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Editorial

The Editorial Board of International Journal of Research in E-learning (IJREL) is privileged to present a new volume 11(1) 2025. The content of the current issue was divided into four chapters and includes eight articles. The first is devoted to Methodological and Technological Aspects of Innovational Approach in Education, and contains two articles. The second contains articles concerned with E-learning in COVID and Post-COVID-19 Time. The third includes research results on Immersive Technologies in Education. The fourth chapter is devoted to Theoretical and Practical Aspects of Using Artificial Intelligence (AI) in Education.

Chapter I is entitled "Methodological and Technological Aspects of Innovational Approach in Education", and contains two articles.

The first article of the volume is "Designing MOOC User Activity", prepared by Anna Ślósarz from Poland who analyzes how students use discussion forums in 208 MOOCs on the Polish Navoica platform. The study focused on substantive forums only, excluding introductory and organizational ones. The results show very low activity: 11% of courses had no forums, 31% had no posts, 15% had only a few posts, and 28% contained mostly organizational messages. Only 15% of forums had over 25 posts. Student participation – also in language courses – was rare and unrelated to enrollment numbers, certificates, or course popularity. The activity was usually triggered by opinion-based questions, self-promotion, peer commenting, or coordinator involvement. The findings align with global research and indicate the need for further work to support literacy and multilingual competences among MOOC users.

Joanna Wójcik, Joanna Świętoniowska, and Jacek Jakieła submitted the manuscript "The Impact of Game-Based Learning on Sustainability Education for Next Generations: a Case Study Analysis". The researchers stressed that higher education institutions must prepare students to address sustainability challenges, and that game-based learning offers a promising approach. This study evaluates the SEED simulation game, designed with the Octalysis Framework, and its potential to enhance sustainability education. A mixed-methods study with 45 university students included a post-game questionnaire, statistical analyses, and a thematic review of qualitative feedback. The results show that the SEED game generated moderate to high engagement, motivation, and perceived knowledge

gains. The strongest motivational drivers were Development & Accomplishment and Social Influence & Relatedness, with engagement strongly correlated with motivation. Students appreciated the game's realism, personalization, and social interaction. The findings indicate that well-designed simulation games can support transformative sustainability learning and meet the preferences of new generations. The study highlights the importance of transparent feedback and alignment with learner needs, consistent with experiences reported at European universities.

Chapter II is titled "E-learning in COVID and Post-COVID-19 Time", and includes two manuscripts.

"Blended Learning and Accounting Student Success in Oman: An Empirical Post-COVID-19 Study" was prepared by Khafiya Sultan Al-Wahaibi, Bashayar Badar Al-Amri, Mohammed Muneerali Thottoli from University of Nizwa, Oman and from RWTH Aachen University, School of Business and Economics, Aachen, Germany. This research aims to explore blended learning (basic requirements and knowledge) and accounting students' success after COVID-19 among graduating students in Oman. Furthermore, this study examines how blended learning (BL) effectiveness acts as a mediator between the BL basic requirements and the success of accounting students, as well as between the BL basic knowledge and the success of accounting students. A quantitative research methodology was employed to collect data for this study, using a questionnaire distributed through WhatsApp and email to students attending various universities in the Sultanate of Oman. Following that, the researchers analyzed the data using partial least squares structural equation modeling (PLS-SEM). The study found that the BL basic requirements have a positive impact on accounting students' success.

The manuscript "The Analysis of the Moodle Platform E-learning Course Activity at the Faculty of Science and Technology at the University of Silesia" was prepared by the Polish team of authors, Małgorzata Przybyła-Kasperek, Jakub Sacewicz, Paweł Pawełczyk. The research presents an evaluation of online course activity across academic disciplines. The dataset, collected before Moodle archiving, included student enrollment, instructor logins, and the size of uploaded materials. Using descriptive statistics, non-parametric tests, and linear regression, the study examined differences between fields and trends from 2012–2024. The results show clear disparities in course activity, with some disciplines demonstrating high student numbers and intensive resource use, while others showed long instructor inactivity. Course visibility did not significantly affect instructor engagement. A slight upward trend in course numbers and teacher participation was observed, with a sharp increase in 2020 during the COVID-19 pandemic. The findings point to the need for targeted strategies to improve digital course management and support sustainable e-learning development.

Chapter III, titled "Immersive technologies in education", contains two articles.

The international team of authors, Saima Mehboob, Alberto Fornasari, Eugenia Smyrnova-Trybulska, prepared the manuscript titled "A Study on the Impact of

Verse in the Metaverse: Exploring the Role of Avatars in Scientific Storytelling". The study examines how Avatar-Based Storytelling in a metaverse-like environment influences learning, engagement, and emotional-social experience in primary school science education. A quasi-experimental pre-test/post-test design was conducted in Poland with 50 students aged 8–12. The experimental group used interactive science scripts with avatars for two weeks, while the control group accessed the same content through standard digital media. The results from tests and engagement surveys showed significantly higher learning gains and engagement in the avatar group ($p < .001$). Qualitative focus group data indicated that students viewed avatars as credible, relatable, and emotionally engaging. The findings suggest that short-term avatar-based narratives can enhance cognitive performance, motivation, and emotional bonding in virtual learning environments. Implications for immersive pedagogy and directions for future longitudinal research are discussed.

The manuscript titled "Carrying the Burden of Innovation in Education: Becoming Educational Events Organizers in Social Virtual Reality" was prepared by the international team of researchers, Jan Waligórski, Sylwia Butkiewicz, Aleksandra Cząstkiewicz, Jowita Guja, Zofia Samsel. Recent research highlights the potential of virtual reality in education, but practical challenges limit wider adoption. This study uses collaborative and analytic autoethnography of five organizers of educational events in social VR to examine real-world difficulties. Key limitations include discomfort and low accessibility of head-mounted displays, non-inclusive platform features, risks to content quality, and the need for new digital skills. Organizers reported high responsibility, stress, and increased workload linked to technical and formal issues, but also strong motivation, personal growth, and strengthened academic identity. Despite challenges, participation fostered skill development, collaboration, community building, and inclusivity. The study concludes with recommendations to help educators address social VR barriers and reduce negative impacts on organizers.

Chapter IV "Theoretical and Practical Aspects of Using Artificial Intelligence (AI) in Education" includes two manuscripts.

Aleksandra Kalaga and Marzena Wysocka-Narewska from University of Silesia, Poland wrote the article titled "ChatGPT in Philology Education: A Pilot Study on AI-Supported Language Learning". This pilot study explores how university students use ChatGPT in foreign language learning. Using a mixed-methods approach, it examines English and Romance Philology students' academic and out-of-class practices. The questionnaire results show that students most often use ChatGPT outside the classroom, mainly for writing support, vocabulary expansion, and grammar correction, with a clear preference for autonomous use. Qualitative data indicate that students value the tool's speed and versatility but remain aware of limitations such as inaccuracies, formulaic style, and ethical issues. Interpreted through Self-Directed Learning, the Technology Acceptance Model, and Constructivist Learning Theory, the findings suggest that ChatGPT serves mainly as

a complementary aid. The study offers pedagogical recommendations and highlights the need for AI literacy and teacher guidance in modern language education.

Lucie Zormanova from Poland and Hana Vavříková from The Czech Republic prepared the manuscript titled "Attitudes of Czech and Polish Teachers Towards the Use of Artificial Intelligence in Schools". The study examines how teachers in both countries perceive the introduction of AI into education. Using qualitative research and semi-structured interviews with primary and secondary school teachers, the authors explored similarities and differences in attitudes. Czech teachers often expressed concerns about AI, especially the risk of cheating and plagiarism. This fear did not appear among Polish teachers, who generally viewed AI as helpful and had initial positive experiences with its use. Some Czech teachers also reported benefits, noting that chatbots can reduce workload. Both Czech and Polish teachers agreed that AI's arrival is inevitable and that educators must guide students in using it effectively. They also recognized that teaching methods will need to change, with new types of assignments that AI cannot complete for pupils.

This volume brings together diverse studies exploring innovation in contemporary education. Contributions explore MOOC user behaviour, and the effectiveness of sustainability simulation games. The next manuscript analyses e-learning activity in COVID and Post-COVID-19 time, in particularly, on the Moodle platform. Further research presented and reflected on the challenges and opportunities of immersive technology in primary education, the impact of avatar-based storytelling in metaverse environments and social VR in higher education. The closing studies examine teachers' attitudes toward AI in schools, and investigate the role of ChatGPT in language learning at the university. Together, these papers highlight emerging technologies, pedagogical transformations, and the evolving competencies needed for modern learners and educators.

The Editorial Board wishes all readers inspiration, curiosity, and continued passion for exploring innovative approaches to teaching and learning. May the insights in this volume support your academic work, enrich your educational practice, and encourage bold experimentation with new technologies. We hope these contributions spark further research, meaningful collaboration, and a shared commitment to shaping the future of education.

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Designing MOOC User Activity

Abstract

In recent years, xMOOC, one-way knowledge transfer have been replaced by cMOOCs which allow users to co-create knowledge. Substantive discussion forums are mainly used for this purpose. However, students use forums for more than just this type of collaboration. The aim of the study was to analyze the purpose and extent to which students enrolled in 208 MOOC courses posted on the Polish "Navoica" platform use discussion forums and how MOOC authors encourage or discourage students from participating in substantive forums. Introductory and organizational forums were excluded from this study. Discussion forums user activity on substantive issues was low. Findings of this study support findings included in the research conducted in other regions of the world. 11% of studied courses did not include discussion forums; in 31% of forums there were no posts; in 15% of forums there were a few to a dozen of posts; and in 28% of MOOCs there were entries predominantly about organizational matters. In only 15% forums there were more than 25 posts. Students, including those enrolled in language learning courses, rarely posted on forums. Number of posts did not correspond to number of participants, number of certificates issued, or popularity of the course. Participants' activity was usually triggered by question inspiring expression of their opinion, self-promotion, commenting on colleagues' entries, and also by course coordinator's participation in the discussion. Participation of Polish MOOCs platform users in discussion forums deserves further research to promote development off first and second key competences, i.e., *Literacy competence* and *Multilingual competence*. The main results may be generalized to the entire MOOC-user population.

K e y w o r d s: auto-presentation, communication, personal, post, question, story

Introduction

Research Problem

xMOOCs, one-way knowledge transfer platforms, are being increasingly replaced by cMOOCs allowing users to co-create new knowledge based on peer-learning, but not by discussions with the tutor, because MOOCs are not moderated. To what extent, then, is it rational to participate in a discussion forum? Does posting in a substantive forum unequivocally contribute to the development of knowledge and competences? Or is it a waste of time or exposing self to unpleasant consequences such as *hate speech* known from social media? These doubts and fear of judgment (Bouchet, Labarthe, Bachelet, & Yacef, 2017) are not unfamiliar to MOOC participants. Yet, the conditions of their activity in discussion forums have not been sufficiently researched. This paper fills this research gap by presenting ways of encouraging as well as discouraging MOOC users to post in substantive forums, and also various strategies utilised by the authors of posts. Awareness of the verbal interaction, the ability to formulate and express arguments, awareness of the impact the words have on people have become crucial in times of social communication dominated by mainstream media and AI which create and disseminate compelling cognitive amalgamates frequently distorting the perception of reality. Moreover, mainstream media, social media and AI recurrently promote specific points of view, axiological reality assumptions, and obvious biases.

Education, on the other hand, does not only involve the process of acquiring knowledge, but it also develops key competences. The European Union classified *Literacy competence* and *Multilingual competence* as crucial key competences (2018, p. 7). This means that the aim of education is to promote subjective communication, i.e., expression of one's point of view, independent thinking, critical appraise of external messages, and also effective communication with peers and tutors.

Communication skills are necessary to interpret the world, obtain information, learning process, asking for assistance, meeting various demands, and forming healthy relationships with others. Skilled communication can be practiced verbally or in a written form, with the use of different communications styles and languages depending on the needs, contexts, and traditions of learners. Ludwig Wittgenstein's famous quote from *Tractatus Logico-Philosophisus*: *Die Grenzen meiner Sprache bedeuten die Grenzen meiner Welt* [*The limits of my language mean the limits of my world*] (5.6) captures the relationship between the extend of acquired concepts and the degree to which reality is understood. MOOCs' discussion forums promote learning by endorsing reciprocal encouragement.

The designers of cMOOCs (Siemens, 2005) rightly assume that learners' cooperation results in creation of knowledge. That is why for the next decades

discussion forums are to be mandated features of courses delivered on the American platforms "edX" and "Coursera", the European platform "Future Learn", and, partially, the Polish MOOC "Navoica" platform . These platforms offer identically structured courses in which discussion forums play an important didactic role. They also serve self-promotional purposes, bonding users with the platform, encouraging them to read fellow students' posts, post comments, and, on the principle of peer assessment, evaluating other participants' assignments. When a user posts an assignment in the "Future Learn" substantive forum, he/she immediately receive randomly selected assignments from other users for evaluation. This process is managed by Artificial Intelligence which means that the actual activity of users in discussion forums is low and AI compounds this problem. There are forums, however, moderated by instructors who offer social, educational, and cognitive presence (Goshtasbpour, Swinnerton, & Morris 2020, p. 234).

Research Focus

In the contemporary Western world, private entities that run business activities in parallel with education are the owners of the most popular MOOC platforms such as "Coursera", "edX", "FutureLearn" or "Alison". In the other hand in some countries there are platforms managed by foundations, local governments, or educational institutions established specifically for this purpose by the relevant Ministry of Education or Science. Such platforms are for example "France Université Numérique", "EduOpen" (Italy), "Navoica" (Poland), "XuetangX" (China), or "SWAYAM" (India). Commercial platforms extensively use artificial intelligence and marketing tricks to sell educational services. Non-commercial platforms, on the other hand, better reflect national educational policies and embrace authentic ways of teaching by teachers. This happens in parallel with the users' activities which reveal their true educational expectations. The largest Western MOOC platforms managed by universities, i.e., "edX" and "EduLearn", have been purchased by private entities in the last three years. The same happens to other national and university platforms. In the face of the rapidly advancing commercialization of MOOC platforms, which were supposed to be universally available and free of charge, this study focuses on the current behavioral patterns of users of non-commercial platform administered by the Polish Minister of Science, i.e., the MOOC "Navoica" platform. It can be expected that the commercialization of Western MOOCs will continue and subjecting those platforms to marketing strategies will lead to an increased neglect of the real expectations and needs of their users. Hence, it is worth examining current expectations and needs of users of one of the increasingly uncommon non-for-profit platforms which does not utilise AI to activate discussion forums, contrary to e.g., "FutureLearn".

The aim of the research was to characterize lecturers' strategies and to analyze participants' engagement in substantive discussions in MOOCs courses available on the Polish educational "Navoica" platform as an exemplary ministerial and non-profit platform. The study focused on strategies used by the course authors aiming at encouraging participants to post on discussion forums, communication strategies used by the students and those supported by the platform.

Special attention was paid to foreign language learning courses, because posting in those courses not only develops communicative competences and supports acquisition of specialist knowledge, but also consolidates practical knowledge of vocabulary, syntax and phraseology of a given language. In language courses – both stationary and delivered in distance-education mode – verbal interaction between an instructor and participant is essential in learning basic vocabulary, phrases, and expressions. The "Navoica" platform MOOCs are not moderated. There are no verbal interactions of students with the teacher; only written interactions with peers necessary for language learning, i.e., learning effective communications, remain. Discussion forums in language learning courses play a very important role in the process of knowledge acquisition. Therefore, the presented study especially focused on the organization of language learning courses and on users' participation patterns.

Related Research

The analysis of user activity in MOOCs aimed at identifying ways allowing for reducing students' high dropout rate, because social interactions have a positive impact on learning outcomes: *MOOCs lacking social support, social presence and peer interaction result in high dropout rates* (Loh, Martins van Jaarsveld, Masutoglu, & Baars 2024, p. 02). Correlation was observed *between the learners' course completion status and the level of their activity in the forums* (Cohen, Shimony, Nachmias, & Soffer, 2019, p. 178) and *positive correlation between forum activity and course grade* (He, Ma, Zhou, & Wu 2018, p. 1). The following activity patterns were identified: homophily (tendency to associate with similar persons), reciprocity (paired up conversation with a returned flow), transitivity (ties with participants who are the friends of the friends), and preferential attachment (participants actively involved in forum are likely to become even more engaged) (Zhang, Skryabin, & Song, 2017). It was concluded that user engagement can be promoted by *individualized tutoring, interactivity, and feedback* (Estrada-Molina, & Fuentes-Cancell, 2022, p. 1). All of which can be implemented on forums to allow participants *seek help, provide suggestions, and engage in discussions* (Naskar, Hasan, & Das 2021, p. 1). Special attention was paid to the role of social media, which propose patterns for building relationships which are subsequently adapted by contemporary students *in areas such as establishing new contacts,*

maintaining offline relationships, mutual learning and self-presentation (Frania, Correia, Kotecki, & Kokić 2022, p. 1).

Thus, researchers emphasize the role of a tutor who can facilitate critical thinking by engaging participants in intellectually stimulating discussions, challenging tasks, analyzing information, questioning imposed ideas, drawing conclusions (Tirthali, & Murai 2024, p. 2) and *help low-achieving students make significant progress* (Wei, Liu, Xu, Kolletar-Zhu, & Zhang 2023, p. 1). Tutor involvement is also important for enhancing users' intrinsic motivation (Tang, Xing, & Pei 2018, p. 368). Therefore, attempts have been made to develop a tool to automatically find *posts that necessitate their intervention* (Ntourmas, Daskalaki, Dimitriadis, & Avouris 2023, p. 162). Entries that require urgent teacher's response are identified from thousands of similar by the use of purposely developed tools (Khodeir 2024; Lee, D., Rothstein, R., Dunford, A., Berger, E., & Rhoads, J.F., & DeBoer, J. 2020). However, in MOOC a huge number of entries still poses a problem for a moderator.

Not receiving an answer to a question can be very discouraging to students. It is essential to support information exchange. Unmoderated general forum, apart from posts on substantive issues, often contains a number of posts covering *course-related issues such as reporting problems and suggesting* (Onah, Sinclair, & Russell 2014, p. 5). Moderation of the substantive forum by the teacher allows students to get a prompt and reliable response to a specific question (Onah, Sinclair, & Russell 2014, p. 5). However, a number of MOOC platforms function without any supervision. On such platforms, the users can only support each other, while *only a small fraction of all MOOC participants use the forum to communicate* (Hecking, T., Chounta, I.-A., & Hoppe H.U., 2017, p. 1). It seems reasonable to appoint volunteers to moderate forums, for example recruited from among graduates of a given MOOC course (Krasny, DuBois, Adameit, Atiogbe, Baih, Bold-Erdene et al., 2018; Gamage, 2021) or teaching assistants (Wang, Cheng & Cai, 2023). MOOC participants look forward to not only the acquisition of knowledge, but also social presence including emotional expression, communication, co-presence, and group cohesion.

Methodology

Research Gap and Research Questions

Research to date has not sufficiently addressed the factors dependent on MOOC teachers and course designers that influence participants' activity in substantive discussion forums. To fill this research gap, the following research questions were formulated:

1. To what extent are MOOCs equipped with substantive discussion forums and what is the level of users' participation in substantive discussion forums?

Two additional questions were formulated:

2. How is users' participation in substantive discussion forums supported?
3. What is the level of user's activity in language courses forums?

Research Sample

The research sample consisted of MOOCs courses available between 21st and 22nd of May, 2024, on the "Navoica" platform. During the research period, 208 MOOCs were made available by universities, educational institutions, and other organizations. The number of offered courses is presented in Table 1.

Table 1
Universities offering MOOCs

Development Unit	Number of MOOCs
Bialystok University of Technology	32
University of Economics and Human Sciences	30
The West Pomeranian Business School	22
Cracow University of Technology	14
Poznań University of Economy and Business	12
Adam Mickiewicz University in Poznań	12
National Information Processing Institute	12
University of Silesia in Katowice	11
Vistula University	10
WSB University	7
Jan Dlugosz University in Czestochowa	6
WSPiA University of Rzeszów	6
Bydgoszcz WSG University	5
Academia Humanitas	4
Jagiellonian University in Kraków	3
Ignatianum University in Kraków	3
Pawel Wlodkowic University College in Płock	2
University of Szczecin	2
Military University of Technology	2
Warsaw Institute of Banking	2
Lipinski University	1
Bydgoszcz University of Science and Technology	1
Krakow University of Economics	1
University of Gdańsk	1
University of National Education Commission in Krakow	1
Maria Curie-Skłodowska University in Lublin	1
Higher School of Information Technology in Katowice	1
Copernicus Science Centre	1
Human Doc Foundation	1

S o u r c e: Own work.

Courses were designed by 27 Polish higher education institutions. This is a small percentage, because there are in total 96 public and 379 non-public universities, academies and tertiary schools, and 17 religious universities in Poland (Ministry of Science and Higher Education, 2024). This means that university academics are not specifically interested in running MOOCs, in their didactic preparation, or in the activity of users on substantive discussion forums. The entities offering MOOCs on the "Navoica" platform did not provide live moderation of discussion forums. It is technically possible, but rarely practised. In Poland, *Educational Technology* is a non-existing academic discipline or speciality. Preparing or delivering MOOC courses is, therefore, perceived by Polish university employees as a waste of their academic time which they need for conducting research in their main academic discipline, or often in two disciplines.

The "Navoica" platform facilitates participation in online discussion forums by displaying either course forums jointly or chronologically, or separate entries in individual forums. It also allows for tagging and following selected discussions.

Hypothesis

When formulating the hypothesis, reference was made to George Siemens' connectivism, established in 2005, according to which learning is a process of creating networks on three levels: connecting neurons, ideas, and social networks with cognitive agents such as other people, applications, and smartphones. However, in 2020, Siemens stated that social media have become toxic and harmful to learning in some cases. Therefore, he recognized the value of closed learning spaces, where learners can engage in less risky interactions (Steele, 2025). Based on the findings by Siemens, a hypothesis was formulated that *most users of the Polish educational MOOC platform "Navoica" do not participate in substantive discussion forums, because they are not sufficiently encouraged to do so.*

Instruments and Procedures

Using the Firefox browser, 208 MOOCs available on the "Navoica" platform between 21st and 22nd of May, 2024, were logged into. These were archived on the researcher's account so that they could be accessed in August, 2024, for analysis of patterns in the field of organizing substantive discussion forums by teachers and posting in them by users. The content of the *Discussion* tabs was analyzed. Those tabs provide information about all forums available in particular courses, including the introductory forum, which, however, was not included in this study. The content of the introductory forum was excluded. The number of substantive forums on each MOOC and the degree and manner of their use was studied. The number of the

forums, their names, questions posed to users, the number of substantive entries, as well as organizational comments posted by users were documented in an Excel spreadsheet.

The relationship between a forum design and user activity has not been studied. So the exploratory study was designed as it was difficult to hypothesize which variables would be of significance. An exploratory sequential mixed methods design (Creswell, & Creswell, 2018, p. 349–351) content analysis was conducted. The initial stage of the study was quantitative analysis to test the hypothesis. A qualitative analysis followed, i.e., a detailed exploration of organization of forums and of activity of sample users in selected forums. Finally, quantitative and qualitative data were combined to obtain an in-depth analysis to answer the research questions and to obtain uniform interpretation, which would allow formulation of conclusions and recommendations for MOOC designers.

The first phase of the study was conducted to compare the number and topics of entries. A categorization key was developed which included 5 categories of MOOCs:

1. With forum/forums rarely used – with several to a dozen or so user posts.
2. With forums used frequently – with 20 or more substantive user posts. There were several hundred entries in some courses, and over a thousand in case of two courses.
3. With forums used exclusively, or mainly, for organizational purposes.
4. With unused discussion forum/forums – with no user posts.
5. Deprived of substantive discussion forums.

For each MOOC academic discipline, level of course, type of organizer (university, academy, polytechnic, tertiary school, institution, foundation, etc.,), percentage of points required to obtain certificate, number of substantive forums, and number of substantive and organizational entries in each forum were specified. The data was coded in a *Microsoft Excel* spreadsheet for each course separately. The results were then analyzed first quantitatively. After this initial exploration, the qualitative analysis was conducted to generalize the results to the entire MOOC user population.

