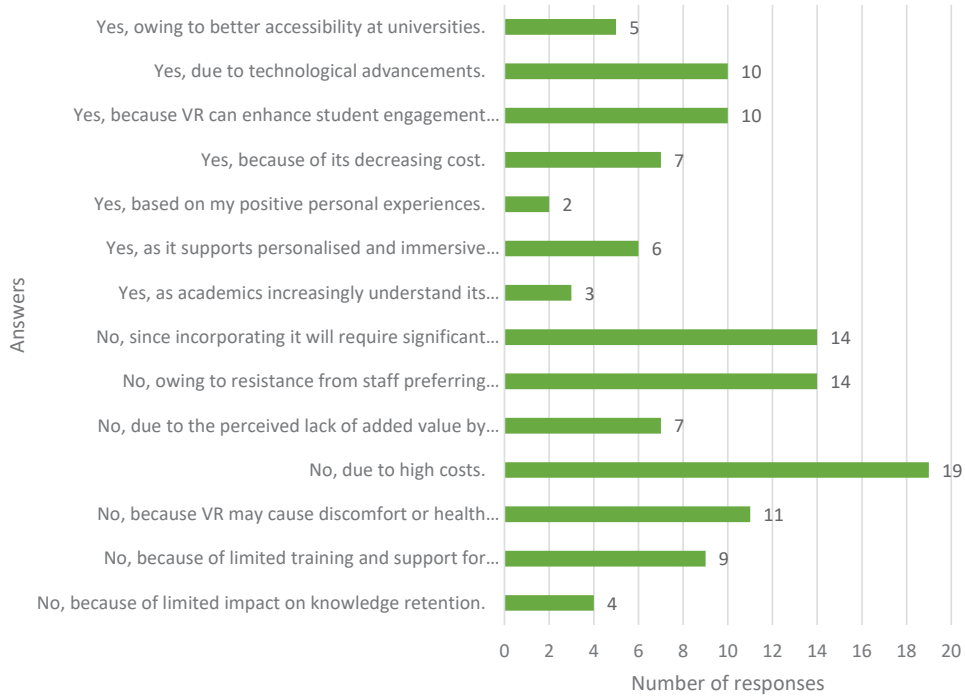

Figure 16. Master's Students – Likelihood of VR Being Used in University-Level Education

N o t e: Data collected and analysed by the authors.

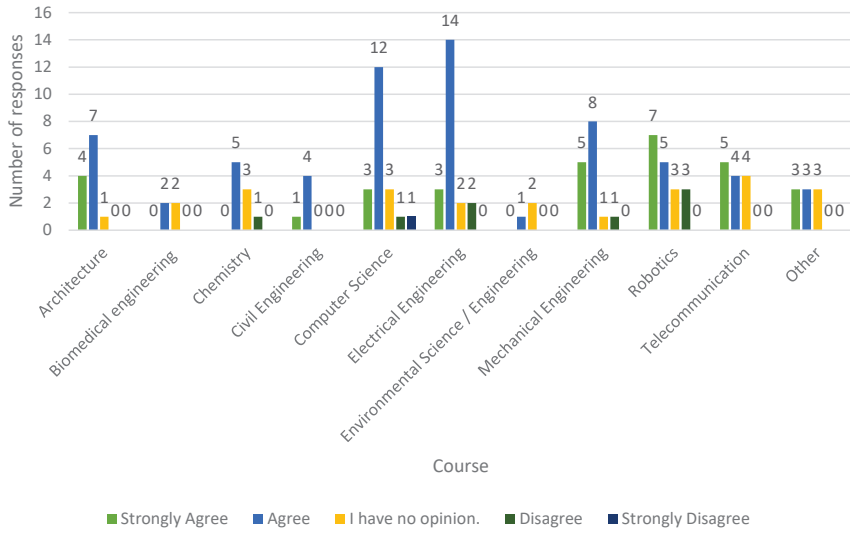

Figure 17. Bachelor's Students – VR-Based Education in the Future

N o t e: Data collected and analysed by the authors.

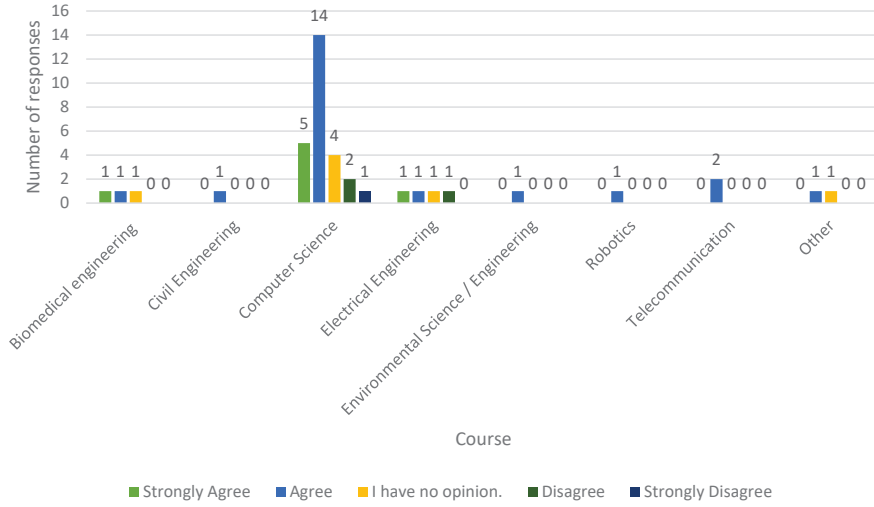

Figure 18. Master's Students – VR-Based Education in the Future

N o t e: Data collected and analysed by the authors.

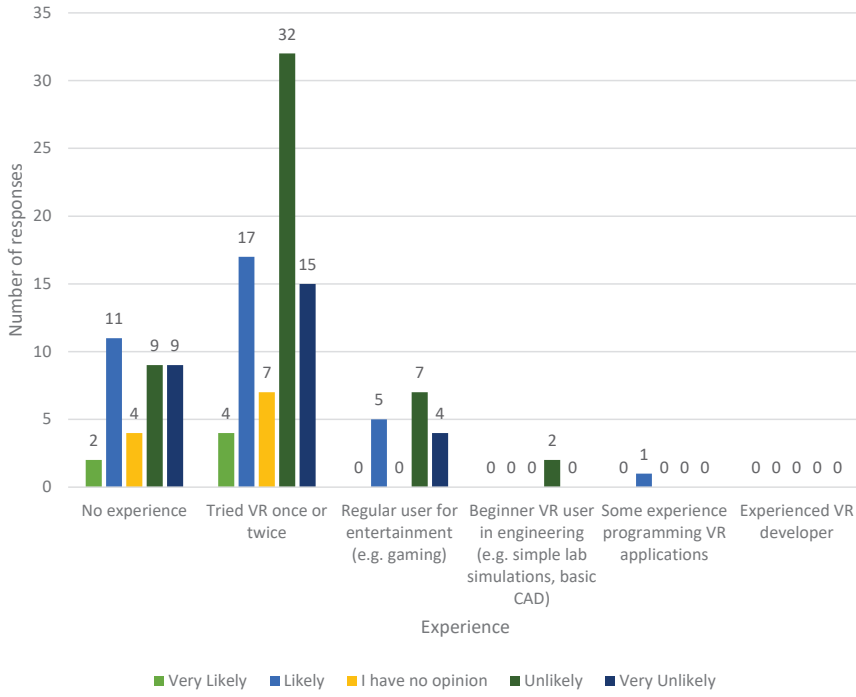

Figure 19. BSc Students' VR Experience and their Attitude Towards VR-Enhanced Classes

N o t e: Data collected and analysed by the authors.

Although the respondents do not expect VR-based classes to be introduced into university education in the near future, they express a desire to see a shift towards this pedagogical innovation. Even if they do not perceive its added value as particularly significant or beneficial, they maintain a positive attitude towards potential VR-based activities or resources that could supplement the learning opportunities with which they are already familiar. If so, educators should adopt an active learning approach to redesign their educational materials, and integrate VR-based activities in a way that enhances student engagement, promotes learning by doing, and supports the development of various skills relevant to their field of study and job market requirements.

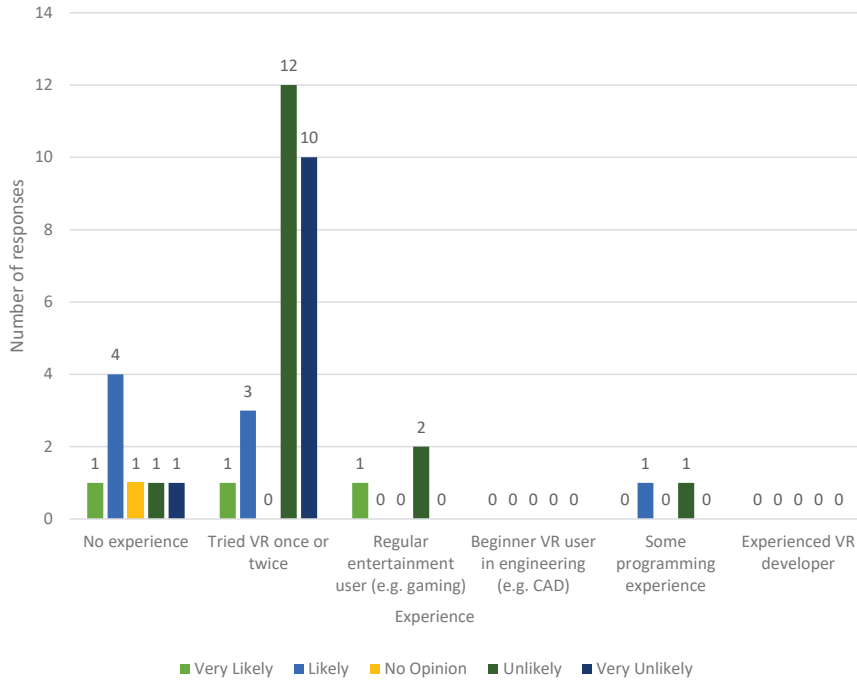

Figure 20. MSc Students' VR Experience and their Attitude Towards VR-Enhanced Classes

N o t e: Data collected and analysed by the authors.

As can be seen in Figure 19, a substantial number of BSc students with some degree of VR experience think that it will not be used to enhance university courses (RQ5) – they tend to associate it more with entertainment than to attribute educational value to it. The analysis of their responses shows that there is no statistically significant association between bachelor's students' VR experience and their attitude towards adopting VR-enhanced classes (χ^2= 9.03; *p-value = 0.7*) – prior VR experience does not strongly predict whether they are likely or unlikely to be

advocates of VR settings. However, several cells in the contingency table contained frequencies below five. To address this, in addition to the standard Chi-Square Test of Independence, a Monte Carlo simulation with 10,000 replicates was conducted to estimate *p-values* ($\chi^2 = 11.87$, simulated $p = 0.709$), confirming the initial result. Furthermore, Fisher's Exact Test was performed, as it is more reliable with sparse data, and also supported this finding ($p = 0.764$).