Results of Research

1. Number of Posts

Number of substantive discussion forums available in MOOCs varies. This is illustrated in *Figure 1.*

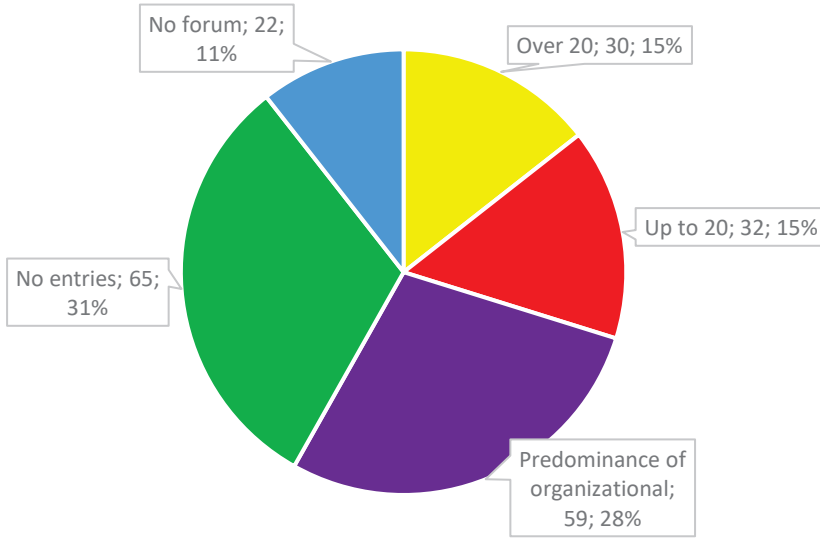

Figure 1. Number of entries on substantive MOOCs forums on the "Navoica" platform

S o u r c e: Own work.

This quantitative analysis of the research material provided the answer to the first part of the main research question:

1a. *To what extent are MOOCs equipped with substantive discussion forums?* Discussion forums were part of 186 of studied courses. Some courses had several dozen discussion forums, e.g., the *Suicide Prevention Course – ELLIPSE* available in 6 languages (Makara et al., 2023) contained 48 forums. There were 80 entries posted in a Polish version of this course and a single one in versions available in other languages. But on the "Navoica" platform, a large number of forums positively correlated with an increasing number of posts. There was no substantive discussion forum in 22 courses. On average, there were 6 forums per "Navoica" platform course.

The number of posts varied depending on the academic field. The most active discussions took place on substantive topics in courses in *Arts/Humanities* and *Social Sciences*; the least active were users of courses in *Natural Sciences*. The average number of posts in the forum was: 119, 43, and 2 respectively. However, the averages were positively influenced by a small number of courses, especially language courses, classified as *Humanities.* The median in *Humanities* was 5, in other groups it was 0. This is presented in *Figure 2*.

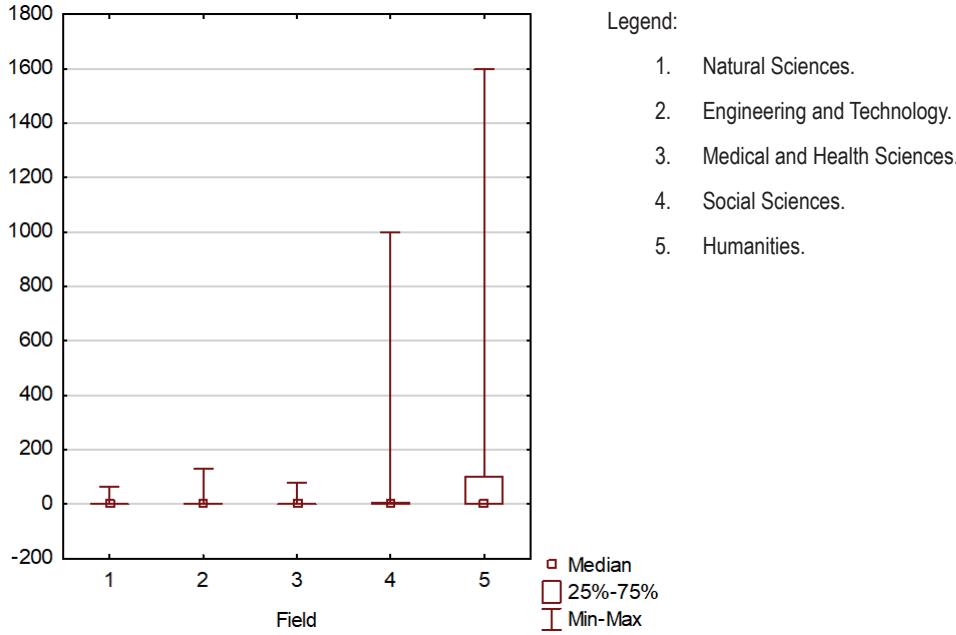

Figure 2. Comparison of the number of substantive entries between different fields

Source: Own work.

The answer to the second part of the main research question was formulated:

1b. *What is the level of user participation in substantive discussion forums?* Only a small number of courses were identified as having active forums. 65 of the 208 analyzed forums contained no posts; other contained diverse number of posts. In 30 courses, the number of posts ranged from a few to a dozen; only in 6 cases – it reached several hundred entries and more. It can, therefore, be said that the overall level of user engagement was low. A small number of courses positively influenced the overall high statistics in *Humanities* and *Social Sciences*.

2. Ways to Support Users of Substantive Discussion Forums

To answer the first additional research question, i.e., to explore the ways of supporting user activity on substantive discussion forums, the forums with a high, low, and no post level were analyzed. Additionally, forums with posts mainly on organizational topics, and forums of language courses were studied to understand the trends and diversity of participants' activity.

2.1. Thematic Forums with High Users' Activity

High users' activity was observed in 30 courses, i.e., the number of posts in substantive forums ranged from 20 to several hundred, in two cases it exceeded a thousand. The majority of posts (1598) were made by students enrolled in the course *Jak efektywnie uczyć się słownictwa w języku angielskim* [*How to learn English vocabulary effectively*] (Kubiak 2022). Students were eager to answer questions such as: *Czy pamiętasz jakieś słowa dotyczące podróży, które utkwiły Ci w głowie?, W jaki sposób uczysz się mniej pasjonujących tematów?, Jakie inne pomysły na naukę angielskiego sprawdziły się u ciebie?* [*Are there any travel-related words that have stuck in your head? How do you learn not so interesting topics? What other English learning ideas have worked for you?*]. This is because such questions referred to student's personal experiences and served as a tool of self-promotion, allowing them to create a positive self-image which, however, frequently was most likely not a true presentation of self – in line with the trend present in the media (Kalisz, Tyc 2018, p. 7). Therefore, substantive discussions forums were utilised by users mainly for self-promotion purposes. The forum questions were formulated in a way that prompted students to create attractive stories (making learning new words easier) and promoted presenting self as interesting discussion partners (Wyrwas 2018, p. 93), e.g.,:

> When I was on holiday two years ago, I totally forgot how to say air conditioning. I asked the lobby guy about sth with AC and I called it like in polish version – klimatyzacja. Happily, he understood what I meant and ask me „you mean AC right?". I promise you, that I will remember how to say AC for my whoole life (Anonym, 07.2024).

Sharing stories and experiences promotes forming and maintaining bonds in the spirit of common attitudes and beliefs (Wyrwas 2018, p. 101). Therefore, reading colleagues' posts might have encouraged some participants to post their own stories. In that way, answers to well-formulated questions became inspirations for some users. The posts of predecessors were read and commented upon. Thus, in this course, the forum was effectively used in teaching of foreign language writing and reading skills by triggering participants' self-presentation and integration skills.

Resignation from an introductory forum in this course was most likely carefully planned. For all MOOCs, the Mann-Whitney test showed that resignation from the introductory forum positively correlated with number of posts in the substantive forum. This is shown in *Figure 3*. In both groups, there were courses with very high users' activity, therefore the inclusion of an introductory forum does not necessarily lead to higher volume of substantive posts, but can assist in reducing the spread of statistical values.

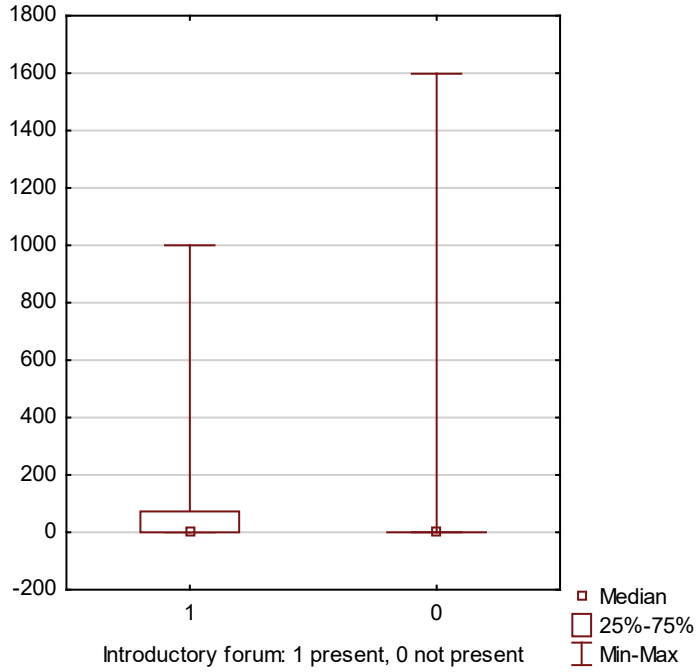

Figure 3. Comparison of the number of substantive entries depending on the existence of an introductory forum

S o u r c e: Own work.

There was no introductory forum in case of 19 courses (66%) with the highest number of forum users. Therefore, users accustomed to introducing themselves at the commencement of the course, due to lack of availability of introductory forum, talked about themselves, their preferences, and shared their observations, thoughts, and views on substantive forums. Lack of the introductory forum seemed to be a strategic move aimed at redirecting users' activity to the substantive forums. Similar strategies for strengthening users' activity were used by the authors of 11 other language courses.

There were 6 courses with 6 substantive forums per each, but the number of posts ranged from 24 in the course *Transport i logistyka. Kurs języka polskiego specjalistycznego dla obcokrajowców* [*Transport and logistics. Specialist Polish language course for foreigners*] (Bambrowicz 2022) to 698 in the *English for Business and IT students* course (Czarnopys 2022). The number of available forums, varied from 1 to 35. An increasing the number of forums resulted in an increase in the number of posts. However, such statistical relationship was not found for *Medical and Health Sciences*. Therefore, it can be said that a high number of substantive discussion forums does not automatically lead to increased number of substantive posts.

Some tutors responded to posts (e.g., Ślósarz 2022) which raised the level of substantive discussion and encouraged students' participation, e.g.,:

> No matter how much times will change and how much technology will advance, for me the main medium of literature will always be a hard copy book. However, having completed the course which showed me the extent to which new technologies influence literature, I want to say that video poetry made the greatest impression on me. I did not expect that poetry could be presented in such a way (Monliszka, 2023).

It seems, therefore, that increased activity of users in substantive forums was partially due by merging those forums with an introductory forum. That promoted students' self-presentation and self-promotion, encouraged them to share their stories, and also prompted them to respond to some of the posts.

2.2. Thematic Forums with Low Users' Activity

Courses with low users' activity, analogically, were found to be the ones with a low number of discussion forums. This is illustrated in *Figure 4*.

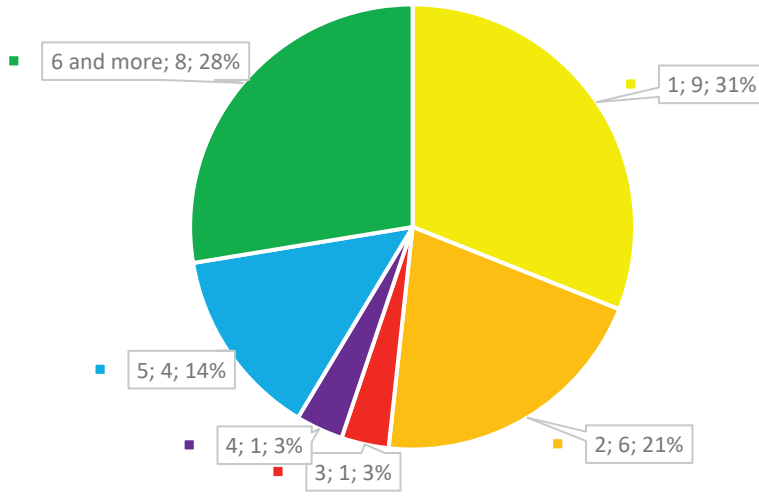

Figure 4. Number of forums in courses with low user's activity

S o u r c e: Own work.

The creators of this group of courses often did not title discussion forums and did not include any questions or instructions. As a result, the forum called *Ogólne* [*General*] had no entries, as for example in the course *Angielski pierwszego kontaktu dla pracowników ochrony zdrowia* [*First-contact English for healthcare workers*] (Szczepańczyk & Szczepańczyk, 2022).

Moreover, users did not show any interest in participation in the discussion forum if it was the only a course forum and titled by default: *Share your opinion about the course* (Rosińska 2022; Golec, 2022; Matyja-Chłąd, 2022). One of such forums contained 10 posts, the other – 6, another – 7, including the post with information about the error in the course material. All entries were enthusiastic, for example:

> This course helped me to learn a lot of new things from the fields of tourism and sports, which are close to me because I'm studying *Tourism and Recreation*, and also to increase my vocabulary. I really like the structure of the course with different themes, a lot of tasks of different formats. The week about airports was especially useful to me, as I plan to work as a flight attendant in the future. Thank you a lot!!! <3 (ifeelikeridinslow, 2023).

The comments were posted anonymously. In other words, the students did not consider these opinions binding. It is possible that they did not identify with them. However, having perceived a request for a positive opinion in the stereotypically formulated question, they fulfilled it. This is because people submit to persuasion: they respond in a socially expected way and make effort to behave in a socially desirable way (Goldstein, Martin, Cialdini, p. 73). In this case the students understood the instructors' question as a request for support in the form of a positive opinion. Therefore, they might have not only expressed it, but also internalized it. The few but homogeneous and exaggerated posts created a social proof (Cialdini 2009, 87–126) of the thesis that courses were *engaging, enjoyable, fantastic, fascinating, very interesting, and well-structured.* Thus, the strategy of prompting participants to provide a positive feedback was effective. However, it was successful only in case of a small number of MOOC users. It discouraged many others students from participating in forum designed in such a way.

The course *Specyfika pracy psychologa* [*The specificity of a psychologist's work*] (Brol, Janowski, 2023) did not have an introductory forum, but 27 other forums, titled e.g. *Psycholog na onkologii* [*Oncology psychologist*], or *Psycholog policyjny* [*Police psychologist*] did have. Those forums did not encourage users to make a substantive post. The forum *Kurs – krytyka, pochwała, sugestie* [*Course – criticism, praise, suggestions*] had only two positive feedbacks about the course. Due to the lack of an introductory forum, personal stories were posted in those forums, e.g.:

> As a former oncology patient, I listened to this interview with great pleasure. I am an example of a patient who claimed that psychological help was nonessential, but later on it occurred to me how wrong I was. I greatly appreciate the work of psycho-oncologists. (Joanna43, 2024)

The reasons for the small number of posts might have been the language barrier combined with the need to answer a complex, multi-level questions, such as: *How to reduce aggressive behaviours (recommended activities?) 1. in a group of children (under the age of 10) 2. in a group of teenagers (aged 11–17) 3. parents towards children.* In the course *Psychologia społeczna* [*Social psychology*] (Dobińska, 2021), 25 users answered the above question, but in an English-language version of the course, there was only one post made.

Users also seem to be discouraged by the lack of responses to their questions. MOOCs are not live moderated, while spontaneous comments from other users are infrequent.

Thus, the low user's activity seemed to be not the result of a small number of discussion forums, but lack of forum moderator, lack or poor-quality stimuli for expression, and language barrier.

2.3. Thematic Forums with No User's Posts

There were 65 courses (31%) in which the users did not post a single substantive entry on the forums. They did not make any comments on organizational issues either. In this group of courses, only 6 incorporated a built-in introductory forum. This may indicate that the tutors were not interested in the content of users' posts, which led to the latter being inactive.

One discussion forum, with no entries, was found in case of 43 courses (21%). Two courses had 12, while other – 4, 5, 6, 8, or 27 discussion forums. The *ELLISE Gatekeeper + Course in Suicide Prevention* (Makara-Studzińska 2023) delivered in English, Dutch, German, Norwegian, Swedish, and Hungarian included 48 discussion forums, which was the largest number of forums identified in any of the studied courses. However, despite such a large number of forums, there was not a single entry made. The reason for the lack of entries could have been the language barrier, but also the lack of questions or discussion forum headings. These were labelled e.g., *C.05 Contact*, *C.09 Contact*. Such a way of naming aimed at organizing the extensive course content consisting of about 200 elements, but did not encourage user participation in discussion. The course was designed by co-authors from 5 countries as part of the Erasmus+ program and of duration of just over 6 months, i.e., a very short time period. This MOOC might have implemented requirements of an international project aiming at certifying a predefined number of participants. The main task was, most likely, the preparation of the course, with non-obligatory participation in the discussion forums. Meanwhile, for the users (not involved in the running of the project) the six-month was, probably, not sufficiently long for familiarising themselves with its content to a degree that would allow them to participate in a substantive discussion. There were also lack of questions inviting students to share their thoughts, observations, etc.. on the forum.

The majority of the forums with no posts contained neither questions that would inspire participants to make posts, nor were labelled in a way encouraging

discussion. For example, *Zadaj pytanie* [*Ask a question*] forum in *Moduł powitalny* [*Welcome module*] had only one entry: *Dzień dobry, zaczynam kurs dziś* [*Good morning, I'm starting the course today*] (Filipczukd 2024). Majority of forums followed standard naming pattern: *Ogólne* [*General*]. Names of the forums were also very general e.g., *Topic of discussion* (Białowąs, Szyszka, & Skikiewicz 2024). To maintain the coherence of the course, specific module topic titles were used, e.g., *Forum – matrices (basic level), Forum – sets of equations (basic level)* (Witczak, 2022). Such naming made it easier for the instructor to navigate the course, but did not encourage course users to post, because forums did not include questions about their personal experience.

In conclusion, it can be said that to encourage participants to post on the forum, it is worth designing the course to be run over a longer period of time, giving forums attractive names, and posting questions that inspire discussion. Ideally, such questions should refer to users' experiences, thoughts, or observations and encourage self-promotion.

2.4. Substantive Forums with a Predominance of Organizational Posts

On the forums of 58 courses (28%), users posted only, or mainly, comments on organizational issues. This value is similar to that provided in the study by Spanish researchers: *less than a quarter of the analyzed comments contain suggestions* (Sánchez, Serrano, Gómez, & Heras, 2024, p. 1).

Analyzed posts from the "Navoica" platform concerned errors in the course materials and remained without a response from the course leader, e.g.:

> Hello Professors from WSB, I did the post-test for basic level and found some mistakes in your answers. 1. Question 6, no answers are correct. The correct answer is y=–59.4+5.89x 2. Final question, no answers are correct. The correct answer is –0.83. (Nguyet, 2023).

In the courses of this group, substantive posts were infrequent. Entries were found only on forums of 8 courses; 2 courses had only one substantive post per each. Lack of personal involvement in discussions led participants to focus not on substantive issues, but on the technical details of the course and the problems associated with this (freezing videos, being unable to download video clips, problems with audio tracks/subtitles, requests to extend the course completion deadline, etc.,) which did not occur in courses with the highest users' activity secondary to their involvement in the course subject matter.

Posts on organizational matters concerned not only errors, but also deadlines for completing tasks, ways of obtaining a certificate of completion, etc. The instructors did not create an organizational forum and frequently there was no introductory one either. Therefore, posts on organizational topics were posted on substantive forums.

The second possible reason for the lack of substantive posts was the subject matter of the courses. 24 courses were from the field of *Natural Sciences*, i.e., they covered mathematics, algorithms, statistics, and programming. Formulas, rules, and principles presented in those courses were not a subject to discussion, contrary to the content of courses from *Social sciences* or *Humanities*. The users of courses from *Natural Sciences* category expected to be presented with "knowledge in a nutshell", a one-way transfer of knowledge. They were unwilling to spend time on posting their comments on the forum.

The third possible reason for the lack of substantive and organizational activity on the forums in courses from this category could be overall a low substantive level of the courses. The group was dominated by courses for beginners (42 courses or 71.2%). The remaining courses were addressed to the intermediate level users. There was not one course for the advanced level users in this group. The number of substantive posts in the courses for beginners and intermediates statistically differed significantly (significance level of $p < 0.05000$). This was mainly due to the large number of posts in six courses, three of which were for beginners and three other for advanced learners. This is shown in *Figure 5*.

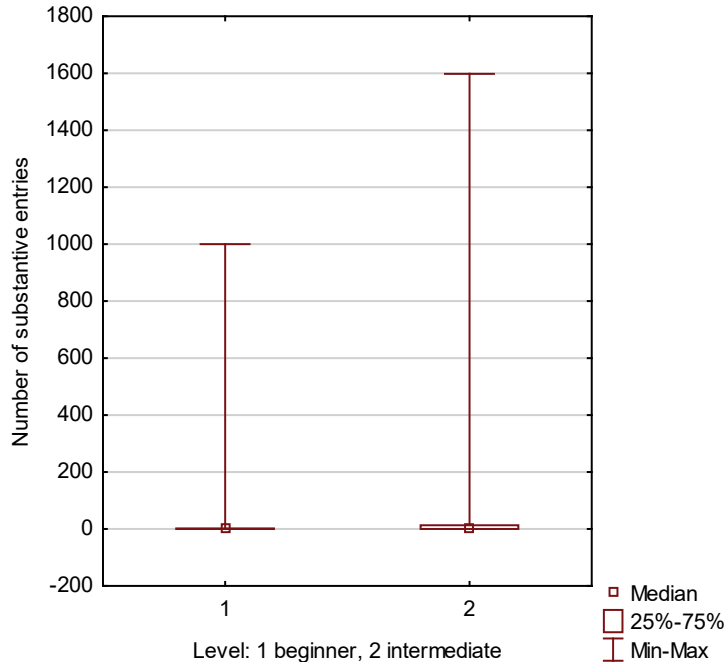

Figure 5. Comparison of the number of substantive entries between beginners and intermediates

S o u r c e: Own work.

Therefore, the correlation between entry statistics and points required to obtain a certificate was analysed. Again, significant differences in the number of entries were found. They are presented in *Figure 6*.

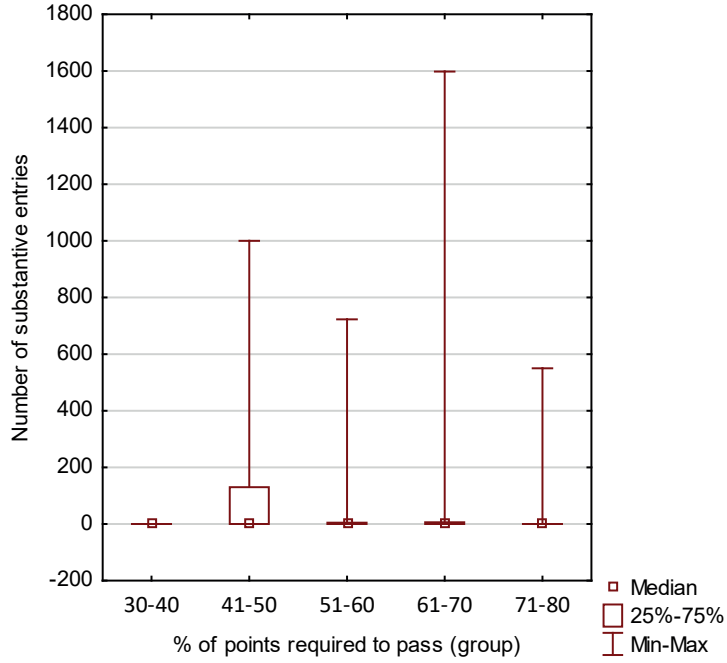

Figure 6. Comparison of the number of substantive entries between the ranges of points required to pass

S o u r c e: Own work.

Among the courses with the dominant number of organizational posts was *Kurs polskiego języka migowego* [*Polish sign language course*] (Irasiak 2023). The completion certificate could be obtained most easily of all courses offered on the platform – for just 30% of points. In this group, there were also 7 courses with required pass level of 40%, while on the entire platform there were just 12 courses with such a low pass level.