For the much smaller master's dataset ($n = 39$) (Fig. 20), the standard Chi-Square Test was applied ($\chi^2=18.56$; $p = 0.1$). Similar to the bachelor's sample, some contingency table cells had expected frequencies below five; therefore, a Monte Carlo simulation was again used to compute *p-values* ($\chi^2 = 18.56$, simulated $p = 0.146$). To further validate these findings, Fisher's Exact Test was also performed, which yielded a statistically significant result ($p = 0.027$). This suggests a potential association between master's students' prior VR experience and their positive attitudes towards adopting VR in education. Besides, master's students' IT expertise is higher, as is their general competence with more advanced subject-related educational activities, so their views may differ at least to some extent from bachelor's students. However, testing the association between high IT skills in MSc students and their attitude towards VR-based inclusions requires further research.

The present findings echo, to some degree, those reported in earlier studies. For example, research by Keskitalo (2012) found that healthcare students held relatively high expectations regarding the use of VR, with 67% of the respondents reporting that they expected "quite a lot" or "a lot." The findings, based on the variable *individual* and *competence-based studying*, suggested that the students anticipated opportunities to build upon their prior knowledge and to set personal learning goals. They also expected to become familiar with and practise using the professional equipment represented in VR and relevant to their future work, although the relatively high standard deviation indicated variability in these expectations. Moreover, the students expected their learning experiences in VR and simulation-based learning environments (SBLEs) to enhance understanding through practical application. They also anticipated that the equipment would be easy to use and that they would develop a high level of proficiency by the end of the course.

On the other hand, Alsalameen et al. (2023) found that their participants' responses on the performance expectancy dimension were close to neutral, suggesting that they were not yet fully aware of the potential usefulness of virtual reality (VR) in their education and future professional practice. They contrasted with previous research suggesting that students considered VR to be useful but experienced difficulties adapting to it. The study further revealed positive and significant relationships between students' perceptions of effort expectancy, performance expectancy, social influence, price value, and habit, and their behavioural intention to use VR in education. Among these factors, performance expectancy showed the strongest association with students' behavioural intention to use VR, while price value exhibited the weakest relationship.

Also, Matome and Jantjies (2021) found that, overall, students' expectations regarding the effectiveness of VR in higher education were moderate rather than excessively high. When asked what they expected from a VR-supported digital learning system, only 15% of the respondents anticipated that VR would provide realistic learning experiences, such as visiting nature reserves. In contrast, 5% of the students believed that a VR-based learning experience might negatively affect their learning. Just over one-fifth of the respondents expected VR to enhance their educational capabilities, both within formal institutions and through individual use. In terms of perceived advantages of integrating VR into higher education, 22% of the students reported that they could not identify any clear benefits. However, 20% viewed VR as an opportunity to gain practical experience rather than relying solely on theoretical learning, which aligns with what Keskitalo (2012) reported, and 19% anticipated that it could improve their learning and knowledge retention. Furthermore, 10% believed that the greatest benefit would be the ability to access and interact with course content remotely, while the remaining 16% highlighted increased interaction with learning materials as the key advantage of a VR-enhanced higher education system, which has not been reported by the present study.

Conclusion

Key findings reported in the literature highlight the most frequently applied teaching methods associated with VR-based education, with experiential learning, project- and problem-based approaches being the most common, while collaborative and game-based methods appear less frequently than anticipated (Zontou et al., 2024, p. 879). However, criticism has also been voiced – as it has been found that some problematic implementations may have resulted from merely replicating or recreating physical classrooms and relying on inadequate instructivist methods (Lege & Bonner, 2020, p. 172). This complies with the survey analysis, which indicates that the students of Gdańsk Tech see academics' unwillingness to adopt active learning methods as one of the major obstacles to the inclusion of VR into education.

The main health concern with VR is cybersickness, which can cause nausea, dizziness, headaches, sweating, eye strain, and disorientation (Ghazali et al., 2024, p. 10) – the literature presents it as a deterrent preventing students from embracing such an educational environment, with which some of the survey participants concurred in their comments. Hence, future research should address precautionary measures, such as limiting session duration and considering the type of VR technology, to help educators deliver the safest possible experiences.

Conventional teaching methods are gradually being replaced by new active learning approaches. This shift is driven by the recognition that educators need to provide students with innovative ways of building knowledge that are suited to a modern society. Virtual reality is among the technological innovations expected to help transform educational experiences into interactive and immersive learning environments. However, higher levels of immersion in VR may not necessarily enhance learning outcomes. Lege and Bonner (2020, p. 174), following previous research, argue that the complexity of immersive VR can generate extraneous cognitive load, which diverts students from essential learning and may reduce the effectiveness of the educational experience; it can also lead to a decrease in knowledge development due to the processing demands of working memory. This seems to be echoed in the respondents' attitudes, who, generally speaking, perceive VR more in terms of its entertainment or illustrative value than as an actively educational tool.

To effectively integrate VR-based activities into education, educators need to restructure their curricula according to constructivist principles (Mokwa-Tarnowska, Tarnowska & Roszak, 2023; Mokwa-Tarnowska, 2017), creating learning environments that are active and learner-centred (Reinfried, 2000). A constructivist classroom encourages a shift in control from teachers to students, supporting autonomy, exploration, and the development of higher-order thinking skills. By using authentic materials within VR settings, students can engage in meaningful learning experiences that promote skills ranging from comprehension and interpretation to the application of new concepts in context (Kołodziejczak, Mokwa-Tarnowska & Roszak, 2017). The inclusion of pictures, videos, and interactive visualisations in VR environments provides powerful visual stimuli, helping learners grasp complex material and construct new knowledge frameworks similar to those of expert users or native speakers.

Constructivism places emphasis on individualisation and learner autonomy, ensuring that learning is tailored to diverse student needs. Because no group of learners is entirely homogeneous, VR-based educational environments can support differentiation by allowing flexibility and learner choice, which in turn fosters motivation and engagement.

Another key constructivist concept is process-related awareness, which transforms traditional classrooms into spaces that promote reflection on learning itself. Within VR contexts, students can develop this awareness through contextualised self-assessment tools, such as multiple-choice, matching, gap-filling tasks and game-based activities, as well as through problem-solving, analytical reasoning, and production activities, involving a VR setting and traditional classroom-based activities. These immersive, process-oriented experiences can help students acquire skills essential for work-oriented and lifelong learning.

Contrary to a great deal of enthusiasm towards the adoption of VR-based materials expressed by educators in the literature in recent years, technically-minded

students overall have doubts about its effectiveness in academic education, particularly among the larger sample of BSc students. They appear to be slightly sceptical and hesitant to acknowledge its presumed added value, possibly due to their IT expertise and their prior experience of traditional, instructivist settings in their university courses. They noted that the time required to understand how to use such applications and learn from them is often disproportionate to the gains in subject-related knowledge and skills development. Hence, educators should proceed with caution, balancing innovation with well-grounded pedagogical strategies to ensure that VR serves as a meaningful enhancement rather than a superficial addition.

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Iwona Mokwa-Tarnowska, Viviana Tarnowska

Z perspektywy studentów: Zanurzyć się czy nie zanurzyć w nowe doświadczenia edukacyjne?

Streszczenie

Włączanie zasobów i aktywności wspomaganych technologią do programów nauczania na uczelniach wyższych wymaga restrukturyzacji programów dydaktycznych. Aby osiągnąć efekt synergii, tradycyjne metody powinny zostać zastąpione podejściami bazującymi na aktywnym uczeniu się, oferującymi studentom innowacyjne, angażujące i oparte na współpracy sposoby zdobywania wiedzy, dostosowane do wymogów współczesnego społeczeństwa. Wirtualna rzeczywistość (VR) należy do tych nowości technologicznych, które mają potencjał przekształcania edukacji w interaktywne i immersyjne środowisko nauki. Artykuł bada, czy wprowadzenie zasobów i aktywności opartych na VR do dydaktyki uniwersyteckiej może, według studentów, zwiększyć ich zainteresowanie dogłębnym zrozumieniem złożonych zjawisk oraz czy może przełożyć się na większe zaangażowanie i lepsze osiąganie efektów kształcenia. Wyzwania związane z wdrażaniem materiałów edukacyjnych wykorzystujących VR analizowane są na podstawie ankiety, w której wzięli udział studenci studiów inżynierskich i magisterskich Politechniki Gdańskiej, przeprowadzonej w czerwcu i lipcu 2025 roku.

Słowa kluczowe: wirtualna rzeczywistość, VR, edukacja, skuteczność, zastosowania VR, efekty kształcenia

Iwona Mokwa-Tarnowska, Viviana Tarnowska

A través de los visores de los estudiantes universitarios: sumergirse o no sumergirse en nuevas experiencias de aprendizaje

Resumen

La integración de recursos y actividades apoyados en la tecnología en los planes de estudio universitarios requiere una reestructuración de los programas de enseñanza. Para lograr un efecto sinérgico, los métodos convencionales deben ser sustituidos por enfoques de aprendizaje activo que ofrezcan a los estudiantes formas innovadoras, motivadoras y colaborativas de construir conocimiento, adaptadas a la sociedad contemporánea. La realidad virtual (VR) se encuentra entre las innovaciones tecnológicas llamadas a transformar la educación en entornos de aprendizaje interactivos e inmersivos. Este artículo analiza si la integración de la VR en los cursos universitarios puede, en opinión de los estudiantes, aumentar su interés por una comprensión más profunda de fenómenos complejos y si esto podría traducirse en un mayor compromiso y en una mejora en el logro de los resultados de aprendizaje. Los desafíos de implementar este tipo de diseño instruccional se examinan a partir de un análisis de las respuestas de estudiantes de grado y máster de la Universidad Tecnológica de Gdansk (Gdańsk Tech), recogidas en junio y julio de 2025.

Palabras clave: realidad virtual, VR, educación, eficacia, aplicaciones de VR, resultados de aprendizaje

Through University Students' Headsets: To Immerse or Not to Immerse in New Learning Experiences

Ивона Моква-Тарновская, Вивиана Тарновская

С точки зрения учащихся: погружаться или не погружаться в новый учебный опыт

Аннотация

Интеграция ресурсов и видов деятельности, усиленных технологиями, в учебные программы университетов требует их реструктуризации. Для достижения синергического эффекта традиционные методы должны быть заменены подходами активного обучения, предлагающими студентам инновационные, увлекательные и коллаборативные способы построения знаний, адаптированные к потребностям современного общества. Виртуальная реальность (VR) относится к тем технологическим инновациям, от которых ожидается трансформация образования в направлении интерактивных и погружных сред обучения. В статье исследуется, может ли интеграция VR в учебные курсы университетов, по мнению студентов, повысить их интерес к более глубокому пониманию сложных явлений и может ли это привести к большему вовлечению и улучшению достижения результатов обучения. Вызовы внедрения такого инструкционного дизайна проанализированы на основе результатов опроса студентов бакалавриата и магистратуры Гданьского политехнического университета (Gdańsk Tech), проведенного в июне-июле 2025 года.