In the group of courses with a predominance of organizational posts, on average, the pass level was set at 54.3%. Therefore, users had time to analyze the course's content and, as majority were university students, most likely they had a solid knowledge base which covered far more than the content of the course. Therefore, they were able to spot errors and mistakes easily. This correlation is presented in *Figure 7*. The highest volume of posts, within 41-50 and 51-60 points ranges, resulted from the fact that the majority of offered courses had a low passing threshold (46 and 121, respectively).

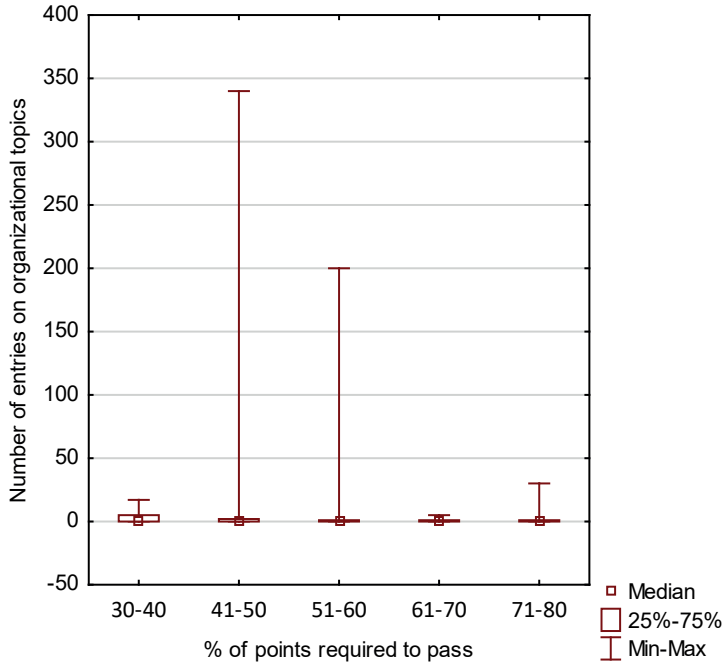

Figure 7. Comparison of the number of organizational entries between the ranges of points required to pass

S o u r c e: Own work.

Posts on organizational matters are a very good indicator of both the substantive knowledge of the participants as well as of their communication skills, including their ability to effectively express their own opinions, which might be contrary to the way of thinking imposed by the course coordinators, organizers, project executors or course leader. One of the participants suggested, among others, to:

> raise the number of points required for obtaining a completion certificate. The threshold can stay as it is but with a condition that the certificate can be obtained only after completing the entire course, and not, as it is now, as soon as after completion of 1/3 of the course. (KosmicznyInzynier 03.2024)

Therefore, it can be said that users of courses with a dominant number of posts on organizational issues want to raise the substantive level of the courses. However, lowering the course requirements followed the rules of the competitions within which courses were developed and made available on the platform. These rules usually oblige the organizers to award a certain number of certificates in each edition of the course. For fear of falling to meet this expectation, the course requirements are set at a low level so that the required number of users would

complete the course within the specified time frame. Obtaining course completion certificates is free of charge because "Navoica" is financed by Ministerstwo Edukacji Narodowej [Ministry of National Education]. By lowering the substantive requirements of the course, the instructors aim at removing the other, non-financial obstacles to achieve this goal. It seems that, in their opinion, these obstacles include insufficient commitment and a low skill level of the users. Meanwhile, this belief is unjustified and discourages more ambitious users.

Thus, the reasons for the overrepresentation of posts on organizational matters seem to be students' expectation of a one-way knowledge transfer, lack of inspirations for starting or joining substantive discussions, and a low substantive level of requirements. All these result in users' being bored with the course and sharing their ideas for course improvement on forums.

After analyzing the relationship between the activity of participants in discussion forums and the ways the courses were designed, the answer to the research question *Is, and how, user participation in substantive discussion forums supported?* was formulated. It turned out that users' activity in substantive forums was the highest when there was no introductory forum and the course coordinator responded to at least some posts. Users' activity also increased in forums with specific names, simple and inspiring opening questions, and lack of barriers such as the need to use a foreign language. Users also found encouraging to post in courses having been delivered for a prolonged period time, an attractive forum title, and inspiring questions, especially regarding users' experiences and observations. On the other hand, posting in organizational topics is stimulated by the lack of incentives for substantive discussions and low course requirements.

2.5. Language Courses Discussion Forums

The third, additional research question, *What is the level of users' activity in language courses' forums?* concerned courses that specifically require verbal interaction between the course co-ordinator and course participants. In unmoderated courses the users are left with the option to interact on the forums with one another, which is necessary for learning a foreign language, i.e., for developing communication skills. According to Chinese researchers (Wei, Liu, Xu, Kolletar-Zhu, & Zhang, 2023) peer-peer interactions in linguistic MOOC *help them advance the learning and obtain new information and linguistic knowledge from peer-made learning materials in the discussion forum.*

28 language courses were available on the "Navoica" platform in the research period. They could be divided into seven thematic categories, as presented in *Table 2*.

Table 2
Thematic categories of language courses

Category	Number of MOOCs
English	2
English for Specific Purposes (ESP)	12
Polish	6
Polish for Specific Purposes	3
German for Specific Purposes (GSP)	1
Phraseology and didactic courses in Italian, Spanish, and French	3
Polish sign language course	1
Total	**28**

S o u r c e: Own work.

English language courses dominated the platform. Yet, as it should be on a Polish educational platform, several MOOCs for learning the Polish language were also offered. There were also singular courses for learning: German, Italian, Spanish, and French. In addition, there was the Polish sign language course available (Irasiak, 2023) – the most popular language course. As of the 22nd of May, 2024, 7710 users obtained 1208 certificates of this course completion (Kolankowski 2024, p. 2).

Foreign language courses for beginners and for advanced students aim at developing vocabulary, pronunciation, and expanding knowledge of grammatical rules. Phrase-didactic courses aim at consolidating phraseological expressions characteristic of a given language. Language courses *for Specific Purposes* (SP), on the other hand, are designed to teach words and expressions needed for effective functioning in specific academic fields, professions, industries, and specializations, such as *English for Academia*, *English for Business and IT students*, *English for Architecture*, *Sprachhandbuch für Ingenieure*, *English for Legal Professionals*, *English in Culture, Art and Media*, *English for Work, Career, and Job-hunting*. All of these MOOCs courses focus on specialized communication structures characteristic of a given area of communication. The course user learns the language by listening, speaking, reading, and writing. Meanwhile, listening and speaking, activities primary for learning foreign language, encounter problems in the unmoderated and asynchronous MOOCs. Discussion forums, on the other hand, are in a good position to develop reading and writing skills. Consequently, all language courses included discussion forums. However, the level of users' activity varied, as illustrated in *Figure 8*.

English for business and IT students course (Czarnopys & Coldron, 2022) included 6 forums, which contained almost 700 posts. A high user activity seemed to result from the instructions referring to user's personal experiences, e.g., *Your career, Constructive discussion about working at home* (a hot topic during the pandemic), *Using e-learning*. Most posts (375) were found in the introductory forum *Two sentences about me*. This is because the topic concerned

user's personal experiences, it called for self-promotion, and the instruction was precise. The introductory forum of the language courses can be considered to have substantive functions.

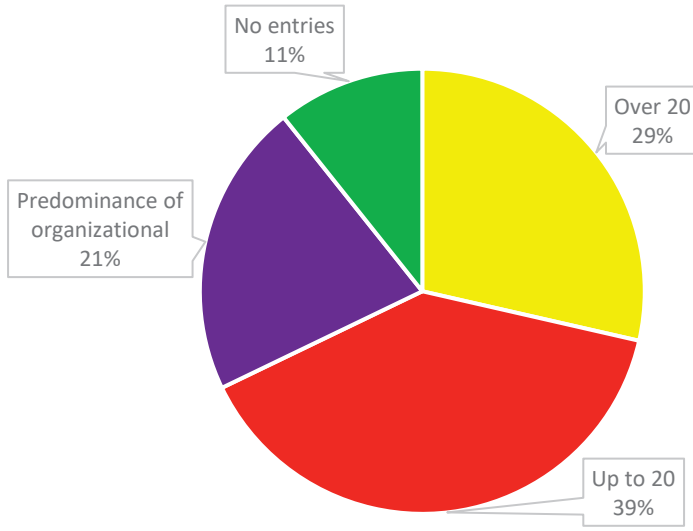

Figure 8. Number of posts on language course forums

S o u r c e: Own work.

The users were also active in the course *Uczymy się polskiego! Przygotowanie glottodydaktyczne dla osób z Ukrainy.* [*We are learning Polish! Glottodidactic preparation for people from Ukraine.*] (Zduniak, Wieczorek, Bambrowicz, Hofmański, & Bondarovych, 2024). There were 310 posts on 34 forums. Questions on every forum inspired the users-lecturers participating in the course to share their musical tastes and didactic reflections, or to attentively watch movies, e.g.: *Jaki tekst kultury (książka, film, piosenka, spektakl…) zaproponujesz uczniom dorosłym na poziomie B1, którzy chcą lepiej poznać polski folklor? Uzasadnij swój wybór. Jakie są twoim zdaniem słabe strony metody bezpośredniej? Które osoby w jury mówią tym samym językiem?* [*What cultural text (book, film, song, play…) would you suggest to adult students at B1 level who want to learn more about Polish folklore? Justify your choice. What do you think are the weaknesses of the direct method? Which people in the jury speak the same language?*]. Moreover, the course was developed in response to the social need for learning Polish language and culture by millions of immigrants from Ukraine.

However, the communicative function of language was infrequently practiced on the forums. The phraseology and didactic courses in French, Italian, and Spanish created as part of a project aimed at developing a phraseology and exercises database (Sułkowska, et al,. 2022) did not include an introductory forum. In the

substantive ones, on the other hand, users did not post a single substantive entry. This could have been due to the high degree of specialization of these courses. The transfer of knowledge turned out to be one-way also because each of these courses contained only *Ogólne* [*General*] forum, which did not contain a question or a command, inspiring discussion. These courses did not contain any video clips either. The transfer of didactic content in those courses was based on the structure of the three-volume script *Frazeologia somatyczna w ćwiczeniach* [*Somatic phraseology in exercises*] (Sułkowska, 2019). The picture on its cover was used as the logo in each of the three courses.

The above analysis allowed to answer the research question *What is the activity of users on language course forums?* It was found that the most posts were made in response to questions about user's personal experiences, allowing for self-creation (with which users are familiar from social media), and when the course met the general demand for learning a given language. On the other hand, the courses which focused on theoretical issues, restricting interaction, adopting one-way communication approach (using the script that was the prototype of the course) limited the activity of users on discussion forums.

Limitations

The sample of 208 MOOCs is not representative because the number, topics and associated authorship of courses may change as MOOCs are closed after a designated period of activity, some are launched in new editions, and new courses are added.

The "Navoica" platform courses have an exceptionally high completion rate. This is partially due to many universities utilising them as learning materials for their students. By May 2024, 192 853 users were registered on the platform, and 141 603 (>73%) of those received graduation certificates. Global Western MOOCs platform graduation rate, for comparison, is as low as a few percent. Polish students complete courses at American "Coursera" platform almost as frequently as they use "Navoica" (Geryk 2024, p. 36). But the pattern of use of the discussion forums studied in this paper is characteristic of Polish users of the "Navoica" platform, i.e., mainly of students from the above-mentioned universities which publish courses on the "Navoica" platform.

Conclusion

The hypothesis that *most users of the Polish educational MOOC platform "Navoica" do not participate in substantive discussion forums because they are not sufficiently encouraged to do so* turned out to be true. The activity of MOOC's users on discussion forums was very low. They often expected a one-way knowledge transfer. However, the users' activity on the forums could be increased by posting in each module questions that refer to users' experiences related to the topic of the module and their views on the presented subject. This would invite the participants to self-promote and integrate, with which they are familiar with from a social media. The inclusion of discussion forums after each module is also advantageous. It encourages users to comment on their peers' posts and eliminates the need for an introductory forum.

The MOOCs on the "Navoica" platform are updated on average every two years, but some are available for only a few months. This is too short a period for users to familiarize themselves with the content and know each other well enough to participate in forums to co-create new knowledge. All courses should be made available on the platform for at least two years.

The users' activity may also be promoted by the course coordinator's moderation and commenting on at least some users' posts. On the other hand, designing MOOCs a part of international projects, translating them into other languages, and developing exercises based on written forms is unsuccessful for promoting users' activity. This is because those methods are characterized by communication strategies non-compatible with social media approaches.

It can be concluded that the activity of users in substantive MOOC discussion forums is largely modelled by their experiences with social media. Therefore, precisely formulated questions and the availability of a moderator are crucial to directing the joint activity towards truly substantive goals. Users seem to be highly discouraged by not receiving responses to their posts related to substantive matters.

The resignation from the introductory forum, a large number of forums and a higher pass threshold for the course do not guarantee an increase in students' activity in the substantive forum, but may promote it. The large dispersion of the statistical results suggests that also some other didactic, organizational or cultural factors influence students' activity. What other factors influence users' activity in substantive discussion forms is a topic that needs to be developed in further research. It is also worth conducting interviews with MOOC users from different fields of science, different levels of advancement and with different pass thresholds, as well as with the authors of these types of MOOCs.

The above findings provide important insights for designers of MOOCs in the 21st century, that is, short questions should be asked that allow users to express their own opinions in a few words and promote self-creation, discussion forums

should be precisely named to properly connect them to the course content, at least some posts should be moderated, substantive content of some should be commented on, and user questions should be answered in a meaningful way. When these requirements are met, substantive discussion forums are more likely to actually fulfill their mission of collaborative knowledge seeking and developing key competencies for the entire population of MOOC users.

Data Availability

Ślósarz, A. (2024). *Elements of cognitivist and constructivist learning on Polish MOOC platform Navoica*. RODBUK (Repository of Open Research Data of Krakow Universities, V1) [data set]. University of the National Education Commission. https://doi.org/10.24917/UKEN/FNMAGC .

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Anna Ślósarz

Projektowanie aktywności użytkownika MOOC

Streszczenie

W ostatnich latach jednokierunkowy transfer wiedzy w xMOOC został zastąpiony kursami cMOOC, które pozwalają użytkownikom współtworzyć wiedzę. W tym celu wykorzystuje się głównie merytoryczne fora dyskusyjne. Jednak studenci wykorzystują fora do czegoś więcej niż tylko tego typu współpracy. Celem badania była analiza celu i zakresu, w jakim studenci zapisani na 208 kursów MOOC opublikowanych na polskiej platformie edukacyjnej „Navoica" korzystają z forów dyskusyjnych oraz w jaki sposób autorzy kursów MOOC zachęcają lub zniechęcają studentów do udziału w forach merytorycznych. Z badania wyłączono fora wprowadzające i organizacyjne. Wyniki: aktywność użytkowników forów dyskusyjnych w kwestiach merytorycznych była niska, co potwierdza rozpoznania ustalone w badaniach przeprowadzonych w innych regionach świata. 11% badanych kursów nie zawierało forów dyskusyjnych; 31% forów nie zawierało żadnych postów; 15%

zawierało od kilku do kilkunastu postów; a 28% kursów MOOC zawierało wpisy głównie o sprawach organizacyjnych. Tylko 15% forów zawierało ponad 25 postów. Studenci rzadko zamieszczali posty nawet na kursach językowych. Liczba postów nie odpowiadała liczbie uczestników, liczbie wydanych certyfikatów ani popularności kursu. Aktywność uczestników była zazwyczaj wywoływana przez pytania zachęcające do wyrażania opinii oraz autopromocji, komentowanie wpisów kolegów, a także przez udział koordynatora kursu w dyskusji. Aktywność użytkowników polskich kursów MOOC w forach dyskusyjnych zasługuje na dalsze badania jako sposobu na rozwijanie pierwszej i drugiej kluczowej kompetencji, tj. w zakresie posługiwania się informacją oraz kompetencji wielojęzycznych. Główne wyniki badania można uogólnić na całą populację użytkowników kursów MOOC.

S ł o w a k l u c z o w e: autoprezentacja, komunikowanie, osobisty, post, pytanie, opowiadanie

Anna Ślósarz

Diseño de la actividad del usuario en MOOC

R e s u m e n

En los últimos años, los MOOC x, que eran cursos unidireccionales de transferencia de conocimiento, han sido reemplazados por los MOOC c, que permiten a los usuarios co-crear conocimiento. Los foros de discusión sustantivos se utilizan principalmente para este propósito. Sin embargo, los estudiantes usan los foros para algo más que este tipo de colaboración. El objetivo del estudio fue analizar el propósito y el grado en que los estudiantes matriculados en 208 cursos MOOC publicados en la plataforma polaca “Navoica” usan foros de discusión y cómo los autores de los MOOC alientan o desalientan a los estudiantes a participar en foros sustantivos. Los foros introductorios y organizativos fueron excluidos de este estudio. Resultados: la actividad de los usuarios de los foros de discusión sobre temas sustantivos fue baja. Los hallazgos de este estudio respaldan los reconocimientos incluidos en la investigación realizada en otras regiones del mundo. El 11% de los cursos estudiados no incluían foros de discusión; el 31% de los foros no tenía publicaciones; el 15% tenía unas pocas o una docena de publicaciones; y el 28% de los MOOC contenían entradas predominantemente sobre asuntos organizativos. Solo el 15% de los foros tenían más de 25 publicaciones. Los estudiantes rara vez publicaban, incluso en cursos de idiomas. El número de publicaciones no se correspondía con el número de participantes, el número de certificados emitidos o la popularidad del curso. La actividad de los participantes se desencadenaba generalmente por preguntas que alentaban la expresión de su opinión, la autopromoción, los comentarios sobre las publicaciones de los colegas y también por la participación del coordinador del curso en la discusión. La participación de los usuarios de MOOC polacos en los foros de discusión merece una mayor investigación como una forma de desarrollar las competencias clave primera y segunda, es decir, la competencia de alfabetización y la competencia multilingüe. Los principales resultados se pueden generalizar a toda la población de usuarios de MOOC.

P a l a b r a s c l a v e: autopresentación, comunicación, personal, post, pregunta, historia

Designing MOOC User Activity

Anna Ślósarz

Проектирование активности пользователей MOOC

Аннотация

В последние годы односторонняя передача знаний xMOOC была заменена cMOOC, которые позволяют пользователям совместно создавать знания. Для этой цели в основном используются форумы для обсуждения по существу. Однако студенты используют форумы не только для этого типа сотрудничества. Целью исследования было проанализировать цель и степень, в которой студенты, зачисленные на 208 курсов MOOC, размещенных на польской платформе „Navoica", используют форумы для обсуждения, и то, как авторы MOOC поощряют или отговаривают студентов от участия в форумах по существу. Вводные и организационные форумы были исключены из этого исследования. Результаты: активность пользователей форумов для обсуждения по существенным вопросам была низкой. Результаты этого исследования подтверждают признание, включенное в исследование, проведенное в других регионах мира. 11% изученных курсов не включали форум для обсуждения; на 31% форумов не было сообщений; на 15% было от нескольких до дюжины сообщений; и 28% MOOC содержали записи, в основном по организационным вопросам. Только на 15% форумов было более 25 сообщений. Студенты редко размещали сообщения даже на языковых курсах. Количество сообщений не соответствовало количеству участников, количеству выданных сертификатов или популярности курса. Активность участников обычно была вызвана вопросом, побуждающим к выражению своего мнения, саморекламой, комментированием записей коллег, а также участием координатора курса в обсуждении. Участие пользователей польских MOOC в дискуссионных форумах заслуживает дальнейшего исследования как способ развития первой и второй ключевых компетенций, т. е. компетенции грамотности и многоязычия. Основные результаты могут быть обобщены на всю популяцию пользователей MOOC.

Ключевые слова: самопрезентация, общение, личное, пост, вопрос, рассказ

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The Impact of Game-based Learning on Sustainability Education for Next Generations: A Case Study Analysis

Abstract

Higher education institutions face increasing pressure to equip students with the competencies needed to address complex sustainability challenges. Game-based learning (GBL) offers a promising approach to engaging students and fostering the development of knowledge, skills, and attitudes required for sustainable development. This study examines the potential of the SEED simulation game, designed using the Octalysis Framework, to improve sustainability education. A mixed-methods study was conducted with 45 university students who participated in the SEED game and completed a post-game evaluation questionnaire. Quantitative analyses included descriptive statistics, correlations, and principal component analysis of motivational factors. Qualitative feedback was also analysed thematically. The results indicate that the SEED game fostered moderate to high levels of student engagement, motivation, and perceived sustainability knowledge gains. Development & Accomplishment and Social Influence & Relatedness emerged as the most effective motivational drivers. A strong positive correlation was found between engagement and motivation. Students particularly valued the game's realism, per-

sonalization, and opportunities for social interaction. The findings underscore the value of integrating well-designed simulation games into sustainability education, especially for new generations who have specific learning preferences. They also highlight key considerations for future game design and educational practice, including the importance of transparent feedback mechanisms and addressing diverse learner expectations. This study contributes to ongoing efforts to leverage gamification to support transformative learning for sustainable development, highlighting benefits for students in terms of engagement and motivation, and for teachers who gain an innovative tool to explain complex sustainability issues. These findings are in line with similar experiences reported at European universities.

K e y w o r d s: Game-based learning, sustainability education, innovative teaching methods, Octalysis Framework, higher education

Nowadays, to educate effectively, it is essential to understand learning preferences of new generations of students and tailor educational strategies accordingly. The UNESCO Education for Sustainable Development (ESD) framework supports this transformation by promoting active learning, critical thinking, and problem-solving (Rieckmann, 2017). Providing ESD is an extremely challenging task for any HEI (Uggla, 2023). Nevertheless, it is essential in the face of increasing demands from employers who need a new set of skills for a workforce who must deal with the challenges of sustainability (Aver et al., 2021). HEI should not be constrained by just trying to achieve Goal 4 ("Quality Education") but also prepare new generations for working with the entire framework of Sustainable Development Goals (SDGs). Graduates need to be prepared not only for personal activities regarding everyday life but also for professional ones within organizations. It is also through the holistic approach in ESD that educators and learners will be able to understand and act on the interrelated environmental, economic, and social dimensions of sustainability. Graduates equipped with SD competencies shall help substantially in attaining all 17 SDGs. When joining the labour market, their understanding of SDGs shall be imperative for companies to easily integrate sustainability into corporate business strategy, processes, and operations. However, there are some barriers that could be encountered by HEI: scepticism of university teachers, students' wrong assumptions about course content, lack of support from university management in integrating ESD content into existing programmes and creating new interdisciplinary subjects that are central to ESG, lack of established ways of curriculum effectiveness (Down, 2006) or training teachers who are able to effectively integrate content to enable students to meet global sustainability challenges (Pavlova, 2013). Another difficulty is defining a set of competencies for sustainable development (Mochizuki and Fadeeva, 2010; Rauch and Steiner, 2013). Nevertheless, all researchers emphasise that effective ESD curricula should

include elements such as interdisciplinary subjects, case studies based on real-world problems, team-based teaching methods and collaboration with the social environment, e.g., projects carried out for different types of organisations. One of the learning strategies is Game-based learning (GBL).

The gaming market has been experiencing dynamic growth, driven by technological innovations, subscription models, and the increasing popularity of mobile games. According to Newzoo, the global games market reached $184 billion in 2023, up 0.6% compared to the previous year. Overall, growth is reflected in both the PC and console segments, which are growing by 5.3% and 1.7%, respectively, while the mobile segment shrinks by 1.4% (Newzoo, 2024). The long-term outlook still appears positive, with estimates that the market will reach $205.4 billion by 2026.

Eurostat data from 2022 (data extracted on 11/09/2024 from [ESTAT]) shows that among EU citizens aged 16 to 24, 58.64% play or download games from the Internet. This percentage is highest in countries such as Finland (78.21%), Greece (76.76%), and Denmark (74.12%). At the other end of the table are Slovakia (36.32%), Croatia (37.48%), and Germany (40.30%). For Polish students, the percentage is also high at 52.81% (42.39%) if the age range is 16 to 29). Still, even the involvement of about 40% of young people in these activities cannot be ignored by schools and universities. Unfortunately, Eurostat data does not show this figure broken down by those studying and those not undertaking higher education.

Given the popularity of digital games among young generations, HEIs have an opportunity to use GBL as a learning strategy to increase students' engagement in sustainability education. This study addresses that gap by examining the educational impact of SEED, a simulation game designed using the Octalysis Framework, which strategically incorporates motivational elements to enhance SD learning outcomes. The aim of the research is to explore how this game influences students' engagement, motivation, and perceived learning related to sustainability. Using a mixed-methods approach, the study evaluates not only the game's motivational effectiveness but also its potential to support the development of key competencies for sustainable development. The findings contribute to the broader discussion on integrating innovative teaching methods into ESD and offer practical insights for educators.

Literature Review

Games for Sustainable Development

The GBL learning strategy, which has proven successful in higher education, is increasingly applied in sustainable development education. Research indicates that students retain knowledge more effectively through game-based approaches,

particularly in interdisciplinary fields that require critical thinking and communication. Educational games give students virtual experiences that can shape their behaviour and reflections. Such games provide an opportunity for the development of problem-solving skills. Ouariachi, Olvera-Lobo and Gutiérrez-Pérez (Ouariachi et al., 2017) highlight that games for sustainability often use narratives and interactivity to engage players in solving problems related to climate, waste management or natural resource management and present local scenarios. By solving unstructured problems in a game-like context, students will be better equipped to solve real-world challenges they meet in their careers. The ability of educational games to support collaborative learning at universities is substantial, many sustainability-focused games involve teamwork. Researchers also highlight that positive discourse and reward systems in games foster engagement and promote proactive attitudes. Whittaker, Russell-Bennett and Mulcahy (Whittaker et al., 2021) conducted a field study that found that reward-based game mechanics significantly influence players' sustainability knowledge and behavioural intentions. Results from other researchers suggest that game designers should combine economic, social and environmental dimensions in games, and often games only focus on one or two of these effects (Stanitsas, Kirytopoulos and Vareilles, 2019). Numerous successful applications of GBL in sustainability education are documented in the literature (Janakiraman et al., 2018; Jääskä et al., 2021; Fernández and Hamari, 2021). A detailed classification of games for SD can be found in the work of Katsaliaki and Mustafee (Katsaliaki and Mustafee 2015) helping users, both teachers and students to identify the games that best suit their teaching and learning needs. Still, the wider diffusion of GBL in higher education faces barriers to broader adoption, including high development costs for advanced game solutions, time required, and significant involvement of academics to integrate games within the curriculum.

The Octalysis Framework in Educational Contexts

The Octalysis Framework was developed by Yu-kai Chou (Chou, 2015) and is widely used to design gamification strategies in various educational and business contexts. The Octalysis Framework was based on the results from Self-Determination Theory (SDT), behavioural economics, Abraham Maslow's hierarchy of needs and shares many features with the Positive Psychology School and The Behaviourist School of Thought (Beerda, 2024). The widespread use of this framework is evidenced by the number of citations: a Google Scholar search for the keyword "Octalysis" returns more than 3000 results (as of 2024). Studies of the application of this framework in various fields such as education, finance and marketing and others have shown that its use changes user behaviour and increases user engagement (Mohanty and Christopher, 2023). The framework can

be applied either to diagnose motivational factors in gamification and games or even at an earlier stage to design game and gamification elements to maximise participant engagement and, in a business context, increase companies' revenues. The Octalysis Group website offers many examples of applications of this framework and empirical evidence of its effectiveness. It is interesting to note that, according to Mohanty and Christopher (Mohanty and Christopher, 2023), 66.6% of the research on this framework is conducted in the social sciences, compared to the sciences and engineering. Interest in this framework can also be seen during the Covid-19 pandemic and its application to increase student engagement in e-learning activities (Marisa et al., 2020). An overview of the eight Octalysis Core Drives and their examples is presented in Table 1.

Table 1
The Octalysis Framework: core drives and examples

Factor no.	Name	Description	Examples
Core Drive 1	Epic Meaning & Calling	Acting for a higher purpose – the need to feel responsible and the need to be noticed and appreciated.	participating in charitable projects or social causes
Core Drive 2	Development & Accomplishment	The need to grow, achieve goals, develop skills, succeed, win and ultimately overcome challenges and difficulties.	points systems, badges, certificates
Core Drive 3	Empowerment of Creativity & Feedback	The need to engage in the creative process, to create new things and ideas and the need to receive feedback	interactive educational platforms with creative tasks
Core Drive 4	Ownership & Possession	The need to own something and improve it.	the ability to set one's own learning paths and goals
Core Drive 5	Social Influence & Relatedness	Includes social aspects such as social life, atmosphere, social acceptance, competition.	team challenges and leaderboards
Core Drive 6	Scarcity & Impatience	The need and compulsion to wait.	time-limited challenges or exclusive content
Core Drive 7	Unpredictability & Curiosity	The need to satisfy curiosity about what will happen next.	unexpected quiz questions or rewards
Core Drive 8	Loss & Avoidance	avoidance of something negative such as failure	deadlines and consequences for incomplete modules

S o u r c e: Own work based on (Chou, 2019).

In the above eight areas, respondents completed an evaluation by selecting the response that best reflected how they felt about each motivator on a scale of 1 to 5 (strongly disagree to strongly agree). The mapping of questionnaire items to Octalysis Core Drives is shown in Table 2.

Table 2
Mapping of questionnaire items to Octalysis Core Drives

Questionnaire item	Corresponding Octalysis Core Drive	Core Drive number
I was motivated by managing the virtual café in a sustainable way – a sense of doing something for the greater good	Epic Meaning & Calling	Core Drive 1
I was motivated by gaining points and ranking positions, completing rounds of gameplay and developing skills	Development & Accomplishment	Core Drive 2
I was motivated by discovering new things, new strategies in the game and feedback	Empowerment of Creativity & Feedback	Core Drive 3
I was motivated by having my own café, which I had to develop in successive rounds of the game	Ownership & Possession	Core Drive 4
I was motivated by the cooperation with other teams during the activities, the friendly competition, the atmosphere in the activities	Social Influence & Relatedness	Core Drive 5
I was motivated by the need to wait for the next round to start so that I could test my strategy as soon as possible	Scarcity & Impatience	Core Drive 6
I was motivated by curiosity about what would be triggered in the next rounds and what lay ahead.	Unpredictability & Curiosity	Core Drive 7
I was motivated by the desire to avoid failure, i.e. to score low (get a low grade)	Loss & Avoidance	Core Drive 8

S o u r c e: Own work.

Research Questions

The aim of this study was to examine the potential of game-based learning for advancing sustainability education through the SEED simulation game. In particular, the study sought to explore how different motivational factors affect engagement and learning outcomes, and whether these effects vary across student subgroups.

Based on prior research on GBL (Ouariachi et al., 2017; Whittaker et al., 2021; Fernández and Hamari, 2021) and the Octalysis Framework (Chou, 2019), the following research questions were formulated:

- RQ1: Does participation in the SEED simulation game increase students' sustainability knowledge and skills?
- RQ2: Which Octalysis core drives are most effective in motivating students in the SEED simulation game?

- RQ3: Are there gender-based and field-of-study-based differences in engagement and motivation?
- RQ4: What is the relationship between engagement and motivation, and how does gaming experience affect these outcomes?

Research Methodology

Participants

A total of 45 students from the University of Information Technology and Management in Rzeszów participated voluntarily in the study. The mean age of participants was 20.89 years (SD = 2.53), ranging from 19 to 35 years. Of the 45 participants, 48.9% (n = 22) were male and 51.1% (n = 23) female. Most participants (62.2%, n = 28) were enrolled in Business and Economics programs, and 37.8% (n = 17) were from Engineering and Technology fields. Participation in the game was voluntary, and the results of the game did not affect any academic grading.

Game Description

The Sustainable Entrepreneurship in EDucation (SEED) project, funded by the European Union (2022-1-PL01-KA220-HED-000088765), aimed to develop a set of innovative didactic tools that would enable young people to make decisions and act in a way that would contribute positively to sustainable development (SD). One of the outcomes of the project is the SEED simulation game where students become managers and make decisions in an activity encompassing the whole business called The Café. Students engage themselves in a simulation game that teaches them how to run their own businesses, with an emphasis on sustainability. Game design was guided by the Octalysis Framework to enhance engagement and motivation. The students are afforded the opportunity to make decisions regarding a number of variables, including the location of the business in consideration of the target customer base, the composition of the menu, the furnishing of the premises, and the recruitment of staff. Additionally, they bear responsibility for advertising and marketing, assessing the response to the product, monitoring competitor activities, and implementing changes to the business strategy as necessary. Their business is placed in a crowded market alongside other businesses built by other teams within the same group. A detailed description of the sustainability competencies it aims to develop is provided in Jakieła, Świętoniowska, and Wójcik (2024).

The choice of coffee shops as an exemplary business was due to two factors. Firstly, coffee shops are an integral part of student life, and secondly, many students are considering running a small catering business as their first business. Through the game, students can develop strategic thinking and decision-making skills. The game promotes environmental awareness and sustainable business practices. As the game operates in the context of a university, an obvious aim of its creation was also to facilitate the work of teachers and to increase student involvement in the learning process through an innovative teaching tool.

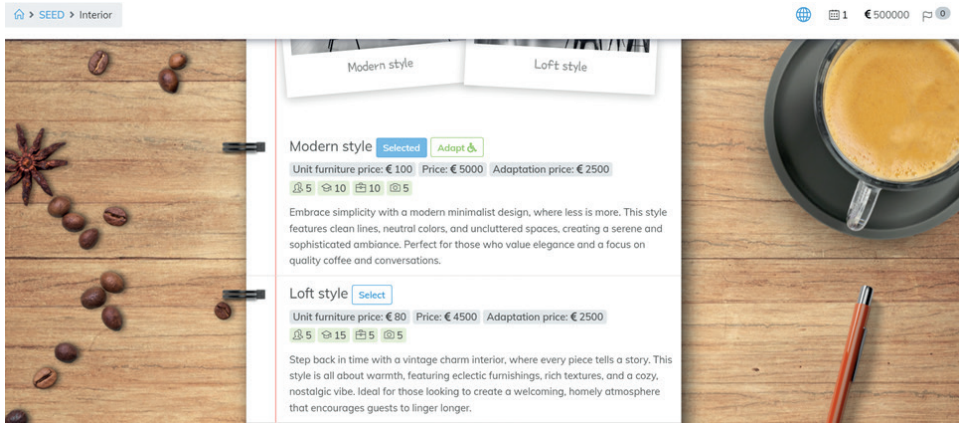

Figure 1. Example of SEED Game Interface: Customizing Café Location and Design (illustrating Ownership & Possession drive)

S o u r c e: SEED Simulation Game (Jakieła, Świętoniowska and Wójcik, 2024).

The game design process used the iterative Agile Software Development methodology. As all Agile methodologies emphasise regular feedback from stakeholders, the game design process involved academics, students and other experts (sustainability researchers, IT specialists, business practitioners working with the university, remote learning methodologists) to ensure that the game met the learning objectives and user needs. The SEED simulation game was developed as part of the Erasmus Plus programme with partners from Poland (*University of Information Technology and Management in Rzeszów*) and the company *Wirtualis*, responsible for the technical implementation of the game, Iceland (*Reykjavik University*), Portugal (*Politécnico da Guarda*) and Lithuania (*Kazimiero Simonavičiaus Universitetas*). The international perspective made it possible to prepare a game that could be used across Europe. This sprint-based design process helped address/avoid problems such as: 1) the lack of ongoing feedback from students and teachers in the early stages of development, 2) the disruption of communication between the development team and academic partners, 3) the lack of end-user oriented design in this case the student which

often leads to a product that meets the provisions of the design proposal but is not engaging for the students.

The SEED simulation game was programmed in Phalcon framework for PHP language with a responsive user interface created in JavaScript. The SEED Game interface is illustrated in Figure 1. The game is divided into 15 rounds, of which 1–7 are warm-up rounds and 8–15 are the actual game:

- (Round 1) Choosing the name and logo of the café, defining the café's mission; selecting the location on the map, choosing a specific establishment from those available in the selected district; selecting the interior design; setting the café's opening hours.
- (Round 2) Composing the menu: deciding on the products offered in the café (coffee, drinks, pastries, sandwiches, ice cream, seasonal products); determining the level of variety in the assortment of each product; choosing between one's own production or purchase from suppliers.
- (Round 3) Completion of equipment: purchase of the necessary equipment for the production of the selected products, taking into account capacity, price, cost of use, eco-friendliness of materials and disposal costs.
- (Round 4) HR: hiring of staff in different categories (waiters, baristas, cooks, etc.), decisions on the number of staff, their diversity, salaries, bonuses and training.
- (Round 5) Supply planning: estimating order quantities for the first period of operation of the café, selecting suppliers and planning orders for ingredients, taking into account cost and quality.
- (Round 6) Pricing products for the coming period, planning promotions such as price reductions or 'buy X, get Y' combined offers.
- (Round 7) Choice of marketing tools, both digital and traditional; planning a marketing strategy targeting different customer groups.
- (Round 8-15) Gameplay: changes to the menu, ingredient purchasing and delivery strategy; continuation of marketing activities and promotions; further HR decisions (recruitment, training); equipment purchases or upgrades.

Figure 2 presents the SEED Game feedback screen with rankings and performance indicators.

The game uses the following five-step algorithm to calculate demand and sales value:

- STEP 1 Estimate the number of potential customers based on opening hours, location and population of customer groups
- STEP 2 Determining the number of interested buyers, taking into account décor, variety of offer, prices, production and marketing
- STEP 3 Analyse the impact of product quality and staff on purchasing decisions.
- STEP 4 Analyse the impact of promotions and technical restrictions on sales.
- STEP 5 Summary of sales revenue.

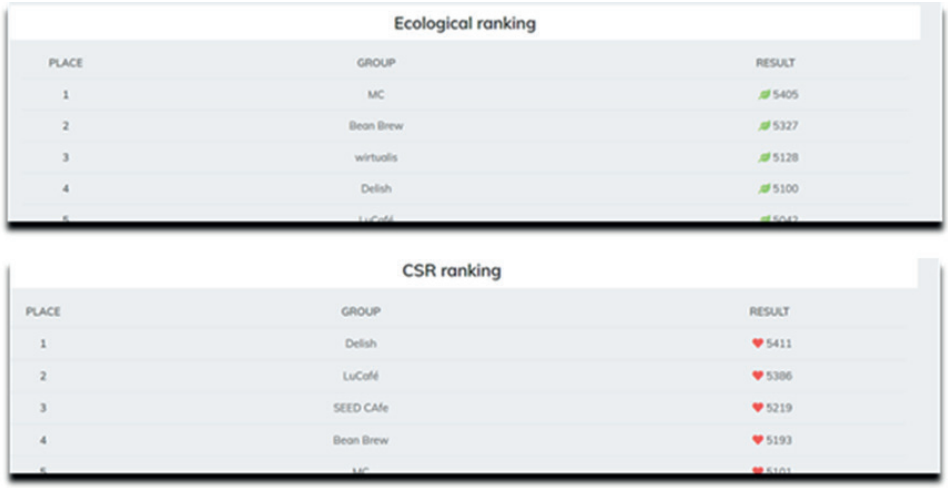

Figure 2. Example of SEED Game Feedback Screen: Rankings and Performance Indicators (illustrating Development & Accomplishment and Transparency)

S o u r c e: SEED Simulation Game (Jakieła, Świętoniowska and Wójcik, 2024).

The game offers three rankings that measure the success of participants. The scoring criteria and performance ranking components of the SEED Game are detailed in Table 3.

Table 3
SEED Game: scoring criteria and components of performance rankings

Ranking 1) Financial performance	Ranking 2) Eco	Ranking 3) CSR
Assesses the profitability of coffee shops	Based on: Average eco-index of equipment owned. Weighted average eco-index of suppliers of procured components. Eco index of marketing shares (based on choices made in previous rounds). Number of leftovers disposed of (leftovers) after each round.	Based on: Eco ranking Adapting cafés for people with disabilities. Employment of people with disabilities. CSR index of marketing actions (based on the message conveyed and the form of marketing actions).

S o u r c e: Own work.

Questionnaire

The process of data collection has been done with the use of the *Sustainability Game Evaluation Questionnaire*, tailored for this research. The questionnaire contains parts related to students' demographics – age, gender and field of study. Participant gaming habits (frequency and duration of gaming sessions, types of games played) have also been taken into consideration.

Five-point Likert scales for rating single-item measures of engagement (*"How engaging did you find the game?"*) and motivation (*"How motivated were you to complete the game objectives?*") have been used to assess participants' experience with the SEED simulation game. Using the Octalysis Framework as a foundation for the research required to include eight items to assess different motivational drives participants experienced during gameplay. They used a five-point Likert scale to express their motivation levels (from 1 = strongly disagree to 5 = strongly agree) with regard to such drivers as: managing the virtual café sustainably, gaining points and ranking positions, discovering new strategies and feedback, developing one's own café, cooperating with other teams, anticipation of future rounds, curiosity about game developments, and the desire to avoid failure. The engagement was measured using single item question, which represents a limitation of the study as it does not fully capture an engagement which is multi-dimensional in its nature (Fredricks et al., 2004). We consider this as area of further improvement. As Octalysis-based motivational items represent conceptually different aspects of motivation (e.g., social influence, accomplishment, curiosity) no calculations or interpretation have been performed for overall scale reliability.

The next important aspect that the questionnaire takes into account is the assessment of how relevant are the challenges provided by game to real world sustainability issues. These are perceived knowledge gain, confidence in applying sustainability knowledge in real life and whether the game helped participants to develop any new skills related to sustainability. The likelihood of recommending the game to others has also been rated. Finally, the questionnaire included two open-ended questions, inviting participants to describe which elements of the game they liked most and which they found less favourable. The two open-ended questions were used to determine which elements of the game were most and least favoured.

Procedure and Data Analysis Methods and Tools

Throughout class meetings, the students participated in the SEED simulation game. Upon completing the game, they were invited to fill out an online form which could be submitted anonymously. The data gathering took place in the spring semester of 2024.

The quantitative data were processed with IBM SPSS Statistics Base 29.0. Normality was checked with Shapiro-Wilk tests. Based on the distribution characteristics, non-parametric (Mann-Whitney U, Chi-square) or parametric tests (t-tests, ANOVA) were conducted. Motivational items structures were explored with Principal component analysis (PCA), the relationships between the variables were examined using Pearson and Kendall's tau-b correlations and qualitative answers were analysed thematically.

Research Results

Game Experience – Engagement, Motivation, Knowledge Gain and Skills

The game was assessed by participants as moderately engaging (M = 3.51, SD = 1.04) and motivating (M = 3.38, SD = 1.11). Knowledge gain was also evaluated as moderate (M = 3.27, SD = 1.27), with confidence in applying sustainability knowledge rated at M = 3.07 (SD = 1.20). 40% of students reported acquiring new sustainability-related skills. A summary of descriptive statistics for these outcomes is presented in Table 4.

Table 4
Descriptive statistics for engagement, motivation, and knowledge/skills outcomes

Questionnaire questions	Mean	Std. Deviation
How engaging did you find the game?	3.51	1.036
How motivated were you to complete the game objectives?	3.38	1.114
How much did the game increase your knowledge about sustainability?	3.27	1.268
How confident do you feel in applying the sustainability knowledge gained from the game in real life?	3.07	1.195

S o u r c e: Own work.

Octalysis core drives related to motivation participants rated as is shown in Table 5.

Figure 3 shows the mean ratings of motivational drivers mapped to the Octalysis Core Drives. From the study, earning points and having a collaborative environment were marked as the most motivating factors, whereas not wanting to fail ranked at the bottom most position.

Table 5
Mean ratings of motivational drivers (Octalysis Core Drives)

Motivation drivers	Core drive (Octalysis Framework)	No of core drive	Mean
Cooperation and competition	Social Influence & Relatedness	Core Drive 5	4.33
Gaining points and ranking positions	Development & Accomplishment	Core Drive 2	4.20
Managing the virtual café sustainably	Epic Meaning & Calling	Core Drive 1	3.96
Developing one's café	Ownership & Possession	Core Drive 4	3.80
Discovering new strategies	Empowerment of Creativity & Feedback	Core Drive 3	3.76
Waiting for the next round	Scarcity & Impatience	Core Drive 6	3.62
Curiosity about future rounds	Unpredictability & Curiosity	Core Drive 7	3.62
Avoiding failure	Loss & Avoidance	Core Drive 8	1.84

S o u r c e: Own work.

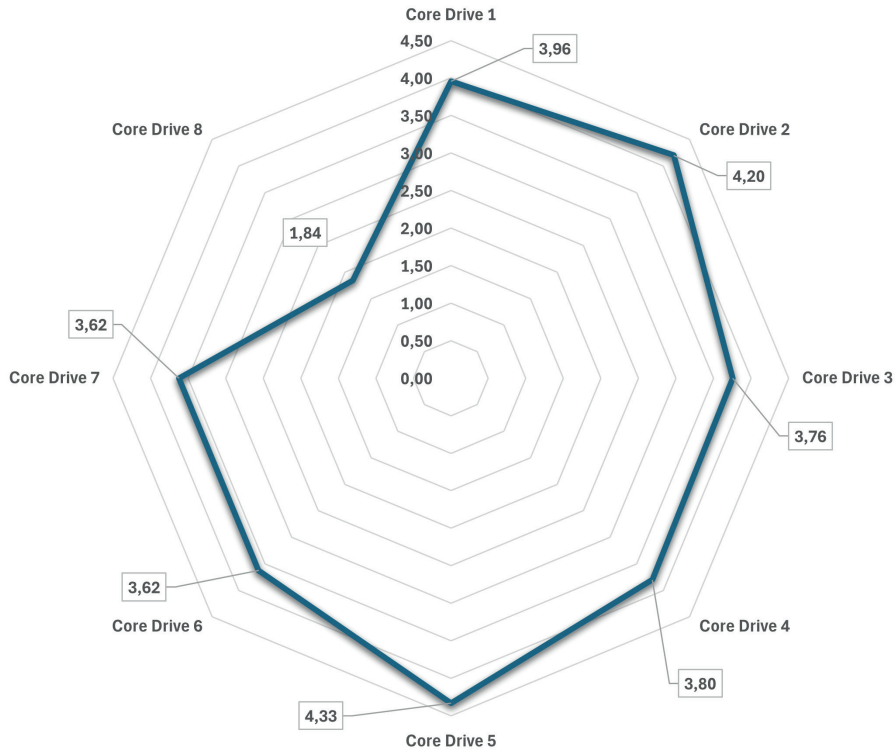

Figure 3. Mean ratings of SEED game motivational drivers mapped to Octalysis Core Drives

S o u r c e: Own work.

Do the Gender and Field of Study Affect Motivation and Engagement?

According to the research, gender has not affected engagement and motivation of participants. In a similar way, *Business and Economics* and Engineering and Technology students engagement and motivation have not shown important differences in these areas. However, the "*desire to avoid failure*" significantly differs across fields of study ($F(1,43) = 7.433$, $p = .009$), pointing at Engineering and Technology students who wanted to avoid failure more.

Are Engagement, Motivation, and Gaming Experience Correlated?

The relationships between game-based learning variables are illustrated in Figure 4. According to the research results engagement and motivation are strongly correlated ($r = .85$, $p < .001$). Experienced gamers, who spend more time playing games were less engaged in playing SEED game as the time spent playing games is negatively correlated with perceived engagement ($r = -0.296$, $p = .049$). Between time spent gaming and motivation, no significant correlation was found ($r = -0.036$, $p = .817$). What research results also suggest is the fact that perceived knowledge gain and confidence in applying acquired knowledge are positively correlated ($r = .42$, $p = .004$). This indicates that participants who feel they have learned more also tend to feel more confident in using that knowledge in practice.