Ключевые слова: виртуальная реальность, VR, образование, эффективность, применение VR, результаты обучения

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Immersive Technologies (AR/VR) for Enhancing Learning in Multicultural Classrooms: Addressing the Needs of International Students

Abstract

As a result of globalization, European universities now attract students from all over the world, enriching the campus community with their different backgrounds and perspectives. However, they frequently face challenges to involvement and well-being due to language obstacles, cultural mismatch, and social isolation. The new trends of innovative tools, immersive technologies like AR and VR, have arisen to meet these problems head-on. Immersive technologies have the potential to improve learning experiences, facilitate more culturally and linguistically inclusive instruction, and impact the motivation, engagement, and overall health of international students. This theoretical study delves into these themes, giving the theoretical aspect of this domain. The paper analyses current literature in a thematic manner within the European context, specifically focusing on Italy, drawing on sociocultural theory, cognitive load theory, and self-determination theory. Additionally, it highlights important difficulties and solutions for using immersive technology in multicultural classrooms. The results show that when created with inclusivity in mind, AR/VR spaces have the ability to revolutionize universities by promoting psychological safety, intercultural competence, and deep learning.

K e y w o r d s: Immersive technologies, AR/VR, Multicultural Classroom

Introduction

Greater international student mobility over the last 20 years has caused a sea change in European higher education. There is a wide range of linguistic, cultural, and pedagogical backgrounds represented among the more than 1.5 million international students attending EU institutions in terms of both language and cultural background (Bakay, 2023; Kassim, 2023). Because of this shift, institutions now have to find new ways to teach that value diversity while still pushing students to do their best academically (Starck et al., 2021). Cultural dissonance, social isolation, language barriers, and unfamiliar academic standards are common challenges for international students (Mulyadi et al., 2024). International students at European institutions report more stress and less involvement than their local colleagues, which is supported by research (Alharbi & Smith, 2018). As pointed out by Moskal and Schweisfurth (2018), these difficulties are worsened in Italy due to the lack of institutional readiness for culturally responsive education.

Rigidity, reliance on texts, and cultural monolithicity are common complaints leveled against traditional lecture-based pedagogies (Tshering, 2024). Inadvertently, these methods put some students at a disadvantage because students are more proficient in the target language and have more exposure to local cultural allusions (Abduqodirova et al., 2025). As a result, not only are fewer opportunities for intercultural learning presented to domestic students, but also fewer opportunities for involvement from overseas students are reduced (Oduwaye et al., 2023). Emergence of AR/VR presents a game-changing option (Ali et al., 2025). In contrast to virtual reality (VR), augmented reality (AR) superimposes digital information on top of the actual world (Dargan et al., 2023). Rather than passively interacting with content, learners can engage experientially through the use of these tools, which can mimic real-life cultural and linguistic situations (Akçayır & Akçayır, 2017). A trend towards experiential education is being signaled by the proliferation of immersive learning labs in European universities (Hawkinson, 2025).

According to Di Natale et al. (2020), immersive environments are designed to accommodate multiple learning styles by delivering knowledge through visual, aural, and kinesthetic channels. This approach decreases the reliance on verbal proficiency (Ngo et al., 2025). This is in line with the concepts of universal design for learning (UDL) which stress the need of offering many types of representation, interaction, and expression to cater to the diversity of learners (Evmenova, 2018). Using augmented and virtual reality, educational materials can incorporate culturally diverse scenarios, characters, and stories, which can make a positive impact on international pupils (Yeh et al., 2022).

Culturally responsive pedagogy (Gay, 2015) is in line with these methods since it places an emphasis on recognizing and incorporating students' cultural identities into the classroom experience. A sense of community and smaller cultural distance

can result from this (Iv, 2017). Determination Theory (Deci & Ryan, 2012) states that relatedness, competence, and autonomy are the three main components of motivation. Virtual reality and augmented reality meet these demands by providing students with social bonding opportunities through collaborative simulations, adaptive challenges, and learning routes depending on their own choices (Scavarelli et al., 2021). The immersive nature of AR/VR makes people feel more socially present, which is crucial for meaningful interaction, according to Garrison et al. (2000), Community of Inquiry theory (Cho et al., 2023).

One of the most important conditions (including psychologically safe learning environment, an inclusive teacher-student relationship, and culturally responsive pedagogy, opportunities for meaningful interaction, equitable participation practices, clear communication and language support and positive classroom norms and values are essential) for multicultural classrooms is to feel emotionally and socially present in the classroom so that they can actively participate in learning (Xiong, 2025). Anxiety, homesickness, and loneliness are common among international students and can hinder their ability to learn (Dost, 2025). As a result of providing safe places to practice, experiment, and connect with others, immersive settings promote emotional health and self-assurance (Tay et al., 2025). Research on the effects of augmented and virtual reality on the motivation, engagement, and well-being of international students in multicultural European contexts is limited, despite the abundance of evidence documenting the cognitive benefits of these technologies. While the use of augmented and virtual reality in classrooms is still in its early stages, very few studies have focused on this country (Alalwan et al., 2020; Al-Ansi et al., 2023).

This paper presents a new theoretical framework for augmented and virtual reality in higher education. It improves upon previous models by taking an equity-driven approach rather than focusing just on technological or cognitive outcomes. This framework integrates several theories into a single paradigm, unlike previous research that has focused on immersive tools as supplementary learning tools. These theories include Experiential Learning Theory, Cognitive Load Theory, UDL, CRP, and SDT. By drawing from a variety of theories, AR/VR can be seen as an inclusive educational ecosystem that aims to improve students' motivation, cultural representation, cognitive comprehension, and social and emotional health all at once. Instead of viewing immersive technologies merely as means of disseminating information, the framework reimagines them as agents of cultural inclusion and psychological support, with the enhancement of a sense of belonging, affirmation of identity, and emotional safety as central goals. Moreover, it provides a context-sensitive roadmap for universities that aim to support diverse and multicultural cohorts, as it is firmly rooted in the European and Italian higher education landscape and aligns with policy initiatives like the Erasmus digitalization agenda and the European Higher Education Area (EHEA). Students from other countries studying in Italy have unique challenges in conventional, lecture-

based classes, including language limitations, cultural dissonance, and social isolation.

This approach can help them overcome these obstacles. The framework helps students connect more fairly with academic subject by including multilingual support, culturally varied narratives, and multimodal visual content. This decreases cognitive burden while affirming students' cultural identities. Following SDT's lead, it demonstrates how immersive environments can inspire more intrinsic motivation by strengthening competence through scaffolded feedback, relatedness through collaborative tasks, and autonomy through tailored learning paths. For students who might otherwise feel disengaged, these design elements enhance social, cognitive, and instructional presence (Community of Inquiry model). In addition, the framework emphasizes how immersive settings can construct emotionally safe spaces with low stakes, which can help international students overcome fear and boost their confidence. This will improve their mental health in addition to their academic performance. This way, immersive technologies are positioned as a strategic route for inclusive and globally competitive higher education, which not only tackles individual learning impediments but also coincides with Italy's broader internationalization drive.

Purpose and Objectives

This paper therefore aims to: (1) explore how AR/VR enhances learning experiences; (2) investigate how AR/VR supports culturally and linguistically inclusive teaching; (3) examine impacts on motivation, engagement, and well-being; and (4) identify challenges and best practices for integration in multicultural higher education classrooms, especially in Europe and Italy. Based on research objectives, the following were the research questions of the study;

RQ1: In what ways does AR/VR improve students' learning?
RQ2: How does AR/VR support teaching for students from different cultures and languages?
RQ3: How does AR/VR affect students' motivation, engagement, and well-being?
RQ4: What challenges and best practices are found when using AR/VR in multicultural classrooms in Europe and Italy?

Significance

The purpose of this study is to develop a theoretical framework that addresses the unique educational requirements of international students enrolled in multicultural universities by combining inclusive pedagogy with immersive technology (AR/VR). Universities in Europe are becoming more globalized, attracting

students from all over the world with a wide range of cultural, linguistic, and academic backgrounds (Robertson & Kedzierski, 2016). Unfortunately, these students are frequently under-engaged, unmotivated, and academically unsuccessful since conventional teaching approaches do not adequately engage or support them (Zhiqiao et al., 2025).

To fill this important need, this study theorizes how augmented and virtual reality (AR/VR) technologies can revolutionize education by fostering more inclusive classrooms. Its major contribution is the way it integrates several theoretical frameworks, including UDL, SDT, CRP, and Social Constructivism, into a unified whole. The research conceptualizes the potential of immersive technologies to erase cultural and language barriers, increase engagement, and personalize learning routes by integrating these viewpoints. Importantly, this theoretical integration lays out a conceptual road map for lawmakers and teachers to follow to include immersive technologies into inclusive teaching rather than viewing them as standalone digital tools.

Equally important is the study's emphasis on Europe. Policy initiatives in higher education throughout Europe have emphasized diversity, equity, and inclusion (Siri et al., 2022). Examples include the Bologna Process and the European Higher Education Area (EHEA), both of which promote student-centered learning and international mobility (Li, 2023). Even if there has been an increase in the number of international students, studies show that many of them still experience cultural marginalization, language barriers, and lower engagement in classroom discussions (Tavares, 2024). This article coincides with and advances Europe's strategic goal of constructing cohesive multicultural learning communities by framing AR/VR as methods to bridge these gaps.

When researchers narrow our focus to Italy, the study becomes even more relevant. International students, especially those participating in Erasmus+ and similar mobility programs, have been steadily increasing their enrollment at Italian universities. Many international students, however, have reported having trouble adjusting to Italian language classes, culturally unfamiliar pedagogical techniques, and the lack of social inclusion as obstacles to integration (Bianchi & Martini, 2023). Supporting its globalization drive and tackling persistent equity inequalities, this study offers a theoretical perspective for AR/VR-supported inclusive education and recommends a strategic solution for Italy.

By drawing attention to the motivational and emotional aspects of learning in addition to the cognitive ones, the article adds to the larger academic conversation. Studies have shown that a sense of belonging, cultural safety, and identity affirmation have a significant impact on the engagement and well-being of international students (Corney et al., 2024). Immersive environments can improve academic and emotional inclusion by simulating culturally contextualized scenarios, multilingual support systems, and collaborative virtual spaces (Yeganeh et al., 2025). Current

theoretical models frequently fail to account for the social and emotional components of inclusion, so this focus on students' overall health is an essential addition.

This paper proposed framework that has real-world applications for universities in Europe and Italy, including policymaking, teacher education, and course creation. It provides a theoretical framework for the development of immersive education policies, programs, and practices, as well as for the acquisition of necessary technology. Universities can benefit from the study's theoretically informed approaches to AR/VR integration into multicultural pedagogy and away from superficial or fragmented adoption of these technologies. The study also contributes to the growing body of literature on the topic of educational technology adoption.

While interest in augmented and virtual reality (AR/VR) is on the rise in the academy, most of the current research is either technology- or outcome-driven, with an emphasis on tools or exam scores (Shadiev et al., 2025; Yeganeh et al., 2025). Few studies connect immersive technology directly to issues of diversity, inclusiveness, and the lived experience of international students (Siddiqi, 2024; Zhang et al., 2017). Filling that void, this study broadens the theoretical discussion surrounding technology's role in inclusive education by reimagining AR and VR as equity-driven educational interventions rather than digital breakthroughs in and of themselves. Finally, this paper is important for reasons outside of academia.

In doing so, it provides indirect support for larger social goals, such as cultural pluralism, intercultural communication, and global citizenship education, all of which are fundamental principles within the social and educational agenda of the European Union. Future citizens who are more socially cohesive and culturally aware can be helped by immersive technologies that encourage deeper engagement, cultural sensitivity, and collaboration among various learners.

Literature Review

Augmented and virtual reality (AR/VR) and other immersive technologies have piqued a lot of interest in the realm of higher education, particularly in multicultural classrooms where students come from a variety of cultural and linguistic backgrounds (Baxter & Hainey, 2024). From a focus on the novelty of AR/VR to a more methodical examination of their pedagogical potential, the literature on AR/VR in education has progressed significantly. The use of augmented and virtual reality (AR/VR) to meet the educational goals, interests, and needs of overseas students is becoming more important as more European universities open their doors to students from all over the world. Italy is dealing with the problem of accommodating an influx of international students by creating welcoming and stimulating classrooms for all students (Mohajeri et al., 2025). The purpose of this literature study is to investigate, using examples from Europe and Italy, how immersive technologies might improve education in multiethnic classrooms.

Enhancing Learning Experiences through Immersive Technologies

A large amount of research presents augmented and virtual reality as potent resources for developing context-specific learning spaces (Chamusca et al., 2025). Meaningful learning takes place via direct experience, reflection, and theory-building, as stated in Kolb's Experiential Learning Theory (1984) (Doherty, 2023). Virtual reality (VR) environments help students make the transition from classroom theory to practical application by simulating real-world situations in which they can hone their abilities and put their notions into practice (Marougkas et al., 2023). Immersive simulations are more effective than traditional methods of training in fostering spatial awareness, conceptual mastery, and problem-solving abilities, according to studies conducted in STEM and health sciences across European universities (Chasokela, 2025).

The worth of AR/VR is further supported by constructivist learning theory, which places an emphasis on the learner's active engagement and knowledge production (Scavarelli et al., 2021). This experience component helps foreign students understand and remember more information by reducing the need of textual or lecture-heavy delivery formats, which can be difficult for students learning a second language (Hajian et al., 2021). Research found that students learning multiple languages were more engaged and understood more in virtual reality engineering labs (Aruanno et al., 2025).

An additional viewpoint is provided by Cognitive Load Theory (Sweller, 1994). This theory states that AR/VR can alleviate unnecessary mental strain and enhance relevant processing by utilizing many sensory channels, such as sight, sound, and spatial perception (Sweller, 2020). This is of utmost importance for foreign students, since they frequently face a heavy cognitive burden while attempting to comprehend academic material in a language other than their native tongue. Optimal design of immersive platforms allows for visual scaffolding of complicated knowledge, which improves conceptual clarity and learning performance (Ouwehand et al., 2025).

Supporting Culturally and Linguistically Inclusive Teaching

Being sensitive to cultural representations, providing help in several languages, and ensuring equal participation are all necessary for inclusive education in multicultural settings. The concepts of Universal Design for Learning (UDL), which are in line with the affordances of AR/VR, place an emphasis on different modes of representation, engagement, and expression (Fortes, et al., 2024). To help students of different linguistic abilities understand instructional content, key concepts, classroom interactions and immersive platforms can incorporate features like audio narration, visual hints, captions, and subtitles in real-time (Poggianti et al., 2025).

Evidence from studies conducted in European universities on augmented reality language learning tasks shows that foreign students are able to overcome language obstacles through multimodal design, since they acquire new vocabulary more quickly and retain more of what they learn (Rudnik, 2023).

Analyzing immersive design can also be done via the viewpoint of Culturally Responsive Pedagogy (La Serna, 2020). According to the research, virtual reality (VR) simulations can either support or undermine students' different identities depending on the cultural material and visual representations they contain (Mills et al., 2020). Collaborating with students, using case studies from many cultures, and working to eliminate prejudices are all parts of inclusive immersive design. Italy is home to new programs like "Immersive Italy" that aim to help international students feel more at home by creating virtual reality (VR) cultural heritage courses that incorporate stories from a variety of ethnic backgrounds (Freina & Bottino, 2016).

Equalizing participation dynamics in multicultural classrooms is another benefit of immersive platforms (Siddiqi, 2024). Theoretically, learning takes place in a cultural setting through interactions between people, according to Vygotsky's Sociocultural Theory (Marginson & Dang, 2017). International students can participate actively alongside their native-speaking classmates in multi-user virtual reality (VR) environments that promote collaborative problem-solving using visual actions, shared virtual artifacts, and gestures, thus decreasing the need for sophisticated language skills.

Impact on International Students' Motivation, Engagement, and Well-being

Problems with language and cultural adjustment stress can lead international students to feel lonely, anxious, and less motivated than their domestic counterparts (Mesidor & Sly, 2015). Using the concepts from Self-Determination Theory, research indicates that AR/VR can have a positive impact on their motivation and engagement (Deci & Ryan, 1985). Student intrinsic motivation is enhanced by the three pillars of immersive learning: autonomy (the ability to choose one's own learning path), competence (the gradual mastery of tasks), and relatedness (the ability to collaborate in shared virtual spaces).

Studies conducted in European universities found that virtual reality (VR) learning interventions significantly improved engagement, attention, and perseverance when compared to more conventional approaches (Di Natale et al., 2020). While research in Italy is still in its early stages, what little there is suggests comparable trends; for instance, international students reported less language-related anxiety and higher attendance and task perseverance in virtual reality (VR) anatomy labs at the University of Bologna. Low-stakes practice settings provided by AR/VR can help students overcome performance anxiety and safely practice

presentations or social interactions, which in turn supports emotional well-being (Zielke et al., 2025).

To aid the mental health of overseas students, some European pilot programs have implemented virtual reality stress-reduction modules, including guided mindfulness simulations (Kampa et al., 2022). These results are in line with the beliefs of Pleasant Psychology, which state that happiness can be enhanced through participation, achievement, and pleasant emotions. International students can indirectly benefit from AR/VR's ability to create immersive places that boost belonging and decrease fear, which in turn improves their academic achievements.

Challenges and Best Practices for Integrating AR/VR in Multicultural Higher Education

Everyone agrees that AR/VR has great potential, but there are a lot of obstacles to overcome, according to Creed et al. (2024). High software and hardware expenses, insufficient digital infrastructure, insufficient teacher preparation, and worries about accessibility and equity are common obstacles. Faculty members' opinions on the usefulness of technology and how easy it is to use it have a significant impact on whether they choose to incorporate AR/VR into their lessons (Bermejo et al., 2023). Despite interest in immersive tools among Italian professors, polls reveal that their use is limited due to a lack of institutional support and training opportunities.

The best practices that have been found in European initiatives involve a gradual rollout (beginning with affordable mobile AR and working up to more complex VR), seminars for faculty professional development, and the alignment of immersive activities with specific learning goals (Kuhlmann & Rip, 2014). It is crucial to take accessibility into account; the Universal Design methodology suggests features like compatibility with screen readers, alternate input devices, and motion sickness reduction to make sure that students with disabilities may participate.

To combat cultural bias and promote diversity, institutional policies should back cross-cultural co-design of immersive content. International student involvement in content production teams is highly recommended by the Europe collaboration. This will help ensure cultural sensitivity and give students a stronger sense of ownership and belonging. Such procedures are vital in Italy, a country with an increasingly diversified international population and still-developing formal structures for the culturally inclusive integration of AR and VR.

Synthesis and Research Gaps

A consistent theoretical pattern emerges from the literature review: immersive technologies can help international students learn more effectively by empowering them to take an active role in their own learning, lowering the threshold for linguistic and cognitive barriers (Cognitive Load Theory, UDL), and promoting social presence and cultural inclusion (Sociocultural Theory, Culturally Responsive Pedagogy) (Shadiev et al., 2025). But these advantages can only be realized with careful planning, backing from institutions, and evaluation tailored to each individual situation.

International students in multicultural classrooms, especially in Italy, have not been the subject of many empirical investigations, despite the growing body of literature on immersive learning in Europe (Bakay, 2023). Considering the mental health challenges experienced by mobile student populations, it is crucial to address the lack of research that connects AR/VR-based learning to students' well-being address these deficiencies, the current theoretical framework was developed. It compiles and synthesizes previous research to provide guidelines for the culturally inclusive, motivational, and wellbeing-oriented integration of AR/VR in higher education (Di Natale et al., 2020).

Theoretical Framework

To better understand how augmented and virtual reality (AR/VR) might improve the learning, motivation, engagement, and well-being of foreign students in multicultural classrooms, this paper presents a theoretical framework that combines important ideas and results from the theme literature. The framework fills in deficiencies in the Italian higher education setting while also aligning with Europe's dedication to digitalized and inclusive education.

Fundamental to the framework is the Experiential Learning Theory (Kolb, 1984) that places an emphasis on learning via the repeated cycle of doing, reflecting, thinking, and trying again (Morris, 2020). Accelerators in this cycle include augmented and virtual reality systems, which allow foreign students to interact with content beyond language barriers using realistic and contextual rich simulations (AlGerafi et al., 2023). To ensure that students with different language proficiency levels have equal access to difficult academic content, Cognitive Load Theory (Yang & Farley, 2019) provides support for this experiential core by arguing that AR/VR materials should be multimodal and spatially arranged to avoid superfluous load.

An inclusive teaching framework based on the concepts of UDL and Culturally Responsive Pedagogy (Kieran & Anderson, 2019) surrounds this experiential core. Teaching in these approaches places an emphasis on recognizing and respecting

students' cultural identities, facilitating their knowledge acquisition and expression through a variety of means, and removing language barriers. The capabilities of augmented and virtual reality, such as culturally varied avatars, visual-gestural interactions, and multilingual narration, put these concepts into practice and make them real in virtual worlds (Rahmanu et al., 2024). This layer of design makes sure that immersive learning spaces are welcoming to many languages and cultures, in addition to being successful for cognitive learning.