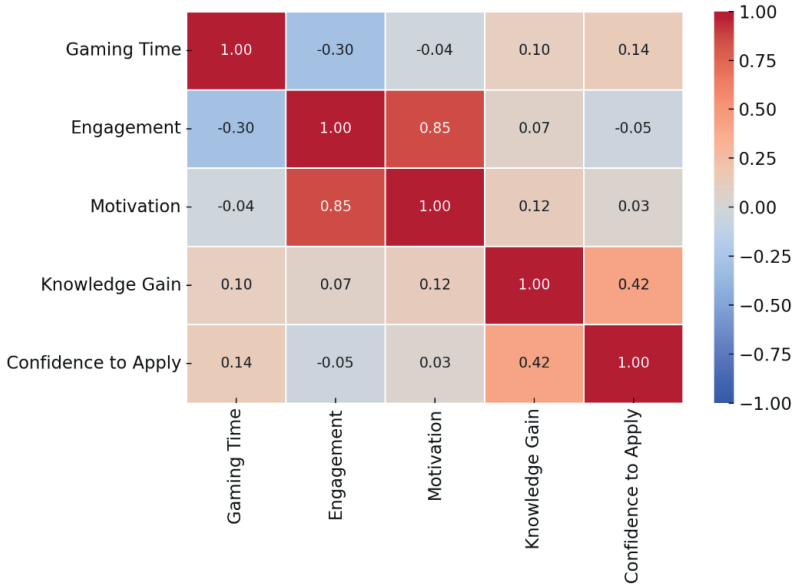

Figure 4. Correlation Matrix of Game-Based Learning Variables

S o u r c e: Own work.

What provides game design hints is the correlation between engagement and motivation. Increasing an engagement level of players may boost their motivation. When focus on correlation between perceived knowledge gain and confidence in applying knowledge, the educational value of SEED game is well visible.

Factor Structure of Octalysis Framework Motivational Drivers

Before the presentation of the results it is worth noting that suitability of data set for *Principal Component Analysis* has been assessed. It was done by calculating Kaiser-Meyer-Olkin (KMO) measure which determines sampling adequacy and Bartlett's Test of Sphericity. KMO was 0.425 while recommended threshold is 0,5. This value shows that data set is minimally suitable for factor analysis. The Bartlett's Test of Sphericity was non-significant ($\chi^2(28) = 18.44$, $p = .915$). This suggests that the study's findings should be interpreted in light of its methodological constraints as the correlation matrix may not significantly differ from an identity matrix. Despite the limitations, as the study conducted is exploratory in nature, PCA has been done to investigate the patterns among motivational factors. Five main components (eigenvalues > 1) have been identified in rotated components matrix. There are the following:

- Component 1: Epic Meaning & Calling, Ownership & Possession (personalization and meaningful management)
- Component 2: Scarcity & Impatience (anticipation-driven motivation)
- Component 3: Loss & Avoidance (performance anxiety and risk aversion)
- Component 4: Empowerment of Creativity & Feedback (curiosity and learning)
- Component 5: Development & Accomplishment (achievement orientation through points and rankings)

All these components together explain 75.91% of the variance. The component loadings of motivational items are provided in Table 6.

The results summarized in table 6 allow for drawing few insights. There is an interplay between social and accomplishment-related motivations. Moreover, the factor structure is aligned meaningfully with key Octalysis Core Drives. As such, it proves the relevance of the framework in the attempt to understand the players' motivation when using the game in learning context related to sustainability.

To synthesize the main findings, the results are summarized in Table 7, covering each research question together with the corresponding statistical values and additional comments.

Table 6
Principal Component Analysis: Component Loadings of Motivational Items

Component Matrix[a]					
	Component				
	1	2	3	4	5
3.1. I was motivated by managing the virtual café in a sustainable way – a sense of doing something for the greater good	,610	,038	,035	,203	,462
3.2. I was motivated by gaining points and ranking positions, completing rounds of gameplay and developing skills	–,057	,182	,571	,627	–,335
3.3. I was motivated by discovering new things, new strategies in the game and feedback	–,172	,505	,435	–,156	,603
3.4. I was motivated by having my own café, which I had to develop in successive rounds of the game	,706	,195	–,293	–,137	,082
3.5. I was motivated by the cooperation with other teams during the activities, the friendly competition, the atmosphere in the activities	,206	,703	–,231	,423	–,107
3.6. I was motivated by the need to wait for the next round to start so that I could test my strategy as soon as possible	,413	–,401	,631	–,067	,101
3.7. I was motivated by the desire to find out what the next rounds of the game would be triggered, what would be in front of me	,637	,036	,173	–,236	–,480
3.8. I was motivated by the desire to avoid failure, i.e. to score low (get a low grade)	,119	–,547	–,258	,607	,264
Extraction Method: Principal Component Analysis.[a]					
a. 5 components extracted.					

S o u r c e: Own work.

Table 7
Research questions quantitative analysis summary

Research question	Statistics values	Additional comments
RQ1: Does participation in the SEED simulation game increase students' sustainability knowledge and skills?	• Perceived knowledge increase M = 3.27; SD = 1.27 • Confidence in applying knowledge. M = 3.07; SD = 1.20 • 40% of students self-reported acquiring new sustainability-related skills	A moderate positive correlation was found between knowledge gain and confidence in application (r = 0.42, p = .004).

RQ2: Which Octalysis core drives are most effective in motivating students in the SEED simulation game?	The most motivating factors in the SEED game • Social Influence & Relatedness (Core Drive 5): M = 4.33 • Development & Accomplishment (Core Drive 2): M = 4.20 • The least motivating factor • Loss & Avoidance (Core Drive 8): M = 1.84	PCA identified five motivational dimensions explaining 75.91% of total variance. The dataset showed low suitability for factor analysis (KMO = 0.425; Bartlett's test p = .915).
RQ3: Are there gender-based and field-of-study-based differences in engagement and motivation?	Significant difference emerged for the Loss & Avoidance driver: Engineering and Technology students scored higher on this factor ($F(1,43) = 7.433$, $p = .009$)	No statistically significant differences in engagement or motivation were found based on gender or academic background.
RQ4: What is the relationship between engagement and motivation, and how does gaming experience affect these outcomes?	• Engagement and motivation were strongly positively correlated ($r = .85$, $p < .001$) • Time spent on gaming was negatively correlated with engagement ($r = −.296$, $p = .049$) • No significant correlation was observed between gaming time and motivation ($r = −.036$, $p = .817$)	These findings confirm that engagement and motivation are closely linked and provide insight into the role of motivational structure and user background in shaping learning outcomes through GBL.

S o u r c e: Own work.

Qualitative Findings From Open-ended Questions

The answers to open-ended questions have also been source of interesting insights. They may be summarized as follows:

- Realistic business scenario enabled students to better understand nuances related to running business which operations support SDG.
- Students' engagement, to some extent, was driven by game's personalization feature (business configuration in the areas of location, menu, interior design). It has also deepened the feeling of ownership, what stimulated engagement.
- Learning experience was significantly improved by game environment that promotes social interactions and cooperation.
- The catalyst for understanding the sustainability principles was "learning by doing" and making decisions in simulated business environment.

What is also beneficial includes answers to open-ended questions which have provided the feedback for possible improvements in the next releases of the game. The most important are the following:

- Game complexity and not clear enough relationships between decisions made and final results displayed in rankings. This constrained an improvement of decisions made and deeper understanding of decisions' payoff in terms of SDG achievement.
- Technical problems with using game on smartphones.
- Time needed for a gameplay (some students perceived it as too long) and frequency of feedback with clear connection to decisions made. This kind of feedback may improve learning of sustainability issues.
- Focus only on one business domain (café). Extending the game environment to more business domains may provide better applicability and more realistic scenarios of running business that aligns with SDG.

Discussion

As students have reported, knowledge gains and higher confidence level in applying sustainability concepts, and a real potential of using game-based learning to sustainability education is visible. The study also confirmed the important role of educational games in developing sustainability awareness in students. Apart from knowledge and awareness gains, skills development aspect also seems to be promising – 40% of students reported development of new sustainability related skills, which increases level of competences in this area.

Interesting insights on students' motivation were collected with the use of analysis based on Octalysis Framework. Some findings are similar to patterns identified by Gellner and Buchem (Gellner and Buchem, 2022) and Marisa et al., (2020), who emphasized the importance of mastery and social factors in driving motivation in educational games environments. This study has also shown that Development & Accomplishment (through points and rankings) and Social Influence & Relatedness (through cooperation and team atmosphere) are the most powerful motivation drivers in e-learning and gamified educational settings.

Some factors like Unpredictability & Curiosity and Loss & Avoidance turned out to have smaller impact. It has also been observed and discussed by Marisa et al., (Marisa et al., 2020) who stated that the power of these drives strongly depends on context and can have even negative effects. In sustainability education, too much unpredictability can undermine learners' sense of control and confidence in using what they have learned.

The analysis focused on differences in motivation and engagement that is connected to gender has shown that SEED game offers inclusive environment as

no gender-related differences were investigated. The issue that should be addressed in further research is different levels of desire to avoid failure that depend on major students came form - Engineering and Technology students exhibit stronger desire towards avoiding failure. It may be related to learning styles or cultures (including perception of risk) that are common for specific discipline.

A valuable hint for educational games designers comes from negative correlation between gaming time/ players' experience and their engagement. The longer the time spent gaming, the higher the expectations with regard to game attractiveness (more sophisticated plots, visually appealing game design, etc.). Therefore, in case of educational games, in which main priority is efficient and effective learning, players may feel less engaged. These findings mirror the concerns regarding relationship between time spent on playing games and engagement that have been raised in the literature.

Another insight can be drawn from a strong correlation between engagement and motivation. Hence, in the design, educational game features that positively affect these two elements should be developed. However, as in this study, we have noticed some limitations connected to the way an engagement was measured (single-item global question), further research should use properly selected scales to have better understanding of different engagement dimensions (Fredricks et al., 2004; Sinatra et al., 2015) – behavioural, emotional, and cognitive.

Even though the initial analysis of the dataset showed some limitations, a factor analysis was carried out and its results put stronger emphasis on complex nature of students motivation in game-based learning of sustainability-related issues. The factor analysis has also shown that components extracted can me mapped into key Octalysis Framework drives, which confirmed the framework applicability for this study.

Finally, the qualitative findings provided some educational game development hints based on students preferences. The game environment should include features that support personalisation, cooperation, clear and timely feedback, flexibility and realism. These hints are consistent with sustainability games development methodologies best practices that take into account mechanisms assisting experiential learning team-based interaction, and opportunities for reflection on real-world issues (Pineda-Martínez et al., 2023).

Nevertheless, there are some limitations of the study. The following are the most important:

- small sample size and single-university context,
- the engagement was measured with only one dimension, but as researchers suggest it is a multi-dimensional component (Fredricks et al., 2004; Sinatra et al., 2015),
- unbalanced analysis of engagement and motivation that are distinct psychological constructs (Fredricks et al., 2004; Ryan & Deci, 2000); motivation was assessed with the combination of a single-item question and eight Octalysis-

based drives while engagement was measured with a single-item self-report question ("How engaging did you find the game?"),
- the impact on long-term behaviour regarding sustainability-related skills and awareness developed as well as knowledge gained have not been assessed,
- Octalysis Framework used does not fully captures the experiential or affective dimensions of engagement in learning contexts,
- the data set analysed does not fully meet the requirements for PCA (KMO value (.425) and non-significant Bartlett's test indicate that results should be interpreted with caution)
- the study is focused on students' subjective experiences and self-reported learning outcomes; the actual performance outcomes achieved by students within the SEED simulation game (e.g., financial, eco, CSR scores) have not been deeply analysed.

Conclusions and Further Research

The main aim of the study was to contribute to better understanding of how learning strategies preferred by new generations of students, game-based learning, may be used to develop skills and awareness related to running business in a sustainable way. Research has shown promising results with regard to using SEED simulation game. The study was backed by Octalysis Framework that enabled to better understand students' engagement and motivation. The experiment has also shown that students improved their skills in the area of sustainability, developed awareness in this area and gained knowledge that made them more confident in applying these new personal resources in practice.

Mastery and collaborative learning in educational games have been identified as learning experience components connected with key motivational drivers – Development & Accomplishment and Social Influence & Relatedness. As engagement and motivation turned out to be strongly correlated, game-based learning solutions should actively stimulate both.

The insights drawn from a qualitative part of the study provided design hints by pointing at the features of GBL environments that students valued the most. They should support realism, personalization, feedback and social interaction. These hints are consistent with best practices in sustainability game development which emphasize experiential learning, team-based interaction, and reflection on real-world issues.

While several limitations of the study have already been noted, they also point to clear directions for further research. Future work should include larger and more diverse student samples across multiple universities, apply multi-dimensional

engagement measures, analyse actual in-game performance outcomes, and adopt longitudinal designs to capture the lasting impact of game-based learning on sustainability competencies. Further studies could also explore cross-cultural differences in motivational responses to the SEED game and examine how advanced game mechanics – such as adaptive feedback and real-time personalization supported by AI tools – may influence student engagement, motivation, and learning outcomes. Despite these limitations, the study results suggest that game-based learning may be a valuable support for sustainability education at universities, helping students to engage more deeply and gain practical competencies, while providing teachers with a structured and attractive method to introduce complex content. Compared with traditional learning situations without game elements, these advantages are significant, and they reflect trends observed in other European higher education contexts.

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Joanna Wójcik, Joanna Świętoniowska, Jacek Jakieła

Edukacja nowych pokoleń na rzecz zrównoważonego rozwoju poprzez gry: analiza studium przypadku

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

Instytucje szkolnictwa wyższego coraz częściej poszukują innowacyjnych metod nauczania wspierających rozwój kompetencji na rzecz zrównoważonego rozwoju. Uczenie się oparte na grach (*Game-based Learning*) stanowi jedną z obiecujących strategii dydaktycznych, umożliwiających zwiększenie zaangażowania studentów oraz rozwijanie wiedzy, umiejętności i postaw prospołecznych oraz proekologicznych. Celem niniejszego badania było przeanalizowanie potencjału gry symulacyjnej SEED, zaprojektowanej w oparciu o model Octalysis (*Octalysis Framework*), jako narzędzia wspierającego edukację na rzecz zrównoważonego rozwoju na poziomie uczelni wyższej. W badaniu zastosowano podejście mieszane. W badanie zaangażowano 45 studentów, którzy wzięli udział w rozgrywce i wypełnili kwestionariusz ewaluacyjny po jej zakończeniu. Analiza ilościowa objęła statystyki opisowe, analizę korelacji oraz analizę głównych składowych dla czynników motywacyjnych. Dane jakościowe poddano analizie tematycznej. Wyniki wskazują, że gra symulacyjna SEED sprzyjała umiarkowanemu do wysokiego poziomowi zaangażowania, motywacji oraz przyrostowi wiedzy z zakresu zrównoważonego rozwoju. Zaobserwowano istotną dodatnią korelację pomiędzy zaangażowaniem studentów oraz ich motywacją. Studenci szczególnie docenili realizm gry, możliwość personalizacji doświadczeń oraz interakcje społeczne. Wyniki badania podkreślają potencjał dobrze zaprojektowanych gier symulacyjnych jako narzędzi dydaktycznych w edukacji na rzecz zrównoważonego rozwoju, wskazując jednocześnie na korzyści dla studentów w zakresie większego zaangażowania, motywacji i rozwoju kompetencji oraz dla nauczycieli, którzy zyskują innowacyjne narzędzie do przekazywania złożonych treści. Otrzymane rezultaty są zbieżne z doświadczeniami opisywanymi na uczelniach europejskich.

S ł o w a k l u c z o w e: uczenie się oparte na grach, edukacja na rzecz zrównoważonego rozwoju, innowacyjne metody nauczania, model Octalysis, szkolnictwo wyższe

Joanna Wójcik, Joanna Świętoniowska, Jacek Jakieła

El impacto del aprendizaje basado en juegos en la educación sostenible de las nuevas generaciones: un estudio de caso

R e s u m e n

Indented text of the summary in Spanish. Las instituciones de educación superior enfrentan una presión creciente para dotar a los estudiantes de las competencias necesarias para abordar los complejos desafíos de la sostenibilidad. El aprendizaje basado en juegos (Game-Based Learning, GBL) representa un enfoque prometedor para involucrar a los estudiantes y fomentar el desarrollo de conocimientos, habilidades y actitudes orientadas a la sostenibilidad. Este estudio examina el potencial del juego de simulación SEED, diseñado con base en el modelo Octalysis, para mejorar la educación en sostenibilidad. Se llevó a cabo una investigación con métodos mixtos con 45 estudiantes universitarios que participaron en el juego SEED y completaron un cuestionario de evaluación posterior al juego. Los análisis cuantitativos incluyeron estadísticas descriptivas, correlaciones y análisis

de componentes principales de los factores motivacionales. Los comentarios cualitativos fueron también analizados temáticamente. Los resultados indican que el juego SEED promovió niveles de compromiso, motivación y percepción de aprendizaje en sostenibilidad de moderados a altos. "Desarrollo y Logro" e "Influencia Social y Relación" emergieron como los impulsores motivacionales más eficaces. Se observó una fuerte correlación positiva entre compromiso y motivación. Los estudiantes valoraron especialmente el realismo del juego, la personalización de la experiencia y las oportunidades de interacción social. Los hallazgos destacan el valor de integrar juegos de simulación bien diseñados en la educación para la sostenibilidad, especialmente para las nuevas generaciones con preferencias de aprendizaje específicas. También subrayan consideraciones clave para el diseño de juegos educativos y la práctica docente, incluyendo la importancia de mecanismos transparentes de retroalimentación y la atención a la diversidad de expectativas del alumnado. Este estudio contribuye a los esfuerzos actuales por aprovechar la gamificación como herramienta de apoyo al aprendizaje transformador para el desarrollo sostenible, destacando beneficios para los estudiantes en términos de compromiso, motivación y adquisición de competencias, y para los docentes que cuentan con una herramienta innovadora para explicar contenidos complejos. Estos resultados son coherentes con experiencias similares reportadas en universidades europeas.

P a l a b r a s c l a v e: aprendizaje basado en juegos, educación para la sostenibilidad, métodos de enseñanza innovadores, modelo Octalysis, educación superior

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Влияние игрового обучения на обучение по устойчивому развитию на следующие поколения: анализ примеров

А н н о т а ц и я

В высших учебных заведениях всё сильнее возрастает давление на то, чтобы сформировать у студентов компетенцию справляться со сложными вызовами, связанными с устойчивостью окружающей среды. Игровое обучение (game-based learning, GBL) представляет собой перспективный подход, вовлекающий студентов и способствующий развитию знаний и умений, необходимых для устойчивого развития. В данном исследовании изучается потенциял симуляционной игры SEED, разработанной с использованием Фреймворк Октализа (the Octalysis Framework), для улучшения качества обучения экологической устойчивости. Исследование смешанными методами было проведено 45 высшыми учебными заведениями, принимающими участие в игре SEED, и заполнившими постыгровой эвалюационный опросник. Количественные анализы включали: описательные статистики, корреляции и метод главных компонент. Качественная обратная связь была проанализирована также по тематическому критерию. Результаты показывают, что игра SEED способствует актизивации студентов, побуждает их мотивацию и помогает получить знания по устойчивости окружающей среды на среднем уровне, до высокого. Принципы Развития и достижения, а также Общественного влияния и сопричастности, оказываются самыми эффективными мотивационными факторами. Было найдено сильное соотношение между вовлечённостью и мотивацией. Студенты особенно ценили игровой реализм, персонализацию и возможность входить в социальные взаимодействия. Итоги подчеркнули значение включения умело разработанных игр в процесс обучения устойчивости окружающей среды. Это касается особенно новых поколений, у которых есть специфические образовательные предпочтения. Результаты указывают также на ключевые соображения студентов для будущей разработки игр и образовательной практики, включая большое значение

транспарентных механизмов обратной связи и учёта разновидных ожиданий учащихся. Данное исследование вносит вклад в текущие усилия по использованию геймификации для поддержки преобразующего обучения в области устойчивого развития, подчеркивая преимущества для студентов в плане вовлеченности, мотивации и развития компетенций, а также для преподавателей, которые получают инновационный инструмент для объяснения сложных тем. Эти результаты согласуются с аналогичными наблюдениями в университетах Европы.

К л ю ч е в ы е с л о в а: Игровое обучение, устойчивое развитие, инновационные методы обучения, Фреймворк Октализ, высшее образование

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Blended Learning and Accounting Student Success in Oman: An Empirical Post-COVID-19 Study

Abstract

This research aims to explore blended learning (basic requirements and knowledge) and accounting students' success after COVID-19 among graduating students in Oman. Furthermore, this study examines how blended learning (BL) effectiveness acts as a mediator between the BL basic requirements and the success of accounting students, as well as between the BL basic knowledge and the success of accounting students. A quantitative research methodology was employed to collect data for this study, using a questionnaire distributed through WhatsApp and email to students attending various universities in the Sultanate of Oman. Following that, the researcher analyzed the data using partial least squares structural equation modeling (PLS-SEM). The study found that the BL basic requirements have a positive impact on accounting students' success. It also showed that BL basic knowledge has no significant relation to accounting students' success after COVID-19. The findings also show that there is a mediating effect of BL effectiveness between BL basic requirements and accounting students' success after COVID-19. Limited generalizability exists because the respondents were restricted

to Oman. Future research could expand the sample by including participants enrolled in non-accounting courses. The study highlights the importance of delivering both online and face-to-face learning and a range of online activities. This study emphasizes how students engage with and participate in a BL accounting course.

K e y w o r d s: Blended learning, knowledge, accounting students, COVID-19, Oman

Blended learning (BL) combines conventional and online teaching methods to promote a more adaptable and student-centered approach to learning (Ballouk et al., 2022). Global trends in open and remote learning indicate that BL is vital for any distant or e-learning education institution that wants to stay relevant in an extremely competitive world. A key component of any BL strategy is online learning environments (Hrastinski, 2019). According to Sharma (2010) and Dahmash (2020), BL was first introduced in the year 1990 in the context of language teaching, containing three definitions: "A blend of in-person and online blended learning, a mixture of technology, and a mixture of techniques". BL is a learning strategy that mixes face-to-face and online learning through the use of e-learning resources (Nopiyanto et al., 2021) and it is a style of teaching that employs laptop computers or other technological devices like tablets and cellphones (Altbach & Knight, 2007). Learning technology advancements have forced Higher Educational Institutions (HEIs) to rethink how they create and deliver their programs (Rosenbusch, 2020).

The use of technology enabled teaching strategies in accounting classes is being encouraged (Peng, 2019). Due to the abstract nature of accounting information, some students enrolling in the course may find it difficult to excel academically since they lack the requisite numerical and analytical competencies (Liu & Zainuddin, 2021). However, the usage of a technology-enabled enabled learning component provides such students with enhanced graphics content and visual methods, which is greatly useful for strengthening accounting students' learning abilities (Herrador-Alcaide et al., 2020). Students must embrace and utilize e-learning technologies to guarantee successful online learning. This is especially critical in higher education in the aftermath of the COVID-19 epidemic (Terblanche et al., 2023).

Although BL has become a popular approach in higher education, many institutions still encounter difficulties in fully implementing and conceptualizing such learning environments. The use of multiple learning management systems can be daunting for students who are unfamiliar with the technology, leading to reluctance to participate (Kaisara & Bwalya, 2021). Additionally, some students have reported being unable to access the university's e-learning platform due to

issues with internet data charges. Moreover, slow loading of the e-learning system has caused some students to give up using it, exacerbating the situation (Kaisara & Bwalya, 2021).

The COVID-19 pandemic has put institutions under more pressure than ever before (Fray et al., 2022). Thus, they are working harder than ever to increase student engagement, academic accomplishment, and the pleasure of their education. Although BL had been a successful practice even before the current group of students enrolled in accounting courses, each generation's demands for learning accounting courses required technological advancement (Eliyasni et al., 2019). Thus, the primary objective of this study is to explore BL (basic requirements and knowledge) and accounting students' success after Covid-19 among graduating students in Oman. Furthermore, this study examines how BL effectiveness acts as a mediator between the BL basic requirements and the success of accounting students, as well as between the BL basic knowledge and the success of accounting students.

Therefore, this research intends to address the following research questions (RQs):

RQ1. How does BL basic requirement affect accounting students' success after COVID-19?

RQ2. How does BL basic knowledge affect accounting students' success after COVID-19?

RQ3. Is there a mediation effect of BL effectiveness on the relationship between BL (basic requirements & basic knowledge) and accounting students' success after COVID-19?

Literature Review

The teaching environment and instructional methods have undergone significant changes as a result of COVID-19 (Hill & Fitzgerald, 2020). BL at HEIs is still quite new. Chowdhury (2019) aimed to explore BL, including the development of a BL program, its benefits, and the requirements for effectively implementing such a program in a HEIs.. Online/BL should better address the academic needs of students throughout any type of incident, such as a pandemic, war, or natural disaster. The application of conversational science and data, the entire teaching technique has been transformed into a learner-centered pedagogy by information communication technology-based innovation, with technological skills being the most important capabilities for both teachers/educators and students. Therefore, Bordoloi et al., (2021) aimed to investigate how instructors and students feel about using online and BL paradigms for teaching and learning. They also look

more closely at the advantages and disadvantages of providing online and BL, particularly throughout and after the COVID-1 period.