Integrating the Community of Inquiry model (Garrison, 2000) with Self-Determination Theory (Deci & Ryan, 2012), the third component of the framework focuses on psychosocial dynamics. International students can experience more autonomy, competence, and relatedness with augmented and virtual reality technology (Zhang & Miao, 2025). This, in turn, can lead to greater intrinsic motivation. At the same time, immersive platforms boost engagement with avatars and real-time interaction, cognitive presence is enhanced using problem-based immersive tasks, and teaching presence is enhanced using guided virtual scaffolds (Baxter & Hainey, 2024). International students, who frequently struggle with feelings of loneliness, fear of the unknown, and lack confidence in their abilities while immersed in a new culture, greatly benefit from these engagement and motivational strategies. Aspects of emotional safety and well-being, influenced by theories of social and emotional development, encircle these three fundamental levels (Childs et al., 2023).

Supporting mental health and emotional resilience, immersive environments can lessen acculturative stress, promote belonging, and establish low-stakes areas for exploration. Immersive experiences can support social integration and reduce anxiety among Erasmus students, according to research from Italian institutions, including the University of Bologna's VR-based orientation programs (Faraoni & Battaglia, 2025). Lastly, the framework recognizes institutional and systemic conditions as elements that can either facilitate or hinder progress.

Funding constraints, the lack of faculty training, and gaps in technology infrastructure are some of the obstacles that Italian universities continue to encounter despite EU policy measures (Martins et al., 2025) that encourage digital transformation and inclusiveness. The efficacy of the inner layers learning design, engagement mechanisms, and emotional supports is influenced by these structural variables, which are seen as external modifiers. Therefore, for AR/VR adoption to be successful and long-lasting, there needs to be institutional preparation and policy backing.

Therefore, the suggested paradigm views augmented and virtual reality (AR/VR) immersive learning as a system of interdependent parts, including experiential learning procedures, inclusive instructional design, engagement and motivational mechanisms, supports for emotional health, and enabling institutional settings (Yeganeh et al., 2025). This multi-tiered paradigm provides a theoretically sound means for institutions in Europe, and Italy in particular, to use immersive

technologies to help international students succeed in multicultural classrooms by increasing their equity, inclusion, and academic achievement.

Methodology

The research design is theoretical and literature-based of the research, which is aimed at the synthesis of the existing body of research and does not presuppose the collection of primary empirical information. The design was target at creating a conceptual framework that offers some explanations on how augmented and virtual reality (AR/VR) can enhance multicultural higher education classrooms, in particular, Europe and Italy.

Research Design

The study was founded on the qualitative and thematic literature review paradigm. This choice of design was made due to the fact that the research incorporates multiple theoretical perspectives as Experiential Learning Theory, Universal Design for Learning (UDL), Culturally Responsive Pedagogy (CRP), Cognitive Load Theory (CLT), and Self-Determination Theory (SDT), into one theory of inclusive and immersive pedagogy.

Data Sources

The peer-reviewed journal articles, conference papers, and policy papers published in the years between 2015 and 2025 were going to be analyzed. The search in such databases as Scopus, Web of Science, Google Scholar, and ERIC was conducted with the help of keywords such as AR/VR in higher education, immersive learning, inclusive pedagogy, international students in Europe, and Italy multicultural classrooms. The conducted studies in the European context were taken into account first and other sources all over the world were utilized to present comparative facts.

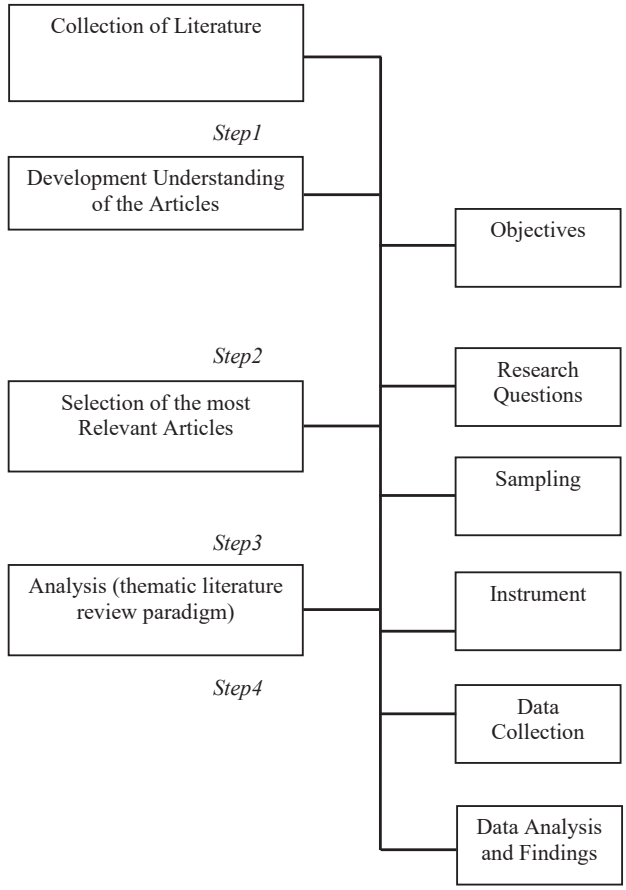

Figure 1. Framework of the study

S o u r c e: Own work.

The search employed combinations of key terms such as *"AR/VR in higher education," "immersive learning," "inclusive pedagogy," "international students,"* and *"multicultural classrooms in Europe and Italy."*

Inclusion and Exclusion Criteria

Inclusion: The application of AR/VR in higher education, multicultural/multilingual classroom, student motivation, engagement, and well-being. A total of 154 records were initially identified; after screening for relevance and removing duplicates, 78 studies met the inclusion criteria and were analyzed in depth. This process is summarized in a literature selection flowchart (Figure 1), illustrating the stages of identification, screening, eligibility, and inclusion.

Exclusion: The literature search was limited to the K-12 setting, sources that concentrate on the technical aspects of the AR/VR but lacks the actual application of the matter in a pedagogical setting.

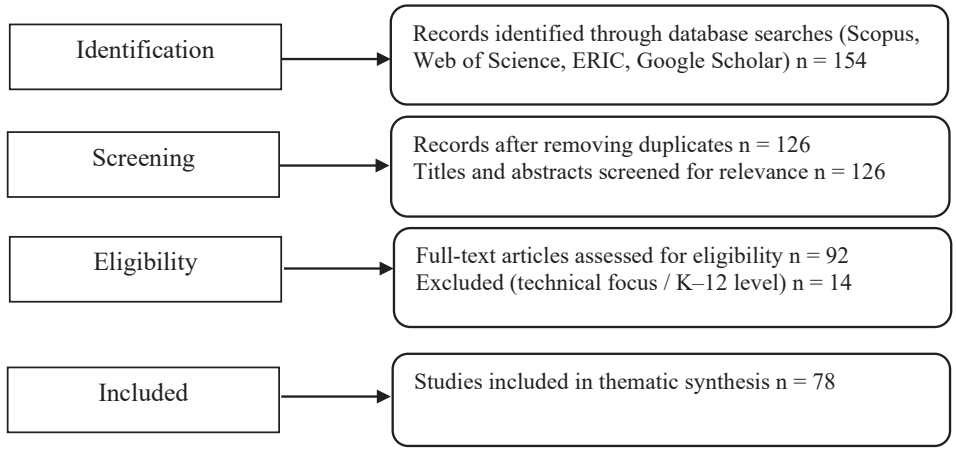

Figure 2. Demonstration of inclusion and exclusion criteria

S o u r c e: Own work.

Analytical Approach

Table 1
Summary of the database search strategy and inclusion parameters for transparency and replicability

Parameters	Description
Databases Searched	Scopus, Web of Science, ERIC, Google Scholar
Search Terms Used	AR/VR in higher education, “immersive learning”, “inclusive pedagogy”, “international students”, “multicultural classrooms”, “Europe”, “Italy
Time Frame	2015–2025
Inclusion Criteria	Studies on AR/VR use in multicultural or multilingual higher education; focus on learning, motivation, engagement, or well-being
Exclusion Criteria	K–12 studies, purely technical/engineering AR-VR studies without educational focus
Total Records Retrieved	154
Final Studies Analyzed	78

S o u r c e: Own work.

Thematic synthesis method was undertaken. The literature was coded (table 1) in accordance with four general themes in accordance to the research objectives and questions:

1. Enhancing the learning process with AR/VR.
2. Fostering language and cultural inclusion teaching.
3. Impact on engagement, commitment and health.
4. Challenges and best practices of integration.

The themes were examined with reference to the relevant educational theories in order to create convergences, gaps, and opportunities to support inclusive higher education.

Validity and Trustworthiness

In order to be rigorous, the review was carried out using theories and source triangulation. The more recent policy documents were also cross-referenced with academic research, off-the-record to place findings into perspective and include documents published by Europe and Italy (e.g., Erasmus+ digitalization agenda, European Higher Education Area framework).

Thematic Literature-Based Analysis

Theme 1 (RQ1): Enhancing Learning Experiences through Immersion (Baxter & Hainey, 2024; Wang & Huang, 2025)

Augmented and virtual reality (AR/VR) and other immersive technologies have the potential to revolutionize education by facilitating the development of learning environments that are both experienced and contextualized. Knowledge is built through a recursive process of direct experience, introspective observation, conceptualization, and subsequent active experimentation, according to Kolb's Experiential Learning Theory. Using augmented and virtual reality technologies, students can engage in simulated real-world experiences, reflect on those experiences in safe digital settings, develop conceptual understanding with the help of interactive feedback, and try out new strategies without realizing the consequences (Dolby & Rahatzad, 2018).

Students from other countries benefit greatly from this immersive learning cycle since linguistic and cultural barriers make it hard for them to connect classroom theory with real-world applications (Shadiev et al., 2025). In addition, according to Kanokpermpoon (2013), unnecessary cognitive load can overwhelm working memory and make comprehension difficult. Therefore, it is crucial to reduce this

burden to maximize learning efficacy. Less reliance on dense text and abstract explanations is achieved through the spatial and visual distribution of information in well-designed immersive content. Because it offers visual scaffolding that is both obvious and easy to understand, this method is particularly helpful for children who struggle to fully understand the instructional words. Augmented and virtual reality (AR/VR) multimodal representations help overcome language barriers and promote equal access to subject knowledge. All these theoretical assertions are backed by evidence from the European environment.

Students from different countries were able to close the accomplishment gap by using visual-spatial representations to follow complicated operations without listening to spoken directions. Similarly, international students at Italy's Polytechnic di Milano who had trouble comprehending Italian technical terms at first were able to make great strides forward with the use of virtual reality (VR) architecture and design simulations (Baxter & Hainey, 2024). These results provide evidence that immersive technologies have the potential to improve educational results by providing experiential, language-independent means of acquiring new information.

Theme 2 (RQ2): Supporting Culturally and Linguistically Inclusive Teaching (Doran, 2017; Reddig et al., 2021)

Augmented and virtual reality has the potential to greatly benefit education in areas such as cultural responsiveness and language inclusion, in addition to cognitive advances. The Culturally Responsive Pedagogy approach proposed by Iv (2017) stresses the significance of relating course material to students' real-world cultural experiences and backgrounds. To validate students' identities and promote inclusivity, AR/VR settings have unique opportunities to add culturally relevant features. These elements can include bilingual narration, culturally varied avatars, and case studies set in students' home areas (Guberina, 2023).

These tools make it easier for international students to feel more connected by placing them in familiar cultural settings. Meyer et al. (2014) cite Universal Design for Learning (UDL) as an additional key lens that supports diverse learners by advocating for multiple forms of representation, participation, and expression (Rao et al., 2023). By making content available in multiple languages, improving it with subtitles, and adding visual or gestural interactions that do not rely on verbal fluency, AR/VR is highly congruent with UDL principles. International students are given the opportunity to demonstrate their understanding in multiple ways with multimodal affordances, which lower linguistic barriers.

Several projects across Europe have shown how AR/VR can be used for inclusive education (Poggianti et al., 2025). Virtual reality (VR) learning modules implemented in the Netherlands, Spain, and Germany as part of the EU-funded "INCLUDE-VR" project, for instance, incorporate intercultural narratives and multilingual support (Analytics et al., 2023). Results from using these courses to foster multicultural classroom collaboration and intercultural awareness have been encouraging. Even while colleges in Italy are welcoming more students from Asia

and Africa, most classes are still taught in Italian, which makes it difficult for some of these students to participate. One possible strategic approach to this gap could be to use AR/VR multilingual modules. These modules could assist instructors in creating classrooms that are more welcoming to students of different language backgrounds, raising levels of engagement and equity.

Theme 3 (RQ3): Impact on Motivation, Engagement, and Well-being (Jedwab et al., 2023; Kessels & Van Houtte, 2022)

Important components of effective international education include students' motivation, engagement, and social and emotional health, all of which can be profoundly affected by immersive technologies. According to Deci and Ryan (2000), who developed the theory of self-determination, intrinsic motivation can be best nurtured when one has a sense of relatedness, competence, and autonomy. Virtual reality (VR) and augmented reality (AR) tools promote independence through tailored learning paths and choice-based exploration, competence via the use of scaffolding to acquire skills and immediate feedback, and relatedness using collaborative virtual projects to foster a feeling of community.

Those motivational affordances can have a profound impact on overseas students' self-efficacy, which can be a challenge in new academic environments. Further explanation of how involvement arises from the interaction of social, cognitive, and instructional presence is provided by the Community of Inquiry (CoI) paradigm (Yulianti & Maghfiroh, 2023). Augmented and virtual reality technologies improve students' social presence through avatars and embodied interactions, students' cognitive presence through immersive problem-based assignments, and teachers' presence through guided virtual scaffolds.

All these things work together to make it easier for overseas students to feel accepted, challenged, and supported in their online communities of learners, regardless of language or cultural hurdles. Considering the cultural and psychological obstacles that many international students encounter, well-being is an additional crucial component. According to research by Guberina (2023), people who experience immersive surroundings report less fear, more feelings of belonging, and more emotional safety while trying new things. For instance, Rossi et al. (2022) found that Erasmus students who participated in trial virtual reality programs at the University of Bologna during the COVID-19 epidemic reported less anxiety and better social integration. Based on these results, augmented and virtual reality technologies have the potential to greatly benefit international students' emotional resilience, mental health, and academic performance in multicultural classrooms.

Theme 4 (RQ4): Challenges and Best Practices for AR/VR Integration (Ashtari et al., 2020; Creed et al., 2024; Dembe, 2024)

Immersive technologies have great promise, but there are still a few obstacles that need to be overcome before they can be widely and effectively used. In underfunded universities, access to AR/VR solutions is generally limited due to their high costs and the advanced technical infrastructure required. Many teachers do

not have the necessary training in immersive pedagogy, which adds to their digital competency issues and faculty opposition to integration. Inadequately diversified augmented and virtual reality content raises ethical concerns with cultural stereotyping and bias.

Further exclusion cannot happen unless we fix the accessibility problems that handicapped students continue to face. Institutional and policy changes are necessary to address these problems. One way to make sure that material is culturally relevant and accurate is to co-design it with different student groups. One way to help people with language and cognitive challenges is to provide them with multilingual support, adjustable difficulty levels, and an inclusive interface design. To develop competence and self-assurance in immersive instruction, faculty training on inclusive digital pedagogy is crucial. In addition, review procedures and ethical standards should be put in place to prevent cultural misrepresentation and the reinforcement of stereotypes.

Italian institutions are way behind the curve when it comes to funding and training for the adoption of AR/VR, even while legislative frameworks like the European Education Area (2025) promote digital innovation at the European level. Erasmus+ digitalization grants and cross-university cooperation could speed up capacity-building and resource sharing through strategic investment. To support Europe's larger dedication to diversity, equity, and inclusion in higher education, institutions must eliminate these systemic obstacles before they can develop long-term strategies for using immersive technologies.

Discussion: European and Italian Context

The wider aims of digital transformation and inclusion in higher education in Europe are congruent with the deployment of AR/VR. Germany, the Netherlands, and Finland are at the forefront of immersive education programs. While there has been some success, adoption has been slower in Italy owing to a lack of funding and more traditional teaching practices. However, there is a need for more culturally sensitive methods due to the increasing number of international students, particularly from Africa and Asia. Italian colleges can use augmented and virtual reality to overcome traditional obstacles by incorporating an inclusive, bilingual, and immersive curriculum that caters to the demands of different student populations (Alalwan et al., 2020).

Higher education institutions throughout Europe are starting to see the potential of augmented and virtual reality (AR/VR) as a tool to promote digital transformation and educational equity. For the future of education across Europe, digital innovation, mobility across borders, and equity are the cornerstones of the European Education Area (EEA) 2025 and the Digital Education Action Plan (2021–2027) of the European Commission. The policies have spurred significant investment

in immersive learning ecosystems, particularly in nations leading the way in incorporating AR/VR into university curricula, such as Germany, the Netherlands, and Finland.

These examples show how augmented and virtual reality (AR/VR) are being used in the classroom to create welcoming spaces for students of all language backgrounds and cultural backgrounds, as well as to facilitate internationalization through hands-on learning (Aruanno et al., 2025). The Italian market for immersive technology, on the other hand, has been slow to catch on and even more disjointed. While there are some innovative initiatives, such as the virtual reality architecture programs at Polytechnic di Milano and the virtual reality orientation modules for Erasmus students at the University of Bologna, these are still small-scale trials rather than system-wide changes (Fricano et al., 2025). There are other elements that are interacting with this slower uptake:

- **Resource constraints**, including limited funding for educational technology infrastructure.
- **Traditional pedagogical cultures** that still favor lecture-based, teacher-centered instruction.
- **Insufficient faculty training** and digital competence for designing inclusive AR/VR content.
- **Regulatory and administrative inertia**, which slows curricular innovation.

There is an urgent need for culturally and linguistically inclusive approaches of education in Italy notwithstanding these obstacles. The number of international students studying in the country has been on the rise, particularly from Africa and Asia, although many programs still only offer instruction in English and are focused on teaching students' European history and culture. This poses serious problems for overseas students, who frequently have difficulties with communication, social integration, and cultural marginalization, all of which have a negative impact on their participation, motivation, and overall health. With AR and VR, Italian colleges can bypass conventional wisdom and join the rest of Europe in adopting cutting-edge practices.

In contrast to more traditional methods, immersive tools can be added to current courses as supplemental treatments that improve them instantly, rather than as a complete revamp of the pedagogical culture. Augmented and virtual reality systems can validate cultural identities while providing international students with equal access to content by incorporating multilingual support (e.g., subtitles, audio in students' native languages), culturally varied avatars and scenarios, and immersive simulations. These elements can alleviate the mental and emotional strain that international students experience by increasing engagement, decreasing cognitive load, and fostering a safer environment.

The strategic objectives of Italy's government regarding the globalization of higher education are compatible with AR/VR. A more international student body and more internationally competitive university system are priorities for Italy's

Ministry of Universities and Research. Italian educational institutions might stand out from the competition by embracing immersive technologies, which would highlight their innovative spirit, inclusivity, and appeal to international students. Additionally, this would help achieve goals set out by the Erasmus+ digitalization agenda, which is open to all EU member states and encourages the use of collaborative and immersive technologies to foster understanding and appreciation of different cultures. But fundamental adjustments are required to go ahead.

To scale AR/VR initiatives, train faculty on culturally responsive digital pedagogy, and collaborate with European immersive learning networks to create inclusive content, Italian universities need to adopt institutional strategies and funding models. One way to speed things up would be to use the Erasmus+ digital transformation funding and the research consortia financed by the EU. If Italy does not make these efforts, the gap between its internationalization goals and what international students experience will only grow. While the rest of Europe is establishing augmented and virtual reality as essential components of accessible online higher education, Italy is at a critical juncture. Universities in Italy can modernize their teaching methods and better accommodate their increasingly diverse student body by adopting immersive technologies as tools for cultural inclusion and experiential learning. This will help fulfill Europe's goal of creating a higher education system that is inclusive, innovative, and globally linked.

Conclusion

Immersive technology has the potential to revolutionize multicultural higher education classrooms, according to this theoretical analysis. With its foundations in experiential learning, UDL, sociocultural theory, and self-determination theory, AR/VR has the potential to elevate foreign students' learning experiences, encourage inclusivity, and cultivate motivation, engagement, and overall wellness. However, training for professors, institutional support, and culturally relevant design are all necessary for a successful rollout. Using immersive technologies may be a smart move for Europe and Italy to get to internationalized education systems that are inclusive.

Immersive technologies hold transformative potential for multicultural higher education classrooms. Drawing upon experiential learning, Universal Design for Learning (UDL), sociocultural theory, and self-determination theory, this theoretical analysis demonstrates how AR/VR can enhance learning experiences, promote inclusivity, and strengthen motivation, engagement, and student well-being.

However, for these benefits to be fully realized, practical steps must be taken by educators and policymakers. Universities should invest in faculty development

programs that train teachers to design and facilitate immersive lessons using inclusive pedagogical principles. Faculty training should include strategies for integrating multilingual support, culturally diverse scenarios, and adaptive feedback mechanisms into AR/VR learning environments.

At the policy level, higher education authorities and institutions are encouraged to establish guidelines for inclusive AR/VR design that emphasize accessibility, cultural representation, and ethical use of immersive technologies. Collaborative initiatives between educators, instructional designers, and international students can help co-create immersive content that reflects cultural diversity and promotes belonging.

Furthermore, policymakers can support these efforts through funding frameworks and institutional incentives aligned with the European Higher Education Area's digitalization and inclusion agendas. By translating theoretical insights into concrete institutional practices, immersive technologies can become a cornerstone of equitable and globally responsive higher education.