Online instructors are developing and implementing a BL model that currently teaches an entire field of teaching, learning, and research. Digital technology is transforming the way that people teach and learn, and today's students are more acclimated to living in a world that is becoming more tech-savvy (Adams et al., 2020). BL is becoming more popular in contemporary lectures (Van Goidsenhoven et al., 2020). Educational institutions have adopted a variety of strategies, such as e-learning and BL to help college students with the ease of access (Hogan & Devi, 2019). Zhang and Dang (2020) aimed to identify factors that could impact advanced technology-supported blended learning. As a result, higher education has witnessed significant changes, transitioning from e-learning to more creative forms of blended learning. Although BL has been used on university and college campuses for 20 years, it continues to top concerns about adopting technology-enabled learning in higher educational institutions (Qian & Huang, 2019).

The literature analysis on BL, however, reveals that there has not been much innovation in the methods used for BL to date. Hence, BL innovation has been considered a management issue, not just for analyzing technical know-how professionals' issues, but as a means of achieving the higher education goal of accounting students' success (Thompson et al., 2019). Higher educational sectors, it is becoming more crucial than ever to support students' engagement and success across a range of academic growth strategies. It is essential to comprehend how college students interact throughout their postsecondary education and how the diversity of engagement qualities contributes to the performance of accounting students given that academic delivery is becoming more challenging at present (Bowden, 2022).

In BL environments, students' interactions with learning management systems (LMSs) may be utilized to identify college students who are in danger of failing (Fahd et al., 2021). Revolutionary technological advancements are dramatically transforming the landscape of teaching and learning in higher education. Among these changes, blended learning stands out as a groundbreaking movement that merges the best of both worlds by combining traditional face-to-face instruction with the flexibility and interactivity of online learning. Hence, examining the theoretical underpinnings of BL research along with how it has been adopted and utilized in relation to students, instructors, and administration is crucial as the number of policies pertaining to BL grows (Anthony et al., 2020). The solution for delivering instruction in the perspective of the twenty-first century should be BL. But unlike traditional education, open schooling has expanded the range of learning under the guiding principle of "Bring your own device to learn".

The widespread adoption of free educational materials, open educational resources, extensive open e-learning courses, use of social media, and widespread use of mobile applications during the period of COVID-19lockdown has expanded

students' minds and made it possible for them to gain essential instructional inputs, training, and competencies. There will be a significant impact on how academic operations are performed in the days to come (Bordoloi et al., 2021). By implementing BL strategies, HEIs can improve the quality of teaching, as well as the accessibility and affordability of their degree programs. However, in order to achieve this, students, parents, teachers, academic researchers, administrators, and policymakers must accept latest theories and methods of teaching and learning (Chowdhury, 2019). BL tactic should be used to alert teachers to potentially challenging students, highlighting the need for additional help or remediation to help them succeed (Fahd et al., 2021).

The primary findings of Anthony et al., (2020) reveal the notions and factors that motivate students, instructors, and administrators in higher education to engage in BL. Additionally, they indicated that the diffusion of improvements and the ad hoc, technological know-how acceptance model, data device success model, and unifying principle of acceptance and utilization of technology, were the most frequently used in prior research to examine BL adoption. Additionally, the social environment has changed as a result of technological improvements and technology has made it easier to develop and deploy new instructional settings and delivery systems, these developments have affected education (Al Fadda, 2019).

Institutions employ BL instructional strategies because they may help to raise student achievement. Fisher et al., (2021) found that blended teaching approaches are delivery strategies rather than instructional strategies since they have a favorable impact on perceptions of engagement, performance, and satisfaction. The "multicomponent BL mode" greatly excelled conventional teaching strategies in terms of both the course assessment score and students' academic accomplishment. According to studies, student engagement and passion for studying have increased Lo et al., (2021). Hussein et al., (2020) found that COVID-19 has had a detrimental effect on BL due to distraction and lack of focus, a hefty workload, technological and internet problems, and a lack of assistance from instructors and peers. Hence, a BL intervention can greatly increase students' learning behaviors, attitudes, inspiration, academic success, and self-efficacy in a mixed learning system (Zhang et al., 2020). In light of this, the following hypotheses have been formed:

H_1: BL basic requirements positively affect BL effectiveness after COVID-19

H_2: BL basic knowledge positively affects BL effectiveness after COVID-19

H_3: BL basic requirements positively affect accounting students' success after COVID-19

H_4: BL basic knowledge positively affects accounting students' success after COVID-19

H_5a: BL effectiveness mediates the relation between BL basic requirements and accounting students' success after COVID-19

H_5b: BL effectiveness mediates the relation between BL basic requirements and accounting students' success after COVID-19

H_6: BL effectiveness positively affects accounting students' success after COVID-19

Accordingly, below logical framework (see Figure 1) was constructed to characterize the relationship between variables.

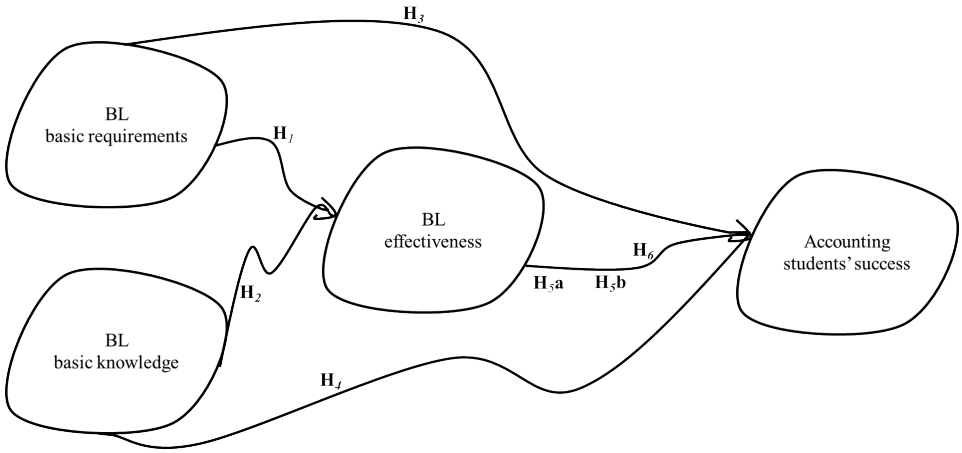

Figure 1. Schematic Diagram of Research Framework

S o u r c e: Own work.

Structure of the Study and Measurements

The BL variables that were hypothesized and the relationships between them in the framework used in this study are adapted from Prinsloo and Van Rooyen (2007) and modified if necessary for mediating variable, that is, BL effectiveness. The proposed extended theoretical framework of the research is shown in figure 1. The study's variables were measured applying a five-point Likert scale across a range of questions, with responses varying from strongly disagree (SD, 1) to strongly agree (SA, 5). Students from various universities and colleges in the Sultanate of Oman participated in a survey to collect the data for the study. There were finally 127 set usable questionnaires considered for this study. To establish adequate reliability, a minimum of three elements were employed for each construct (Nunnally, 1978). Six hypotheses are to be tested in the proposed model.

Data Analysis

The data were examined using Structural Equation Modelling-Partial Least Squares (SEM-PLS). Because it aims to increase the dependent variable, accounting students' success, enhance their ability for prediction, and speed up theory development, this statistical approach was applied in this research (Sinkovics et al., 2016; Hair et al., 2011). According to a Monte Carlo simulation research, SEM-PLS can generate significant findings with a small sample size, like twenty respondents (Hoyle,1999).

Instrument Reliability and Validation

The study employs a composite reliability approach to examine the reliability, which assesses a construct using two types of inner consistency and Cronbach's Alpha (Ghozali, 2006) to ascertain whether a coefficient of dependability is used as adetermining factor. If the coefficient is >0.60, the entire items of the variables are considered reliable. The study was utilized to assess the square root of the average variance extracted (AVE), the frequency of each construct also with correlation with other constructs within the same model as part of the data validity assessment (Ghozali, & Latan, 2014).

Table 1
Results of construct's reliability and validity

Construct	Items	Item Loading	VIF	CA	rho_A	CR	AVE
Accounting Students Success	Acct_SS1			0.799	0.817	0.881	0.713
	Acct_SS2	0.857	1.796				
	Acct_SS3	0.782	1.536				
	Acct_SS4	0.890	1.980				
BL Basic Knowledge	BL_BK1	0.875	2.154	0.894	0.895	0.934	0.826
	BL_BK2	0.937	4.099				
	BL_BK3	0.913	2.154				
BL Basic Requirements	BL_BR1	0.877	2.090	0.818	0.842	0.890	0.731
	BL_BR2	0.812	1.763				
	BL_BR3	0.874	1.743				
BL Effectiveness	BL_E1	0.913	2.540	0.833	0.847	0.900	0.751
	BL_E2	0.876	2.340				
	BL_E3	0.806	1.582				

N o t e: Collinearity Statistics- VIF stand for Variance inflation factor; CA stands for Cronbach's Alpha; CR stands for Composite Reliability; and AVE stands for Average Variance Extracted.

S o u r c e: Own work.

A good value for discriminant validity is considered to exist if the correlation among a construct and the other constructs in the model is higher than the average variance extracted square root of each construct. All of the BL constructs, including the mediating variable, BL efficiency exhibit acceptable Cronbach's alpha (CA), and composite reliability (CR) values. By using the variance inflation factor, the existence of multicollinearity – a situation in which two or more variables are extremely closely linearly linked – was examined (VIF). In the present study, all VIF values are lower than ten. Therefore, the research data did not have any multicollinearity problems. Table 1 shows the results of construct's reliability and validity of the construct.

Results

Demographic Characteristics

The descriptive analysis by construct in Table 2 indicate that, on average, the success of accounting students is average (with a 3.052 mean and a 1.017 standard deviation), but the actual range is large. Of the three components, BL basic knowledge receives the highest score (with a 3.531 mean and a 1.168 standard deviation). The mean scores of BL basic requirements also have a competent value (i.e., 3.424 with a standard deviation of 1.058). The test with the lowest mean score is BL effectiveness (i.e., 3.262 and standard deviation of 1.074).

Table 2
Descriptive statistics by constructs

Variable	n	Mean	Min	Max	SD
Accounting Students Success	127	3.052	1.000	5.000	1.017
BL Basic Knowledge	127	3.531	1.000	5.000	1.168
BL Basic Requirements	127	3.424	1.000	5.000	1.058
BL Effectiveness	127	3.262	1.000	5.000	1.074

S o u r c e: Own work.

The findings regarding the discriminant validity of constructs are presented in Table 3. Discriminant validity assesses the degree of differentiation between the measures of multiple possibilities. However, as shown in Table 3, discriminant validity of the constructs can be explored by looking at the correlation among constructs and the square-root of the study variance produced for a construct. According to the study, each construct's correlations were lower than the square-root of the average by the values that represented that construct, implying that the

measure's discriminant validity was sufficient. The measuring model, in summary, showed acceptable level of reliability, discriminant validity and convergent validity.

Table 3
Discriminant validity of constructs

Constructs	Accounting Students Success	BL Basic Knowledge	BL Basic Requirements	BL Effectiveness
Accounting Students Success	0.844			
BL Basic Knowledge	0.506	0.909		
BL Basic Requirements	0.576	0.873	0.855	
BL Effectiveness	0.633	0.746	0.832	0.866

S o u r c e: Own work.

The current study also examined the coefficient of determination R square (R^2) or adjusted R^2) and Q^2 to assess the structural model. The coefficient of determination, which evaluates the model's likelihood to forecast results, is a measure of the endogenous variable's dispersion and can be described by all exogenous variables. Some disciplines may view coefficients of determination beyond 0.20 as significant, while values between 0.25 and 0.50 are thought to be satisfactory (Achen, 1982). Table 5 illustrates how the exogenous factors' R^2 and adjusted R^2 values of 0.409 and 0.394, respectively, can be used to explain the endogenous variable, accounting for students' success. Though, the endogenous variable, that is, BL effectiveness can be described by the exogenous variables with the value of R^2 and adjusted R^2 respectively by 0.693 and 0.688 which is quite more than accounting students' success. The resultant values denoted that the connections are justified by the strength approaching (Latan and Ghozali, 2015).

Table 4
Variance Explained

Endogenous Construct		Variance Explained (R^2)	(R^2) Adjusted
Exogenous Variables -> Endogenous (Accounting Students Success)	Acct_SS	0.409	0.394
	BL_E	0.693	0.688

S o u r c e: Own work.

The ultimate impact size for each predictor variable varies between 0.09 to 0.19 and is in the small to moderate range. The model has predictive significance as evidenced by the value of predictive relevance, Q^2 which yielded robust endogenous variables, i.e., more than 0.

Table 5
Predictive relevance Q^2

CV redundancy	Excluded predictor	Q^2	Effect size
0.273	Accounting Students Success	0.421	Medium
	BL Basic Knowledge	0.612	Medium
0.501	BL Basic Requirements	0.447	Medium
	BL Effectiveness	0.489	Medium

S o u r c e: Own work.

Hypotheses Testing

Below Table 6 and 7 show the path coefficients and hypotheses test results.

SEM-PLS is employed in regression analysis, which is employed in hypothesis testing. The hypotheses, H_1, H_2, H_3, H_4, and H_6 tested the direct effect on the endogenous variable. The results of the path coefficients and hypotheses test are shown in Table 6. In conclusion, this study supports the findings of the success of accounting students in relation to BL by supporting H^1, H^3, and H^6. Where H^1, reveals that BL basic requirements have a positive effect on BL effectiveness after COVID-19 (β = 0.759, p<0.001); H3, reveals that BL basic requirements have a positive significant effect on accounting students' success after COVID-19 (β = 0.566, p<0.001); and H6 reveals that BL effectiveness has also had a positive effect on accounting students' success after COVID-19 (β = 0.498, p<0.001). However, H_2, shows that BL basic knowledge has no effect on BL effectiveness after COVID-19 (β = 0.083, p>0.05); and H4 presents that BL basic knowledge does not affect accounting students' success after COVID-19 (β = 0.012, p>0.05).

Table 6
Testing of hypotheses and path coefficients (direct effect)

Hypotheses	Relationship	Standard β	Standard error	t-value	P-value	Decision
H_1	BL_BRà BL_E	0.759	0.122	3.801	0.000***	Supported
H_2	BL_BKà BL_E	0.083	0.138	0.599	0.550	Not supported
H_3	BL_BRà Acct_SS	0.566	0.170	3.334	0.001***	Supported
H_4	BL_BKà Acct_SS	0.012	0.167	0.073	0.941	Not supported
H_6	BL_Eà Acct_SS	0.498	0.131	3.801	0.000***	Supported

N o t e: Levels of significance: ***p < 0.001 (t >3.33), **p < 0. 01 (t >2.33), *p < 0.05 (t >1.605) (based in one-tailed test)

S o u r c e: Own work.

H_5a and H_5b test the mediating effect on the endogenous variable. The results of the path coefficients and hypotheses test are presented in Table 7. In conclusion, this study supports the mediating effect of BL effectiveness between BL basic requirements and accounting students' success after COVID-19. H_5a reveals that BL effectiveness mediates the relationship between BL basic requirements and accounting students' success after COVID-19 (β = 0.378, p<0.001). However, H_5b proves that BL effectiveness has no mediating relation between BL basic requirements and accounting students' success after COVID-19 (β = 0.041, p>0.05).

Table 7
Testing of hypotheses and path coefficients (mediating effect)

Hypotheses	Relationship	Standard β	Standard error	t-value	P-value	Decision
H_5a	BL_BRàBL_Eà Acct_SS	0.378	0.110	3.438	0.001***	Supported
H_5b	BL_BKàBL_Eà Acct_SS	0.041	0.073	0.568	0.570	Not supported

N o t e: Levels of Significance: ***p < 0.001 (t >3.33), **p < 0. 01 (t >2.33), *p < 0.05 (t >1.605) (based in one-tailed test)

S o u r c e: Own work.

Discussion

The Effect of BL (Basic Requirements and Basic Knowledge) and BL Effectiveness

The study first examined the link between BL basic requirements with BL effectiveness after COVID-19 . Further, it tested BL's basic knowledge of BL effectiveness after COVID-19 . Several earlier studies indicated that BL basic requirements and basic knowledge might be considered an important determinant for BL effectiveness (Fadhilatunisa et al., 2020; Kadirbergenovna, 2022). The majority of students believe that BL is a successful strategy for fostering learner autonomy because they possess moderately high levels of learning individuality as well as moderately high levels of students' motivation, participation, and responsibility, and suggests that even in a BL approach, teachers continue to play a crucial role (Chen, 2022). The path coefficient assessment shown in Table 6 indicates, for H_1, a significant relationship between BL basic requirements and BL effectiveness (β=0.759, p < 0.001). These findings strengthen the study's hypothesis, which states that BL efficiency among accounting students in Oman might be increased by BL's basic requirements. This research reveals that BL requirements, such as the need for a laptop or desktop computer to participate in online classes, are crucial

factors in determining whether accounting students can effectively participate in BL accounting classes. Adequate internet connectivity to attend online classes is another basic requirement to attend BL accounting classes. However, handling BL accounting course modules using online-based study is crucial. Access to learning resources, the internet, and library resources were all topics of considerable concern. A well-learning management system design helps students to easily access course modules and BL is ideal for learning accounting courses (Gqokonqana et al., 2022). Therefore, it can be inferred that the rational explanation for the accomplishment of this outcome for the hypothesis is that BL basic requirements help BL effectiveness, ultimately resulting in accounting students' success in learning online accounting classes. However, in Hypothesis H2, BL basic knowledge has no effect on BL effectiveness after COVID-19 (β=0.083, p>0.05). Thus, hypothesis H_2 is not in agreement with the hypothesis put forward in the present study. The reason could be that accounting students may be familiar with IT skills, university website browsing, and systems for managing BL.

The Impact of BL (Basic Requirements and Basic Knowledge) and Accounting Students' Success

The study then examined the link between BL basic requirements with accounting students' success after COVID-19. Further, it tested BL basic knowledge of accounting students' success after COVID-19. Several earlier studies indicated that BL basic requirements and basic knowledge might be considered an important determinant for accounting students' success (Fortin et al., 2019; Kamalluarifin et al., 2018). The perspectives of students are influenced by their traits, and a well-designed BL approach can change perceptions and enhance writing and problem-solving skills among accounting students (Russo et al., 2022). The path coefficient assessment shown in Table 7 indicates, for hypothesis H_3, a significant relationship between BL basic requirements with accounting students' success (β=0.566, p<0.001). These findings strengthen the study's hypothesis, which states that accounting students' success after COVID-19 might be increased by BL basic requirements. This research reveals that BL requirements, such as the need for a laptop or desktop computer to participate in online classes, are crucial factors in determining accounting students' success in BL environment. Adequate internet connectivity to attend online classes is another basic requirement for accounting students' success after COVID-19 . When instructors are given the required policies and skills, BL environments in elementary schools raise learners' academic achievement levels. Overall, BL had a positive significant impact on students' learning attainment (Kundu et al., 2021). Therefore, it can be inferred that the rational justification for the accomplishment of this outcome for the hypothesis is that BL basic requirements help accounting students' success after COVID-19 in

learning online accounting classes. However, Hypothesis H_4 proves that BL basic knowledge does not affect accounting students' success after COVID-19 (β=0.012, p>0.05). Thus, hypothesis H4 is not consistent with the hypothesis put forward in the present study. The reason could be that accounting students may not be familiar with general BL technical skills and knowledge systems for managing BL.

The Impact of BL Effectiveness and Accounting Students' Success

The study finally examined the link between BL effectiveness with accounting students' success after COVID-19 . Further, it tested mediating effect of BL effectiveness on the relationship between BL basic requirements and accounting students' success after COVID-19 . It also tested mediating effect of BL effectiveness on the relationship between BL basic knowledge and accounting students' success after COVID-19 . Several earlier studies indicated that BL effectiveness mediates students' success in BL environment (Lin et al., 2020; Law et al., 2019). Varma et al., (2022) stated that perceived learning considerably impacted the link between learning performance and technological commitment to an online accounting program. The path coefficient assessment shown in Table 6 indicates, for hypothesis H_6, a significant relationship between BL effectiveness with accounting students' success after COVID-19 (β=0.498, p<0.001). Further, H_5a shows that BL effectiveness mediates the relation between BL basic requirements and accounting students' success after COVID-19 (β=0.378, p< 0.001). These findings strengthen the study's hypothesis, which states that accounting students' success after COVID-19 might be increased by BL effectiveness. The findings of this study demonstrate that students perceive BL as effective due to factors such as a user-friendly website interface, prompt feedback from teachers when topics are not fully understood during blended learning, and a general preference for blended learning over traditional classroom teaching, particularly in skill-based accounting courses. For future course delivery, it is crucial to assess BL effectiveness, identify the conditions in which they perform best, and enhance the blended activities established from the perspectives of both students and teachers (Serrano et al., 2019). Therefore, it can be inferred that the rational explanation for the accomplishment of this outcome for the hypothesis is that BL effectiveness significantly affects accounting students' success after COVID-19 in learning online accounting classes. However, Hypothesis H_5b proves that BL effectiveness does not mediate the relation between BL basic knowledge and accounting students' success after COVID-19 (β= 0.041, p>0.05).

In Figure 2 below, the structural model is presented, with BL determinants (basic requirements and basic knowledge) and accounting students' success and mediation effect of BL effectiveness in the relation between BL (basic requirements and basic knowledge) and accounting students' success.

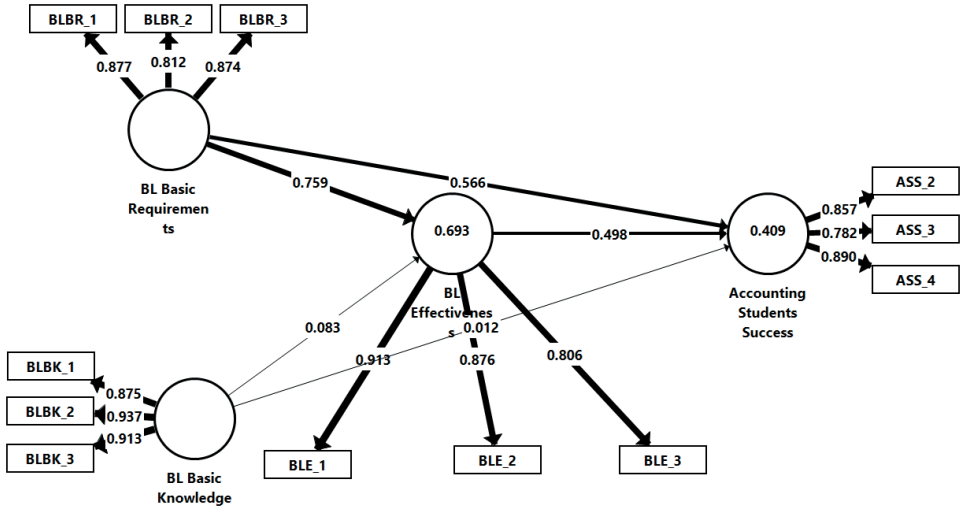

Figure 2. Structural model

Source: Own work.

Conclusion

Fortin et al., (2019) observed that despite a rise in BL studies from recent years, there is still a lack of research studies analyzing BL in accounting courses. Prior research studies on BL (Namyssova et al., 2019; Asarta, & Schmidt, 2020) have generally compared conventional and BL approaches and examined the effects, challenges, and benefits of BL. Though, little study has been performed on the success of accounting majored students and the mediating effect of BL effectiveness in the BL environment. This research contributes to drawing on this BL in the accounting literature. The success of accounting students can be increased by using BL basic requirements as a strategic fusion of technologies. Participating in BL increased accounting students' technical abilities, and they believe that it is more effective than on-campus classroom instruction at helping students understand the concepts covered in the accounting courses they are studying. Additionally, students considered that BL would aid in improving employable skills. This study has shown the validity of BL as a potential direction to enhance the efficiency of teaching, learning, and achieving accounting students' success. Despite the fact that this study examined BL effectiveness as a mediating factor that increases the significance of the research. After COVID-19, accounting students today, especially, have higher expectations of their online platforms. As a result, careful

attention must be paid to have BL basic requirements that result in BL effectiveness, which will ultimately lead to accounting students' success particularly to improve their practical skills in the accounting field.

Implications

The success of accounting students using BL can be understood by this research, which also proposes a theoretical model to comprehend BL basics requirements and BL basic knowledge, and explains the factors that affect accounting students' success. It also tests the mediating effect of BL effectiveness to use BL. Therefore, this study offers a number of theoretical implications for students and faculty that promote the usage of BL. Theoretically, this research defines the basic requirements for BL variables that affect accounting students' success in using BL. The presented model is intended to assist educationalists in making effective pedagogical design judgments concerning the appropriate use of BL in enhancing the strategy of accounting students' learning. Thus, this study provides insight into BL effectiveness as a mediating factor between BL basic requirements and accounting students' success in order to enhance students' practical abilities and competency, particularly from an Oman perspective. The findings thus inform HEIs in Oman on students' competence for adapting and readiness for the eventual use of BL platforms for accounting courses. Additionally, to improve the competency of accounting majored students, these findings motivate lecturers to use technology-enabled teaching in their lectures.

From a practical standpoint, this research provides insights on how future measures should be focused on to enhance the integrity of accounting students' learning and teaching experiences in Oman HEIs institutions. The findings of this research study offer guidance to universities on how to improve learning programs in connection with technological advancements that will be helpful to accelerate BL ideas. Additionally, the results of this research study offer helpful guidelines for the institutional sector to restructure their educational instructions using BL techniques and to better comprehend how specific delivery methods for instruction relate to the growth of students' learning. Therefore, faculties could make take advantage of the findings to better understand why accounting students agree and adopt BL approaches.

Limitations

There are many limitations to this research. The study's results cannot be easily generalized because of the study's small sample size of 127 accounting students. This study is contextually bound to Oman and post-COVID-19 learning environments, which significantly frames the research. Additionally, in classes having a higher number of students, there may be a considerable difference in the resources required for a BL method and the success of accounting students. Observations from students with majors other than accounting are not included in this article because they are outside the purview of the research. Future studies could examine additional factors related to BL across students of various other majors, as well as the effects of online learning on other academic endeavors. Examining the usage of BL in other practical courses would serve to further and extend this research.

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Khafiya Al-Wahaibi, Bashayar Al-Amri, Mohammed Thottoli

Blended Learning i sukces studentów rachunkowości w Omanie: empiryczne badanie po COVID-19

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

Niniejsze badanie ma na celu zbadanie blended learningu (podstawowych wymagań i wiedzy) oraz sukcesu studentów rachunkowości po pandemii COVID-19 wśród kończących studia studentów w Omanie. Analizuje również, w jaki sposób skuteczność blended learningu (BL) pośredniczy w relacji między podstawowymi wymaganiami BL a sukcesem studentów rachunkowości, a także między podstawową wiedzą BL a ich sukcesem. Zastosowano ilościową metodologię badawczą – ankieta została rozpowszechniona za pośrednictwem WhatsAppa i e-maila wśród studentów różnych uczelni w Sułtanacie Omanu, a dane przeanalizowano za pomocą modelowania równań strukturalnych metodą najmniejszych kwadratów cząstkowych (PLS-SEM). Wyniki wykazały, że podstawowe wymagania BL mają pozytywny wpływ na sukces studentów rachunkowości, natomiast podstawowa wiedza BL nie wykazuje istotnego związku z sukcesem studentów po COVID-19. Ponadto stwierdzono, że skuteczność BL odgrywa rolę mediatora między podstawowymi wymaganiami BL a sukcesem studentów rachunkowości. Ze względu na ograniczenie próby do studentów z Omanu, możliwości uogólnienia wyników są ograniczone; przyszłe badania mogłyby objąć studentów innych kierunków. Badanie podkreśla znaczenie łączenia nauki zdalnej i stacjonarnej oraz różnorodnych aktywności online, a także sposób, w jaki studenci angażują się w kursy rachunkowości realizowane w formule BL.

S ł o w a k l u c z o w e: Blended learning, wiedza, studenci, rachunkowości, COVID-19, Oman

Khafiya Al-Wahaibi, Bashayar Al-Amri, Mohammed Thottoli

Aprendizaje combinado y éxito de los estudiantes de contabilidad en Omán: un estudio empírico post-COVID-19

R e s u m e n

Esta investigación tiene como objetivo explorar el aprendizaje combinado (requisitos básicos y conocimientos) y el éxito de los estudiantes de contabilidad después del COVID-19 entre los estudiantes que están finalizando sus estudios en Omán. Además, el estudio analiza cómo la efectividad del aprendizaje combinado (BL, por sus siglas en inglés) actúa como mediadora entre los requisitos básicos del BL y el éxito de los estudiantes de contabilidad, así como entre los conocimientos básicos del BL y dicho éxito. Para la recolección de datos se empleó una metodología de investigación cuantitativa, mediante un cuestionario distribuido a través de WhatsApp y correo electrónico a estudiantes de diversas universidades del Sultanato de Omán. Posteriormente, los datos fueron analizados utilizando el modelo de ecuaciones estructurales por mínimos cuadrados parciales (PLS-SEM). El estudio encontró que los requisitos básicos del BL tienen un impacto positivo en el éxito de los estudiantes de contabilidad. También mostró que los conocimientos básicos del BL no tienen una relación significativa con el éxito de los estudiantes de contabilidad después del COVID-19 . Los hallazgos revelan además que la efectividad del BL tiene un efecto mediador entre los requisitos básicos del BL y el éxito de los estudiantes de contabilidad tras la pandemia. La generalización de los resultados es limitada debido a que los encuestados estaban restringidos a Omán. Investigaciones

futuras podrían ampliar la muestra incluyendo participantes de carreras distintas a contabilidad. El estudio destaca la importancia de ofrecer tanto enseñanza en línea como presencial, así como una variedad de actividades digitales. Esta investigación resalta cómo los estudiantes se implican y participan en un curso de contabilidad basado en aprendizaje combinado.

P a l a b r a s c l a v e: aprendizaje combinado, conocimiento, estudiantes de contabilidad, COVID-19, Omán

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Смешанное обучение и успех студентов бухгалтерского учёта в Омане: эмпирическое исследование после COVID-19

А н н о т а ц и я

Данное исследование направлено на изучение смешанного обучения (базовые требования и знания) и успеха студентов бухгалтерского учёта после COVID-19 среди выпускников в Омане. Кроме того, исследование рассматривает, как эффективность смешанного обучения (BL) выступает в качестве посредника между базовыми требованиями BL и успехом студентов-бухгалтеров, а также между базовыми знаниями BL и их успехом. Для сбора данных была использована количественная методология с применением анкеты, распространённой через WhatsApp и электронную почту среди студентов различных университетов Султаната Оман. Затем данные были проанализированы с использованием моделирования структурных уравнений методом наименьших квадратов (PLS-SEM). Результаты показали, что базовые требования BL положительно влияют на успех студентов-бухгалтеров, тогда как базовые знания BL не имеют значимого влияния на их успех после COVID-19. Также установлено, что эффективность BL оказывает опосредующее влияние между базовыми требованиями BL и успехом студентов-бухгалтеров после пандемии. Возможности обобщения результатов ограничены, так как респонденты были только из Омана. Будущие исследования могут расширить выборку, включив студентов других специальностей. Исследование подчеркивает важность сочетания онлайн- и очного обучения, а также разнообразных онлайн-активностей. Особое внимание уделяется тому, как студенты вовлекаются в курсы бухгалтерского учёта, реализуемые в формате BL.

К л ю ч е в ы е с л о в а: Смешанное обучение, знания, студенты бухгалтерского учёта, COVID-19, Оман

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The Analysis of the Moodle Platform E-learning Course Activity at the Faculty of Science and Technology at the University of Silesia

Abstract

The study presents a comprehensive analysis of e-learning course activity on the Moodle platform at the Faculty of Science and Technology, University of Silesia. The primary objective was to evaluate the structure, engagement, and digital resource usage of online courses across various academic disciplines. The dataset, collected prior to the platform's archiving process, included variables such as student enrollment, instructor login frequency, and the size of uploaded teaching materials. Descriptive statistics and non-parametric tests (Kruskal–Wallis, Mann–Whitney U) were employed to assess differences between fields of study and the impact of course visibility on instructor engagement. Additionally, time series analysis using linear regression was conducted to identify trends in course creation and instructor participation from 2012 to 2024.The findings reveal significant disparities in course activity across disciplines, with some fields showing high student numbers and resource intensity, while others exhibited prolonged instructor inactivity. Contrary to expectations, course visibility did not significantly influence instructor engagement. A positive, though marginally significant, trend

was observed in both the number of courses and instructor involvement over time, with a notable increase in 2020 due to the COVID-19 pandemic. These insights underscore the need for customised strategies in digital course management, supporting institutional efforts to enhance the quality and sustainability of e-learning environments.

K e y w o r d s: Moodle, e-learning, instructor engagement, course activity analysis, digital education, higher education, non-parametric

Introduction

Over the past decade, universities have faced increasing pressure to deliver digital education that is both inclusive and scalable. European and global policy documents emphasise two priorities: building a high-performing digital ecosystem and strengthening digital competences across the sector (e.g., the EU Digital Education Action Plan 2021–2027; EDUCAUSE Horizon Report 2024). These directions align with the continued use of learning management systems (LMSs), such as Moodle, as institutional backbones for blended and online provision. Sector surveys report both progress and persistent inequalities in students' digital experience (Pasichnyi et al., 2024).

Research on LMS data has evolved from simple click counts to more advanced learning analytics interventions and student-facing dashboards. Recent systematic reviews indicate a shift toward pedagogically informed analytics and improved reporting standards, while also highlighting an over-reliance on behavioural proxies and limited contextualization (Pan et al., 2024; Paulsen & Lindsay, 2024; Bergdahl et al., 2024). Our study addresses these gaps by embedding an institutional Moodle audit within recognised theoretical frameworks and policy contexts.

The development and maintenance of high-quality e-learning courses are essential for ensuring effective knowledge transfer, student engagement, and academic success. Well-structured courses that incorporate multimedia resources, interactive elements, and timely instructor feedback can significantly enhance the learning experience. Conversely, poorly maintained or inactive courses may hinder student motivation and learning outcomes. Therefore, continuous monitoring and evaluation of e-learning environments are crucial for maintaining educational standards and identifying areas for improvement.

This study examines Moodle course activity at the Faculty of Science and Technology, University of Silesia, where the platform is widely used to support teaching and learning. Data were extracted on October 7, 2024, just prior to archiving, to capture the full scope of previous academic years. Data were obtained via a plugin

developed by the University's Centre for Online Learning, which aggregated key course-level metadata (e.g., enrolment counts, size of uploaded materials, and instructor login recency) into a dedicated table. The export was anonymised for research purposes. No surveys or interventions were carried out. Ethics approval was not required because the study used anonymised administrative metadata collected under existing regulations and EU law. The analysis followed recognised sector guidelines for learning analytics ethics, and no attempt was made to identify individuals. The research addresses three questions: (1) differences in enrolment and resource size across disciplines, (2) whether course visibility influences instructor activity, and (3) long-term trends in course creation and participation from 2012 to 2024.

By applying descriptive statistics, non-parametric tests, and time series analysis, the study provides valuable insights into the current state of e-learning at the faculty. The findings aim to inform strategic decisions regarding course design, resource allocation, and digital pedagogy, ultimately contributing to the enhancement of the university's online education ecosystem.

Literature Review

The development of e-learning environments has become a central focus in modern higher education, particularly in the context of digital transformation and the growing demand for flexible learning models. Learning management systems (LMS) such as Moodle have been widely adopted due to their open-source nature, modularity, and adaptability to various pedagogical approaches (Salam & Farooq, 2020). Moodle supports both asynchronous and synchronous learning, enabling instructors to design interactive, resource-rich courses that can be tailored to meet the diverse needs of students (McCollum, 2020).

A key area of research in e-learning is the design and evaluation of course activities, including student engagement, instructor participation, and the use of digital resources. Studies have shown that instructor presence and timely feedback are critical to maintaining student motivation and course effectiveness (Prince et al., 2020; Kong & Yang, 2024). The importance of instructor activity and course structure in e-learning environments has been widely recognised. However, institutional analyses that compare these factors across disciplines remain limited. These findings are particularly relevant to our investigation of instructor activity and its relationship to course structure and student enrollment (RQ1). Moreover, the volume and quality of uploaded materials – such as multimedia content and structured assignments – are strong indicators of course richness and pedagogical intent (Videla et al., 2021; Garcia, 2022).

The disciplinary context plays a significant role in shaping e-learning practices. Research by Baran et al. (2021) and Hacıoğlu and Gülhan (2021) indicates that fields such as computer science and engineering tend to adopt more interactive and resource-intensive course designs, while humanities and theoretical sciences may rely more on textual content and asynchronous discussion. Such disciplinary differences in course design and pedagogical strategies provide a foundation for our comparative analysis across academic fields (RQ2). Diana and Sukma (2021) emphasise the effectiveness of project-based learning (PBL) in STEM education, while Rehmat and Hartley (2020) highlight the benefits of problem-based learning (PBL) in fostering critical thinking and engineering awareness.

The temporal analysis of e-learning trends has also gained attention. Studies by Attard et al. (2021) and Pe-Than et al. (2022) show that the COVID-19 pandemic accelerated the adoption of digital tools and reshaped teaching practices. This shift has led to a sustained increase in online course offerings and instructor engagement, as confirmed by longitudinal data analyses. These longitudinal shifts in digital education practices support our investigation into temporal trends in course creation and instructor participation (RQ4).

Recent research has also emphasised the importance of microlearning – a strategy that delivers content in small, focused units to enhance retention and engagement. Smyrnova-Trybulska et al. (2022) explored the use of microlearning in programming education, highlighting its potential for automated assessment and personalised learning pathways. Their work demonstrates how microlearning can be integrated into platforms like Moodle to support self-regulated learning and improve digital competencies. Skalka and Benko et al. (2022) further examined the role of gamification and automated feedback in microlearning environments, showing positive effects on student motivation and performance. The operational aspects of course visibility and their potential influence on instructor behaviour remain underexplored, motivating our inquiry into this relationship (RQ3).

Jatnkoon et al. (2025) provided practical case studies of implementing microlearning in higher education, particularly in teacher training and STEM disciplines. These studies confirm that microlearning can be effectively used to enhance digital literacy and pedagogical innovation.

Hackathons and collaborative events have also been recognised as effective tools for experiential learning. Beretta et al. (2022), Longmeier et al. (2022), and Garcia (2022) describe how such events foster teamwork, creativity, and real-world problem-solving skills. These findings align with the broader literature on active learning strategies (Prince et al., 2020; Videla et al., 2021).

Recent reviews synthesise LMS-based learning analytics in higher education. They highlight a gradual shift from descriptive indicators towards interventions and student-centred dashboards, yet also stress methodological weaknesses (limited context, partial reporting, and behavioural proxies only) (Pan et al., 2024; Bergdahl et al., 2024). Reviews of student-facing dashboards indicate a stronger connection

to learning sciences and theory-informed design emerging after 2020 (Paulsen & Lindsay, 2024).

To align with broader conversations about e-learning ecosystems, we include recent proceedings that demonstrate how cloud infrastructures and augmented reality co-shape digital learning environments (Papadakis et al., 2023; Papadakis et al., 2024). Although our dataset does not track AR usage, these works situate LMS activity within wider, cloud-enabled innovation trajectories.

In conclusion, the reviewed literature supports the importance of structured, data-informed, and discipline-sensitive approaches to e-learning. The integration of microlearning, active learning strategies, and digital analytics into platforms like Moodle offers promising directions for improving the quality and effectiveness of online education.

The reviewed literature highlights key dimensions of e-learning course design and delivery, including instructor engagement, resource intensity, disciplinary differences, and the impact of digital transformation. However, existing studies often focus on isolated aspects or specific pedagogical interventions, without providing a comprehensive, data-driven comparison across academic disciplines. Moreover, the relationship between course visibility and instructor behaviour remains underexplored, and longitudinal analyses of course activity are still limited. These gaps inform the formulation of our research questions, which aim to investigate structural and behavioural patterns in Moodle-based courses, explore discipline-specific trends, assess the role of course visibility, and identify long-term developments in digital education.

Methodology

This study employs a quantitative, exploratory approach to analyse structural and behavioural patterns in Moodle-based e-learning courses. The methodology was designed to address four research questions (RQ1–RQ4) and test the corresponding hypotheses (H1–H4), formulated to explore broader trends in digital education beyond the scope of a single institution.

Research Questions and Hypotheses

The following research questions were formulated:

RQ1: What patterns of student enrollment and instructor activity can be observed in Moodle-based courses, and how might these reflect broader trends in course engagement across higher education institutions?

RQ2: How do academic disciplines influence the structure and activity of Moodle courses, and what does this reveal about discipline-specific patterns in digital education?
RQ3: Does course visibility (hidden vs. visible) correlate with instructor activity, and how can this inform course management practices in online learning environments?
RQ4: What long-term trends in course creation and instructor participation can be identified on Moodle platforms, and how do they reflect broader shifts in digital pedagogy over time?

The hypotheses determined based on RQ1-RQ4 are as follows:

H1: Most Moodle courses show low to moderate student enrollment, with substantial variability in instructor activity across courses.
H2: Academic discipline is associated with significant differences in course structure and activity, including student numbers, file sizes, and instructor login frequency.
H3: There is no statistically significant correlation between course visibility and instructor activity.
H4: There is a positive trend over time in both the number of Moodle courses created and instructor participation, with a notable increase during the COVID-19 pandemic.

To achieve this, multiple statistical metrics were computed, and the results were visually represented using column graphs and boxplot graphs.

The dataset was extracted from the Moodle platform used at the Faculty of Science and Technology, University of Silesia. Although institution-specific, the data structure and variables are representative of common Moodle implementations in higher education, making the findings relevant to broader e-learning contexts.

A detailed analysis of the activity of courses delivered via the Moodle platform (el.us.edu.pl/wnst) for students of the Faculty of Science and Technology at the University of Silesia was conducted. The data were collected on October 7, 2024, prior to the course archiving process on the platform. It is important to note that course archiving on the Moodle platform at the University of Silesia is not performed annually, but rather at irregular intervals, typically every few years. As a result, many courses – including those created as early as 2012 – remained accessible in the system until the most recent archiving process in October 2024. This allowed for the extraction of historical metadata such as course creation dates, instructor login records, and file uploads, enabling longitudinal analysis over twelve years. The dataset was obtained from a manually created table in the database, generated using a custom plugin developed by the Centre for Online Learning at the University of Silesia. The table includes information about courses assigned to categories corresponding to current degree programs (formerly institutes).

The dataset includes the following variables for each course:

- Index – sequential course identifier,

- Category (Program) – category in the system corresponding to the academic program: Applied Computer Science, Biophysics, Biomedical Engineering, Chemical Technology, Chemistry, Didactic Offer (General Academic), English Philology, Environmental Protection, Information Security and Security Administration, Informatics, Materials Engineering, Mathematics, Mechatronics, Medical Physics, Micro- and Nanotechnology, Physics,
- Oldest log – the earliest log entry associated with the course ID, treated as the course start date (reconstructed courses retain the original date),
- Last modification date – the date of the last change to course settings (does not include content updates or grading),
- Course start date – the date from which the course is available to students,
- Course end date – the date from which the course becomes unavailable to students,
- Hidden from students – indicates whether the course is visible to students,
- Size of attached files (Bytes) – total size of uploaded files (e.g., PDFs, audio, video),
- Students in the course – number of users enrolled with the "student" role,
- Tutors with editing rights – number of users with the "tutor" role and editing permissions,
- Tutors without editing rights – number of users with the "tutor" role without editing permissions,
- Days since last instructor login – number of days since the last login by a user with the "instructor" role.

To operationalise the research questions, the following assumptions were adopted.

Student enrollment was used as a proxy for potential course engagement (RQ1), acknowledging that enrollment does not guarantee active participation. Due to platform limitations, detailed activity logs (e.g., forum posts, quiz attempts) were not available; therefore, enrollment numbers were used as indicators of course reach and visibility.

Instructor activity was measured by the number of days since the last login by a user with editing rights (RQ1, RQ3). This metric reflects the recency of course maintenance or pedagogical involvement.

Course visibility was defined based on Moodle's technical setting: whether a course is marked as "hidden" or "visible" to students (RQ3). Hidden courses are typically archived by the teachers, under development, or intentionally restricted, and their presence may reflect institutional practices in course lifecycle management.

Academic discipline was assigned based on course categorisation in the Moodle database (RQ2), allowing for comparative analysis across fields of study.

Temporal trends (RQ4) were analysed using metadata such as the earliest log entry and course creation date, which were preserved in the system even for older courses. This enabled longitudinal analysis from 2012 to 2024.

The study applied descriptive statistics to summarise the dataset and non-parametric tests (Kruskal–Wallis, Mann–Whitney U) to assess differences between groups, given the non-normal distribution of the variables. Spearman's rank correlation was used to examine relationships between selected indicators. Time series analysis using linear regression was conducted to identify long-term trends in course creation and instructor engagement.

This methodological framework supports the investigation of structural and behavioural patterns in e-learning environments. It contributes to the broader understanding of how digital courses are developed, maintained, and utilised across academic disciplines.

Descriptive Statistics

In order to study the structural characteristics of Moodle courses and their relationship with instructor engagement, a descriptive statistical analysis was conducted. The key metrics selected for this analysis were:

- Number of students enrolled in each course,
- Size of uploaded files: teaching materials, students' tasks (converted to kilobytes),
- Number of days since the last instructor login.

These three indicators were chosen as central to the analysis due to their relevance in evaluating course activity and resource intensity. The number of instructors per course is typically one, occasionally two, and very rarely more. Therefore, instructor-related metrics are best interpreted in the context of course-level data.

The descriptive statistics for these variables are presented in Table 1. These values provide insight into the distribution and variability of course engagement and content volume across the faculty.

Table 1.
Descriptive statistics on responses to sociological questions

Statistic	Students	Size_KB	Days_since_login
Count	68606	1504032120.00	1904595
Mean	21.39	468984.13	3207
Std Dev	39.0	1625791.42	509.58
Min	0.0	0.0	0
25%	5.0	9113.60	139.0
50%	13.0	54988.80	493.0
75%	25.0	288460.80	983.5
Max	837.0	39426457.60	1840.0

S o u r c e: Own work.

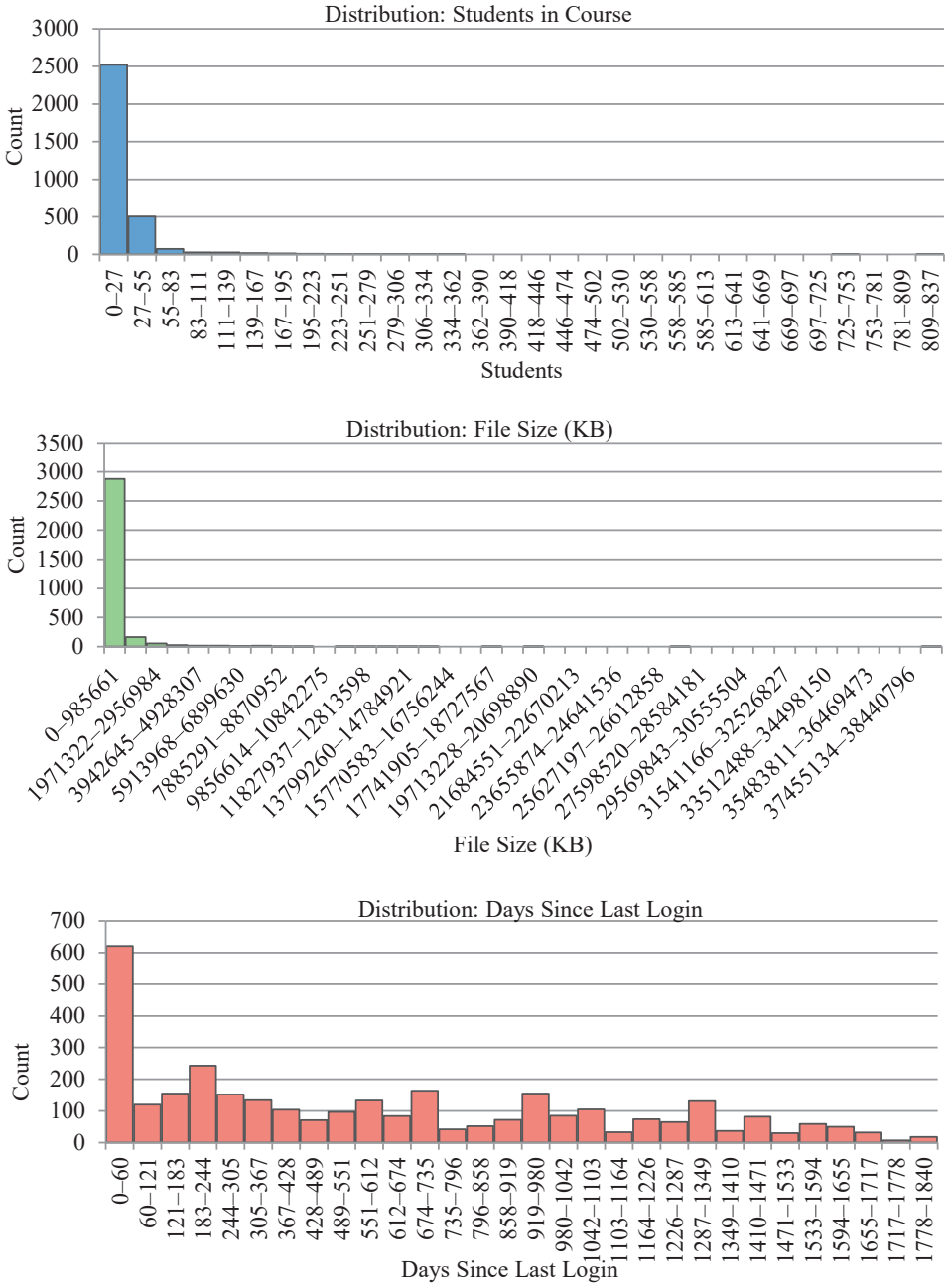

Figure 1. Histograms of the distributions of the three main variables: number of students enrolled in each course, size of uploaded teaching materials (converted to kilobytes), and number of days since the last instructor login.