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Sobia Yasmeen

Technologie immersyjne (AR/VR) dla poprawy jakości nauczania w klasach wielokulturowych: zaspokajanie potrzeb studentów zagranicznych

S t r e s z c z e n i e

W wyniku globalizacji europejskie uniwersytety przyciągają obecnie studentów z całego świata, wzbogacając społeczność kampusu o ich różnorodne pochodzenie i perspektywy. Często jednak napotykają oni trudności w zaangażowaniu i samopoczuciu z powodu barier językowych, niedopasowania kulturowego i izolacji społecznej. Nowe trendy w zakresie innowacyjnych narzędzi, technologii immersyjnych, takich jak AR i VR, powstały, aby stawić czoła tym problemom. Technologie immersyjne mają potencjał, aby poprawić doświadczenia edukacyjne, ułatwić bardziej inkluzywne kulturowo i językowo nauczanie oraz wpłynąć na motywację, zaangażowanie i ogólny stan zdrowia studentów zagranicznych. Niniejsze studium teoretyczne zgłębia te zagadnienia, ukazując teoretyczny aspekt tej dziedziny. Artykuł analizuje aktualną literaturę w sposób tematyczny w kontekście europejskim, ze szczególnym uwzględnieniem Włoch, odwołując się do teorii socjokulturowej, teorii obciążenia poznawczego i teorii samostanowienia. Ponadto, artykuł wskazuje na istotne trudności i rozwiązania związane z wykorzystaniem technologii immersyjnych w klasach wielokulturowych. Wyniki pokazują, że przestrzenie AR/VR, stworzone z myślą o inkluzywności, mają potencjał zrewolucjonizowania uniwersytetów poprzez promowanie bezpieczeństwa psychologicznego, kompetencji międzykulturowych i głębokiego uczenia się.

S ł o w a k l u c z o w e: Technologie immersyjne, AR/VR, Klasa wielokulturowa, Studenci zagraniczni

Sobia Yasmeen

Tecnologías Inmersivas (RA/RV) para Mejorar el Aprendizaje en Aulas Multiculturales: Abordando las Necesidades de los Estudiantes Internacionales

R e s u m e n

Como resultado de la globalización, las universidades europeas atraen a estudiantes de todo el mundo, enriqueciendo a la comunidad universitaria con sus diversos orígenes y perspectivas. Sin embargo, a menudo enfrentan desafíos para la participación y el bienestar debido a las barreras lingüísticas, la desigualdad cultural y el aislamiento social. Nuevas tendencias en herramientas innovadoras, como las tecnologías inmersivas como la RA y la RV, han surgido para abordar estos problemas. Las tecnologías inmersivas tienen el potencial de mejorar las experiencias de aprendizaje, facilitar una instrucción más inclusiva cultural y lingüísticamente, e impactar en la motivación, el compromiso y la salud general de los estudiantes internacionales. Esta revisión teórica profundiza en estas cuestiones, presentando el aspecto teórico de este campo. El artículo analiza la literatura actual temáticamente dentro del contexto europeo, centrándose específicamente en Italia, basándose en la teoría sociocultural, la teoría de la carga cognitiva y la teoría de la autodeterminación. Además, destaca importantes desafíos y soluciones para el uso de la tecnología inmersiva en aulas multiculturales. Los resultados muestran que, cuando se crean priorizando la inclusión, los espacios de RA/

RV tienen el potencial de revolucionar las universidades al promover la seguridad psicológica, la competencia intercultural y el aprendizaje profundo.

P a l a b r a s c l a v e: Tecnologías inmersivas, Realidad virtual/Realidad aumentada, Aula multicultural, Estudiantes internacionales

Собия Ясмин

Иммерсивные технологии (AR/VR) для улучшенного обучения в мультикультурных классах: удовлетворение потребностей иностранных студентов

А н н о т а ц и я

В результате глобализации европейские университеты превратились в глобальные студенческие сообщества, объединяющие университетские сообщества с разным опытом и взглядами. Меню было введено без каких-либо ограничений, без учета необходимости участия и биеннализации, решения языковых барьеров и необходимости культурной и социальной интеграции. Для решения этих проблем были разработаны новые инновационные тенденции, такие как встроенные технологии, такие как дополненная и виртуальная реальность (AR) и виртуальная реальность (VR). Иммерсивные технологии повышают образовательный потенциал, облегчают обучение, учитывают культурные и языковые аспекты, а также влияют на мотивацию, способность к компромиссу и общую дружелюбность иностранных студентов. Данное углубленное теоретическое исследование рассматривает эти темы, предлагая теоретический взгляд на это преобладание. В данной статье анализируется соответствующая литература в тематическом формате в европейском контексте, в частности, в Италии, с опорой на социокультурную теорию, когнитивную теорию и теорию самоопределения. Однако существуют важные проблемы и решения, связанные с использованием иммерсивных технологий в мультикультурной среде. Таким образом, уделяя первостепенное внимание инклюзивности, пространства для отдыха и путешествий позволяют инновационным университетам развивать психологическую безопасность, межкультурную компетентность и углубить обучение.

К л ю ч е в ы е с л о в а: Инклюзивные технологии, Виртуальная реальность/Дополненная реальность, мультикультурная гостиная, иностранные студенты

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A Report from the International Scientific Conference "Theoretical and Practical Aspects of Distance learning" DLCC2025 (www.dlcc.us.edu.pl) subtitled: "E-learning & Interactive Learning. Generative Artificial Intelligence (GAI), Gamification and Immersive Technologies (AR/VR) in Educational Practice and Research" which was held at the University of Silesia, Cieszyn, Poland on October 15 and 16, 2025

The 17th edition of the International Scientific Conference, "Theoretical and Practical Aspects of Distance learning" DLCC2025 (www.dlcc.us.edu.pl) was held under the theme "E-learning & Interactive Learning. Generative Artificial Intelligence (GAI), Gamification and Immersive Technologies (AR/VR) in Educational Practice and Research" on October 15th and 16th, 2025, at the University of Silesia in Katowice. It was organised by the Faculty of Arts and Educational Sciences in Cieszyn, Faculty of Social Sciences, the Faculty of Computer Science and Materials Sciences in Sosnowiec, the Institute of Pedagogy, and Institute of Computer Science, University of Silesia in Katowice, Poland.

The Conference was organized under the auspices of Rector of the University of Silesia in Katowice – Prof. dr hab. Ryszard Koziołek, Dean of the Faculty of Arts and Sciences of Education – Prof. dr hab. Katarzyna Marcol, Dean of the Faculty of Social Sciences – Prof. dr hab. Małgorzata Myśliwiec, Director of the Institute of Pedagogy – Prof. dr hab. Irena Polewczyk, Dean of the Faculty of Science and Technology – Prof. dr hab. Seweryn Kowalski, Director of the Institute of Computer Science – Prof. dr hab. inż. Rafał Doroz. The co-organisers were

the University of Ostrava (UO), the Czech Republic, Silesian University in Opava (SU), the Czech Republic, Constantine the Philosopher University in Nitra (UKF), Slovakia, University of Extremadura (UEx), Spain, University of Twente (UT), The Netherlands, Lisbon Lusiada University (LU), Portugal, Curtin University in Perth (CU), Australia, Borys Grinchenko Kyiv University (BGKU), Ukraine, Dniprovsk State Technical University (DSTU), Ukraine, IADIS – International Association for Development of the Information Society, a non-profit association, Polish Pedagogical Society, Branch in Cieszyn, Polish Scientific Society for Internet Education Association of Academic E-learning, Poland.

The Annual International Scientific Conference "Theoretical and Practical Aspects of Distance Learning" DLCC2025 is an important event within the field of education, particularly focused on distance learning and its practical applications. It is organized annually by prominent academic institutions, including the University of Silesia in Katowice, Poland, and co-organized with various international universities. This conference brings together scholars, experts, and educators from around the world to discuss advancements in distance education, e-learning, and technology-enhanced learning, which is critical as educational systems modernize worldwide.

Members of the International Programme Committee are experienced scientists, scholars, and researchers in the field of ITC and distance learning from many countries in Europe and worldwide. The Honorary Scientific Committee goes as follows:

- Prof. dr hab. Katarzyna Marcol, Dean of the Faculty of Arts and Educational Sciences, University of Silesia in Katowice, Poland
- Prof. dr hab. Małgorzata Myśliwiec, Dean of the Faculty of Social Sciences, University of Silesia in Katowice, Poland
- Prof. dr hab. Piet Kommers, Professor UNESCO, University of Twente, the Netherlands
- Doc. Ing. Katerina Kostolanyova, PhD, Vice-Dean of the Faculty of Pedagogy University of Ostrava, the Czech Republic
- Prof. dr hab. Inż. Jan Kusiak, Head of E-Learning Centre, University of Science and Technology in Cracow (AGH), Poland
- Prof. dr hab. Natalia Morze, Vice-Rector of the Borys Grinchenko Kyiv University, Ukraine
- Prof. Norbert Pachler, London University, United Kingdom
- Prof. dr hab. Irena Polewczyk, Director of the Institute of Pedagogy, University of Silesia in Katowice, Poland
- Prof. dr hab. inż. Rafał Doroz, Director of the Institute of Computer Science, University of Silesia in Katowice, Poland
- Prof. dr hab. Seweryn Kowalski, Dean of the Faculty of Sciences and Technology, University of Silesia in Katowice, Poland

- Prof., dr hab. Maciej Tanaś, Dean of the Pedagogical Faculty, Maria Grzegorzewska Academy of Special Education, Poland
- Prof., dr inż. Milan Turcani, Constantine the Philosopher University in Nitra, Slovakia
- Prof. dr. Pedro Veiga, Vice-rector of the Lisbon University, Portugal
- The conference topics include the following thematic sections:

1. E-learning & GAI, AR/VR, Gamification
   - Generative Artificial Intelligence (GAI), Augmented Reality (AR), Virtual Reality (VR)
   - E-learning & GAI, AR/VR, Gamification
   - AI in Education: perspective and challenges
   - AI Apps: ChatGPT, Gemini, DeepSeek, Copilot, Claud, Perplexity, Beyond
   - Students' and teachers' competences in the area of AI
   - Ethical and Social Aspects of AI
   - Machine Learning. Learning Analytics.
   - Immersive learning environments. Blockchain. ChatBots
   - E-learning and STEAM Education
   - Robots and Coding in education
   - Internet of things. 3D printing
   - STEM education contemporary trends and challenges
   - Distance learning in humanities and science
   - Quality of teaching, training in area of e-learning
   - E-learning for science and technologies
2. E-learning & Enhancing Key Competences.
   - Methodology and Tools Development
   - Use of e-learning in improving the level of specialists and students' digital competences
   - Innovative Educational Technologies, Tools and Methods for E-learning
   - Modern ICT Tools for e-learning in the time of COVID-19 and after pandemic – review, implementation, opportunities for effectiveness of learning and teaching
   - MOOCs – methodology of design, conducting, implementation and evaluation
   - Education 4.0 and Education 5.0
   - E-learning and effectiveness of using Learning Management System (LMS), CMS, VSCR, SSA, CSA
   - Cloud computing environment, social media, multimedia resources
   - Methodological tools. E-tutoring. (Video)tutorial design
   - Simulations, models in e-learning and distance learning
   - Successful examples of M-learning, e-learning
   - Evaluation of synchronous and asynchronous teaching and learning, methodology and good examples

3. E-learning & Enhancing Soft Skills:
   - Key competences and soft skills in the digital society
   - E-learning for humanities and social sciences
   - Self-learning based on e-learning and Internet technology
   - E-learning and online learning
   - Blended learning
   - Legal, social, human, scientific, technical aspects of distance learning and e-learning in different countries
   - European and national standards of e-learning quality evaluation
   - Psychological and ethical aspects of distance learning and e-learning
   - E-collaboration and e-communication in e-learning
   - E-environment of the Contemporary University
   - E-learning in a sustainable society. Ecosystem and green university
   - Comparative approach in research on e-learning
4. E-learning in the Transformation of Education in Digital Society: Training of the specialists and LLL
   - Contemporary trends in world of e-learning in conditions of globalization, internationalization, mobilities
   - Effective development of teachers' digital skills
   - E-learning and Lifelong Learning
   - E-environment and Cyberspace Security Development of Key and Soft Competences and E-learning
   - AI and Cyberspace. Cybersecurity
   - Networking, distance learning systems

Experts from many countries, such as Austria, Bulgaria, Croatia, the Czech Republic, Italy, the Netherlands, Pakistan, Portugal, Poland, Saudi Arabia, Slovakia, Taiwan, Turkey, the United Kingdom, and Ukraine, reflected on innovative educational technologies, tools and methods, particularly Generative Artificial Intelligence (GAI), for e-learning, as they presented their research results, contemporary trends and scientific, as well as educational projects devoted to Artificial Intelligence (AI), MOOCs, Augmented Reality (AR), Virtual Reality (VR), mobile learning and other topics related to digital technologies and innovative methods of education.

On the first day, 15 October, Prof. dr hab Eugenia Smyrnova-Trybulska started the annual international scientific event.

The Dean of the Faculty of Arts and Sciences of Education, Prof. dr hab. Katarzyna Marcol, welcomes conference participants and quest of the conference (Figure 1)

Figure 1. Prof. dr hab. Katarzyna Marcol, Dean of the Faculty of Arts and Sciences of Education openned the DLCC2025

Author of the photo: Emilia Gogol

Professor Prof. Dr. Piet Kommers from the Twente University, the Netherlands, presented a Keynote Lecture titled "Generative AI and Augmented Reality for Deep Learning" on the plenary session.

Figure 2. Keynote Speaker Prof. Dr. Piet Kommers

Author of the photo: Emilia Gogol

He presented experts' reflections, concerning education that evolved from print to the Web, expanding access to knowledge but also causing information overload. We learn that Generative AI, rooted in simulations, expert systems, and machine learning, enables hybrid knowledge by combining insights across disciplines. This aligns with the STEAM approach, which encourages teachers to integrate adjacent fields to enhance learning effectiveness. The keynote highlights how AI, together with STEAM and emerging VR/AR technologies, supports experiential, active learning. New educational media aim not only to improve traditional teaching but to prepare learners for a complex, innovation-driven society and future job market.

Subsequently, within the framework of conference session, Snježana Babić presented the lecture "Determinants Of Students' Perceived Usefulness Of Large Language Models: The Role Of Relevance, Enjoyment, And Ease Of Use". The expert introduced the audience to the topic of research and presented the Perceived usefulness (PU) is a key factor influencing the acceptance and use of technology. As large language models (LLMs) such as ChatGPT gain popularity in higher education, this study examined factors shaping students' perceptions of their usefulness.

Svitlana Skvortsova, Tetiana Symonenko, Kira Hnezdilova, Nataliia Andrusiak presented the lecture titled „Artificial Intelligence In Ukrainian Secondary Education: Empirical Insights Into Its Integration In Teaching Practice" This study of 1,873 Ukrainian secondary teachers found widespread AI use, mainly for lesson preparation and assessment. Primary, math, and ICT teachers use AI most, while arts and PE teachers use it least. Key barriers include accuracy, cost, language support, and skills gaps.

Nataliia Morze, Olha Barna, Oksana Pasichnyk, authors from Ukraine, in their research "Transforming School Informatics Education In The Ai Era: Paradigm Shift, Pedagogical Innovations, And Digital Competence", explored how AI is transforming school informatics education in Ukraine, shifting from a technocratic to an AI-integrated model. Based on teacher surveys and international frameworks, it highlights the need to update digital literacy, creativity, and data skills, while redefining learning goals toward higher-order thinking.

Researchers, Galina Momcheva and Todorka Glushkova from Bulgaria, in their lecture "AI Threat Modelling Active Learning", introduced the audience to a structured, game-based brainstorming method for AI threat modeling using PLOT4AI cards. Applied in STEAM problem-solving tasks, the approach enhanced technical reasoning, reflection, and skill development, while revealing learning gaps and career-related uncertainties.

Protugalian expert, Filipe Carrera, in his report "How To Transform Your Online Training Into Impactful Experiences", explores how effective digital dialogue can improve online training by addressing disengagement and fatigue. It argues for interactive, human-centered learning that blends active methods, emotional

connection, and digital tools, moving beyond one-way lectures to create engaging and impactful online education.

Researchers from Slovakia, Michal Kabát, Juraj Kovalčík, Magdaléna Švecová, Martin Paučin, presented the lecture "Activating the Potential of Generation Z Through Mindless Games: a Literature Review and Pre-Research Framework". This scoping review (2010–2025) shows that low-cognitive-load digital activities, such as micro-breaks and fidgets, can help Gen Z learners sustain attention, reduce fatigue, and improve engagement without harming performance. However, evidence in educational settings remains limited and fragmented.

After the break, two Workshops were held: "Learning with Interactive Kebbi Air Robot, AI and IoT in Pre-school and Primary Education", conducted by Eugenia Smyrnova-Trybulska, Małgorzata Przybyła-Kasperek, Kornel Chromiński, and Tomasz Kopczyński. They presented theoretical and practical aspects of using Kebbi Air Robot in Pre-school and Primary education (Figure 3 a), b)).

In the framework of the second Workshop: "Overview of proprietary VR modules related to geometry", conducted by Jacek Stańdo, Tomasz Kopczyński, Adam Nowak, Anita Dąbrowicz-Tlałka, Katarzyna Kujawska, Magdalena Musielak interesting practical examples of using VR modules in geometry learning and teaching were presented, elaborated during implementation of the Math3DGeoVR project Mathematical Models for Teaching Three-Dimensional Geometry Using Virtual Reality, 2021-1-PL01-KA220-HED-000030365 https://www.math3dgeovr.p.lodz.pl/ (Figure 4. a), b)).

a)

b)

Figure 3. a), b) Workshops: “Learning with Interactive Robot Kebbi Air, AI and IoT in Pre-school and Primary Education”, conducted by Eugenia Smyrnova-Trybulska, Małgorzata Przybyła-Kasperek, Kornel Chromiński, Tomasz Kopczyński (a). Participants of the Workshops (b)

Author of the photo: Emilia Gogol

a)

b)

Figure 4. a), b). Workshop: "Overview of proprietary VR modules related to geometry", conducted by Jacek Stańdo, Tomasz Kopczyński in presense, and Adam Nowak, Anita Dąbrowicz-Tlałka, Katarzyna Kujawska, Magdalena Musielak online

Author of the photo: Emilia Gogol

The second day (October 16), in the framework of DLCC2025 conference, started with the round table debate "E-learning & Interactive Learning. Generative Artificial Intelligence (GAI), Gamification and Immersive Technologies (AR/VR) in Educational Practice and Research", moderated by Prof. Eugenia Smyrnova-Trybulska and Dr Iwona Mokwa-Tarnowska. The participants of the debate were experts from eight countries: Prof. Piet Kommers – the Netherlands, Prof. Todorka Glushkova – Bulgaria, Prof. Nataliia Morze – Ukraine, Prof. Snježana Babić – Croatia, Prof. Štefan Gubo – Slovakia, Prof. Małgorzata Przybyła-Kasperek – Poland, Prof. Filipe Carrera – Portugal, Dr Miroslav Hruby – the Czech Republic (Figure 5. a), b)). The agenda included five topics: Question 1: What are the main benefits and limitations of applying Generative Artificial Intelligence (GAI) in educational content creation and personalized learning? Question 2: How can gamification integrated with immersive technologies (AR/VR) enhance learning effectiveness, and what barriers limit its successful implementation? Question 3: How can good teachers evolve towards even better teachers, even in the era of AI, VR, and Game-based Learning? How are the roles of teachers and educational researchers

changing in interactive learning environments supported by technologies such as GAI and AR/VR? Question 4: How can the availability of AI transform education into more autonomous/authentic learning attitudes, creative problem solving, and prepare for new jobs and future citizenships in terms of counterproductivity? Question 5: Under what conditions do interactive technologies (GAI, AR/VR, gamification) truly improve learning outcomes, and when might their impact be limited? Question 6: Does the availability of AI imply higher learning goals to be imposed?

During the plenary and conference session, on the second day of the conference, the researchers and participants were presented with 24 lectures, and workshops. The workshop ”FITPED-GAI: Empowering Future Educators with Generative AI” was held, conducted by prof. Małgorzata Przybyła-Kasperek and dr Kornel Chromiński.

In total, the conference included 31 presentations, three workshops, a round table debate and a poster session.

The DLCC2025 conference was actively attended by 87 participants (Figure 4) in presence and in online remote mode from over 12 countries; 18 from Poland, including 10 from the University of Silesia, and 59 from abroad. There were also over 100 passive participants.

The articles developed based on the conference participants' papers have been planned for publishing in the monograph on “E-learning & Interactive Learning. Generative Artificial Intelligence (GAI), Gamification and Immersive Technologies (AR/VR) in Educational Practice and Research” by the renowned Springer publishing house.

a)

b)

Figure 5. a), b) Participants of the round table debate "E-learning & Interactive Learning. Generative Artificial Intelligence (GAI), Gamification and Immersive Technologies (AR/VR) in Educational Practice and Research"

Author of the photo: Emilia Gogol

Considering the international scope and involvement of respected institutions, the DLCC2025 conference is a significant international scientific event for a wide range of scientists, teachers, PhD students, students, educators, tutors, mentors, and anyone interested in the future of education, especially in the context of digital learning environments and the implementation of new technologies and innovative methods. The photo reports from DLCC2025 conference are available in the conference photo gallery (https://dlcc.us.edu.pl/gallery/)

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