The analysis of descriptive statistics reveals several important insights into the structure and activity of Moodle courses at the Faculty of Science and Technology. The average number of students per course is 21.39, but the high standard deviation (39.0) indicates significant variability – only a few students attend some courses, while others have enrollments exceeding 200. The average size of uploaded materials is approximately 469,000 kilobytes (about 469 MB), with a wide range from 0 KB to over 1.5 GB. Some courses are either content-rich, possibly including multimedia, large datasets or contain many works submitted by students. On the other hand, some courses may lack substantial materials, and students do not send any reports or projects. The median number of days since the last instructor login is 493, with a minimum of 0 and a maximum of 1840 days. The data indicate that many courses have not been actively maintained for over a year, and some for several years. These findings underscore the importance of regularly auditing course activity and content relevance. Courses with no recent instructor activity, no students, or no uploaded materials may require archiving or removal to maintain the quality and efficiency of the e-learning environment.

It is worth noting that, after these analyses, a comprehensive archiving process for unused courses has already been completed, and the current state of the platform has significantly improved as a result.

Analysis of Variable Distributions

In order to gain a deeper understanding of the characteristics and activity levels of Moodle courses at the Faculty of Science and Technology, we conducted an analysis of the distributions for three key variables: the number of students enrolled in each course, the size of uploaded materials (converted to kilobytes), and the number of days since the last instructor login. The distributions were visualised using histograms to provide a clear picture of how these variables are spread across all courses. The histograms help identify patterns such as skewness, central tendency, and variability within each variable (Figure 1).

The histogram shows a highly right-skewed distribution with most courses having fewer than 50 students. A small number of courses have enrollments exceeding 200 students. Some courses are very popular, but most have relatively low enrollment numbers.

This histogram also displays a right-skewed distribution with most file sizes concentrated below 500,000 KB (~500 MB). There are a few outliers with file sizes exceeding several gigabytes. While many courses use minimal digital resources, some incorporate extensive multimedia content, large datasets or 3D graphic projects.

The histogram shows a more evenly spread distribution but still exhibits right skewness. A significant number of instructors have not logged into their courses for over a year. This highlights potential issues with course maintenance and instructor engagement over time, or developing new versions of courses for another academic semester.

To assess whether the analysed variables follow a normal distribution, the Shapiro-Wilk test was conducted. This test is particularly suitable for small to medium-sized samples and is commonly used to verify the assumption of normality in statistical analyses.

The hypotheses for the test were as follows:

- H0 (null hypothesis): The variable follows a normal distribution.
- Hl (alternative hypothesis): The variable does not follow a normal distribution.

The results of the Shapiro-Wilk test indicated the following. For the variable representing students, the W statistic was 0.418514, the Z statistic was 18.011805, and the p-value was less than 0.000001. For the variable representing the number of days since the last login, the W statistic was 0.91231, the Z statistic was 13.119826, and the p-value was also less than 0.000001. Similarly, for the variable representing file size in kilobytes, the W statistic was 0.91231, the Z statistic was 13.119826, and the p-value was again less than 0.000001.

Given that, all p-values are significantly lower than the commonly used significance level of 0.05, the null hypothesis was rejected in all cases. This leads to the conclusion that none of the analysed variables follow a normal distribution. The distributions of all variables are strongly asymmetric, which confirms the H1 hypothesis that the majority of Moodle courses show low to moderate student enrollment, with substantial variability in instructor activity across courses.

Analysis of Variation Between Fields of Study

To determine whether the field of study significantly influences selected course-related variables, we conducted Kruskal-Wallis ANOVA tests. This non-parametric method is suitable for comparing more than two independent groups when the data are not normally distributed. The analysis included the following variables: number of students enrolled in a course, days since the last login by the instructor, and size of attached files (in KB). The grouping variable was the field of study, categorised into 17 distinct areas: Applied Computer Science, Biophysics, Biomedical Engineering, Chemical Technology, Chemistry, Didactic Offer (General Academic), English Philology, Environmental Protection, Information Security and Security Administration, Informatics, Materials Engineering, Mathematics, Mechatronics, Medical Physics, Micro- and Nanotechnology, Physics and “Other”

group for uncategorised entries. The results of the tests are shown in Table 2. These significant differences in all variables among the fields of study confirm the hypothesis H2.

Table 2.
Kruskal-Wallis test results for course variables by field of study

Variable	H-statistic	p-value	eta squared	Interpretation
Students	368.24	< 0.000001	0.14	Significant differences in student numbers across fields of study
Days Since Last Login	156.19	< 0.000001	0.03	Significant differences in login recency across fields of study
File Size (KB)	190.86	< 0.000001	0.05	Significant differences in file sizes across fields of study

Table 3.
Median Values of Course Variables by Field of Study

Field of Study	Median Students	Median Days Since Last Login	Median File Size (KB)
Applied Computer Science	15.0	261.0	31,846.4
Biomedical Engineering	19.0	363.0	131,788.8
Biophysics	7.0	367.0	6,656.0
Chemical Technology	8.0	657.0	37,171.2
Chemistry	10.0	948.0	26,009.6
Didactic Offer (General Academic)	6.5	150.0	61,696.0
English Philology	18.0	1293.5	188,262.4
Environmental Protection	24.0	294.5	78,950.4
Informatics	21.0	513.0	72,704.0
Information Security and Security Administration	49.0	0.0	206,540.8
Materials Engineering	2.0	301.0	34,816.0
Mathematics	14.0	413.0	31,590.4
Mechatronics	11.0	362.0	120,729.6
Medical Physics	8.0	1216.0	27,955.2
Micro- and Nanotechnology	3.0	720.0	8,499.2
Other	15.0	369.0	24,115.2
Physics	2.0	725.0	35,225.6

Table 3 consolidates the median values of the variables: number of students enrolled in a course, days since the last login by the instructor, and size of attached

files (in kilobytes). The data are grouped by field of study and sorted alphabetically. This format enables a clear comparison of how these variables vary across academic disciplines.

The results of the Kruskal-Wallis tests reveal statistically significant differences across fields of study for all three analysed variables: the number of students enrolled in a course, the number of days since the last login by the instructor, and the size of attached files. These differences are not random but reflect meaningful distinctions in how courses are structured and managed depending on the academic discipline.

To more deeply visualise the differences between fields of study in the variables analysed, boxplot charts by area of study were prepared in Figures 2, 3, and 4.

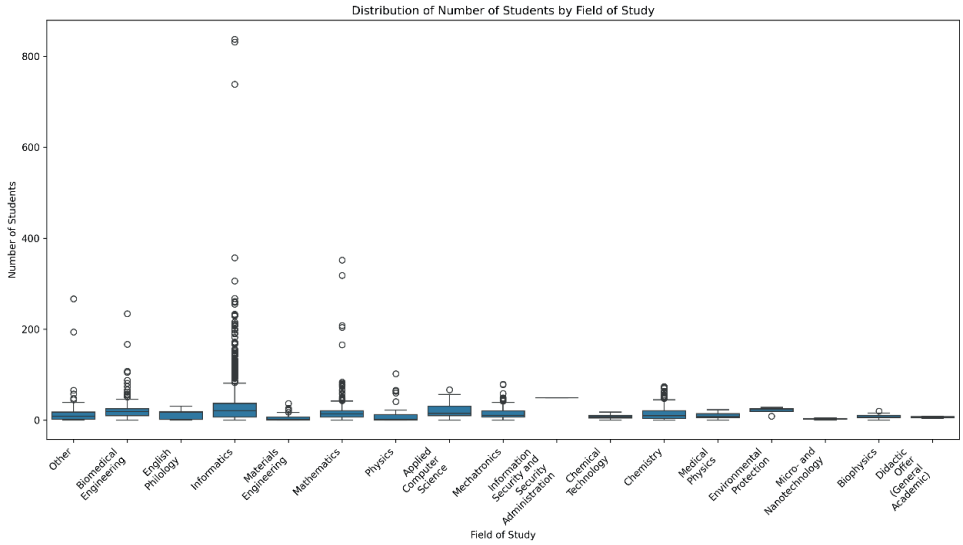

Figure 2. Number of students in courses according to the field of study

In the plot showing the number of students, most fields exhibit moderate enrollment levels. However, Information Security and Security Administration stand out with exceptionally high outliers, reaching nearly 800 students in some courses. Certain programs attract significantly larger groups, possibly due to their relevance, popularity, or mandatory status, or are maintained for a long period and attended by many students across multiple years. Other fields, such as Mathematics, Physics, and Materials Engineering, show tighter distributions, indicating more consistent class sizes across courses.

To enhance precision and support robust comparisons, 95% confidence intervals for the mean number of students per course were calculated for each discipline using bootstrap resampling methods:

Applied Computer Science: CI 17.26 to 26.67 students

Biomedical Engineering: CI 18.10 to 21.99 students
Biophysics: CI 4.78 to 12.33 students
Chemical Technology: CI 6.97 to 8.52 students
Chemistry: CI 13.20 to 16.33 students
Didactic Offer (General Academic): CI 4.00 to 9.00 students
English Philology: CI 6.83 to 17.59 students
Environmental Protection: CI 13.73 to 27.25 students
Informatics: CI 31.35 to 39.35 students
Information Security and Security Administration: CI 25.00 to 49.00 students
Materials Engineering: CI 3.66 to 5.13 students
Mathematics: CI 16.13 to 21.05 students
Mechatronics: CI 13.62 to 16.46 students
Medical Physics: CI 7.69 to 11.83 students
Micro- and Nanotechnology: CI 1.20 to 4.20 students
Other: CI 11.24 to 18.86 students
Physics: CI 6.34 to 22.37 students

These results demonstrate that technical and engineering disciplines tend to have a higher average student participation and greater volume of digital learning materials compared to other fields. This observation is consistent with existing frameworks of institutional digital maturity and technology acceptance models which emphasise the role of discipline-specific digital engagement patterns in shaping e-learning ecosystems.

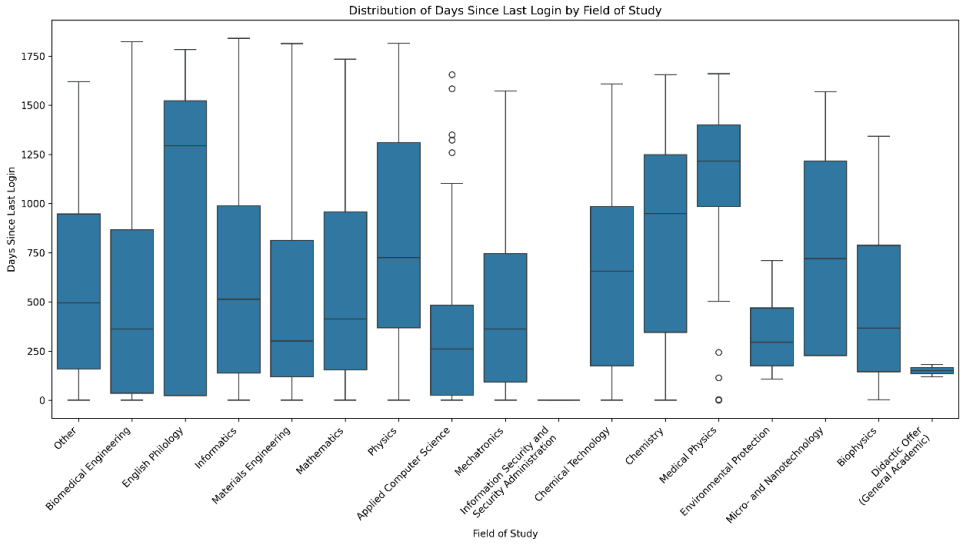

Figure 3. Number of days since last login according to the field of study

The file size distribution reveals that courses in Information Security, English Philology, and Biomedical Engineering often include very large files, with some exceeding 2 GB in size. These outliers may reflect the use of multimedia content, extensive documentation, bundled resources, including tasks done by students and uploaded into the system. In contrast, fields like Biophysics and Micro- and Nanotechnology tend to have smaller file sizes, suggesting more concise or less resource-intensive materials.

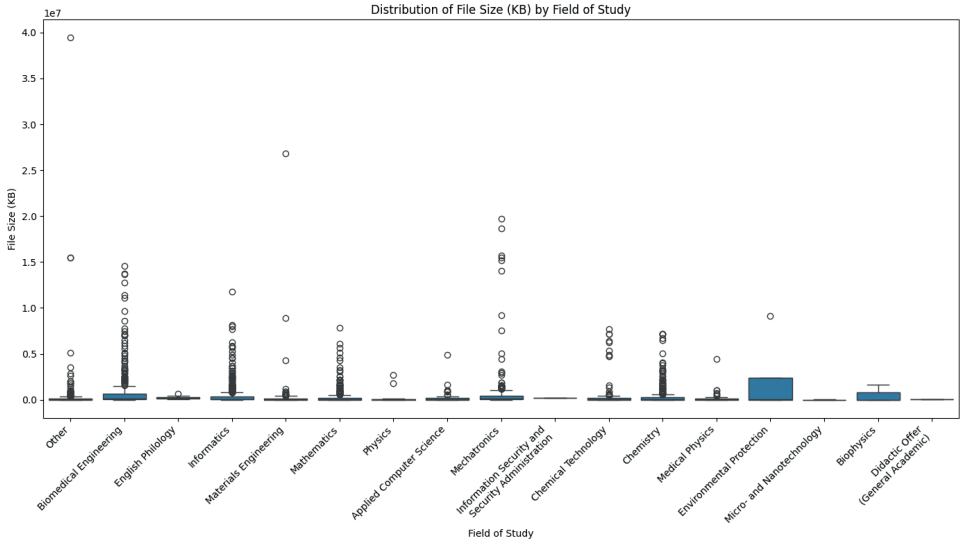

Figure 4. File size (KB) according to the field of study

The third plot, focusing on days since last login, highlights significant disparities in instructor engagement. While Information Security shows a median of zero days – indicating very recent activity – fields such as English Philology, Medical Physics, and Chemistry include outliers where instructors have not logged in for over 1200 days. This could point to abandoned or archived courses, or a lack of ongoing updates, showcasing that in some disciplines, the interest in distance learning happens only during special situations like a pandemic. Fields with more uniform distributions, such as Mathematics and Informatics, suggest regular maintenance and consistent teaching activities.

To enhance precision and support robust comparisons, 95% bootstrap confidence intervals for the mean were estimated per discipline for the number of days since last login and the file size. The results are as follows:

Applied Computer Science: file size CI 80.6 million to 235.1 million bytes; login days CI 267 to 511 days.

Biomedical Engineering: file size CI 132.2 to 176.8 million bytes; login days CI 472 to 573 days.

Biophysics: file size CI 2.3 million to 509.2 million bytes; login days CI 206 to 855 days.
Chemical Technology: file size CI 66.7 to 120.5 million bytes; login days CI 532 to 717 days.
Chemistry: file size CI 71.8 to 107.7 million bytes; login days CI 769 to 877 days.
Didactic Offer (General Academic): file size CI 52.1 to 74.2 million bytes; login days CI 119 to 181 days.
English Philology: file size CI 135.3 to 338.8 million bytes; login days CI 522 to 1334 days.
Environmental Protection: file size CI 1.15 million to 116.7 million bytes; login days CI 153 to 582 days.
Informatics: file size CI 139.6 to 168.4 million bytes; login days CI 567 to 632 days.
Information Security and Security Administration: file size CI 5.2 million to 211.5 million bytes; login data flagged as missing or invalid.
Materials Engineering: file size CI 89.1 to 137.1 million bytes; login days CI 451 to 599 days.
Mathematics: file size CI 112.1 to 152.1 million bytes; login days CI 526 to 611 days.
Mechatronics: file size CI 139.4 to 201.4 million bytes; login days CI 424 to 529 days.
Medical Physics: file size CI 51.7 to 172.2 million bytes; login days CI 948 to 1248 days.
Micro- and Nanotechnology: file size CI 2.5 to 15.3 million bytes; login days CI 326 to 1258 days.
Other: file size CI 81.7 to 134.0 million bytes; login days CI 511 to 638 days.
Physics: file size CI 26.5 to 57.7 million bytes; login days CI 624 to 976 days.

Technical and engineering disciplines, such as Informatics, Applied Computer Science, and Biomedical Engineering, tend to have larger digital resource volumes, with moderate to high instructor activity reflected by login recency. Humanities and general academic disciplines show wider variability in both metrics, suggesting more diverse or intermittent use of e-learning resources. The wide confidence intervals in some fields (e.g., Biophysics, English Philology) point to heterogeneous teaching practices and course structures within those disciplines. These results provide nuanced insight into discipline-specific digital engagement patterns within the Moodle e-learning environment.

Taken together, these plots illustrate how different academic disciplines vary not only in student participation but also in digital resource usage and instructor involvement. Courses with high outliers in student numbers and file sizes may require additional platform support or optimisation. At the same time, those with long login delays might benefit from administrative review or re-engagement strategies.

These insights can inform decisions about course design, resource allocation, and institutional priorities.

In terms of student enrollment, the highest median values were observed in fields such as Information Security and Security Administration, Environmental Protection, and Informatics, suggesting that these areas tend to attract larger student groups. In contrast, fields like Physics and Materials Engineering had the lowest median enrollments which may indicate more specialised or less populated programs.

The variable representing instructor activity, measured by the number of days since the last login, also varied considerably. Fields such as English Philology and Medical Physics showed the longest periods of inactivity, with medians exceeding 1200 days, while Information Security and Security Administration stood out with a median of zero, indicating very recent or ongoing engagement. This may reflect differences in course delivery models, administrative oversight, or the frequency of updates required in each field.

File size medians further highlight disparities in course content or resource intensity. The largest files were associated with Information Security, English Philology, and Biomedical Engineering, potentially pointing to more extensive use of multimedia, documentation, or data-heavy materials. In some cases, students have created large course sizes by submitting their works, including videos or 3D projects which consume significant server disk space. Also, there are courses which were reused over the years by new students uploading their tasks, resulting in many old, unnecessary files in the course. On the other hand, fields like Biophysics and Micro- and Nanotechnology had much smaller file sizes, which could suggest more concise or less resource-intensive course formats. There were courses containing only quizzes or final assignments for students, especially those created during the pandemic period.

Spearman's rank correlation coefficients were computed between file size (in bytes), number of instructors with editing rights, and days since the last instructor login (a proxy for recency of activity). The matrix revealed a small positive correlation between file size and number of instructors: 0.062, suggesting courses with more instructors tend to have slightly larger digital resources. There was a very weak negative correlation between file size and days since last login: –0.015, indicating that larger courses show a tendency for more recent instructor activity, though the relationship is minimal. Additionally, a small negative correlation was found between the number of instructors and days since last login: –0.043, implying that courses with more instructors generally have marginally more recent logins.

Overall, the findings underscore that the academic field significantly influences how courses are populated, maintained, and resourced. These insights can inform decisions related to platform optimisation, resource allocation, and instructional design tailored to the specific needs and behaviours of different disciplines.

Course Visibility Analysis

The focus of analysis in this section is on the relationship between course visibility on the Moodle platform and instructor activity and other factors. The goal was to see whether hiding a course from students affects the frequency with which instructors log in and changes over time. The data were divided into two groups: visible courses and hidden courses. The Kruskal-Wallis non-parametric test was used due to the non-normal distribution of the variable number of days since the last login. The research hypotheses were defined as follows:

- H0 (null hypothesis): Course visibility does not affect instructor activity.
- H1 (alternative hypothesis): Hidden courses differ significantly in terms of instructor activity.

Given that, the data did not follow a normal distribution and the comparison involved two independent groups, the Mann-Whitney U test – a non-parametric alternative to the t-test – was applied. The test compared the distribution of login activity between hidden and visible courses. The results of the test were as follows: U statistic: 1,243,805.0, p-value: 0.502.

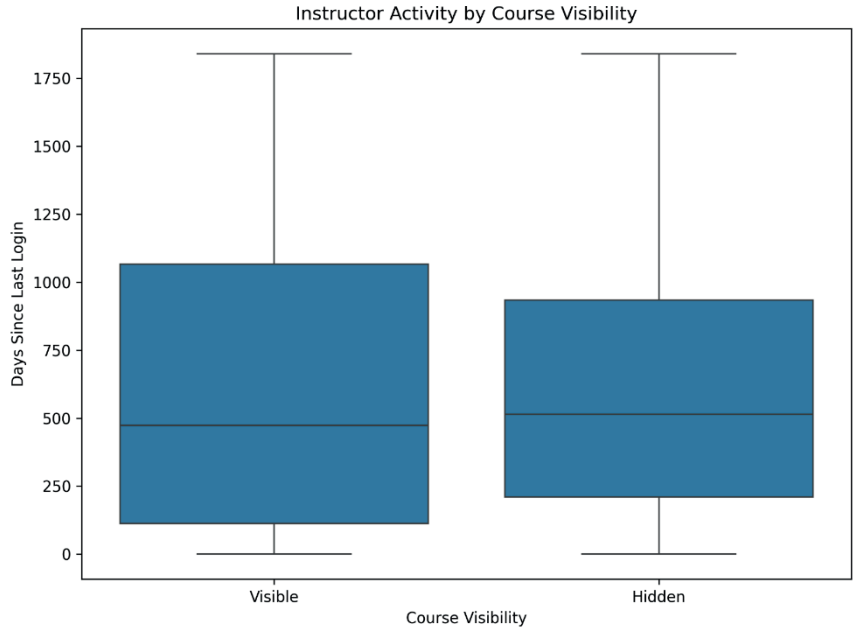

Figure 5. Instructor activity by course visibility (Days since last login)

Since the p-value is substantially greater than the conventional significance level of 0.05, we fail to reject the null hypothesis. This means that there is no sta-

tistically significant difference in instructor activity between hidden and visible courses, which confirms the H3 hypothesis. In practical terms, whether a course is hidden from students or not does not appear to influence how recently instructors have logged into the system. This finding suggests that course visibility is not a reliable indicator of instructor engagement, and other factors may be more influential in determining instructor activity levels.

Figure 5 shows the box plot for days since the last login, divided by course visibility. The box plot comparing instructor activity based on course visibility reveals that there is no significant difference in login behaviour between instructors of visible and hidden courses. In both categories, the median number of days since the last login is approximately 500, indicating that instructors, regardless of course visibility, tend to have similar patterns of inactivity. The interquartile range for both groups spans from around 250 to 1000 days, suggesting a wide variation in instructor engagement. Additionally, the presence of extreme values reaching up to 1750 days highlights that some courses' versions have been abandoned, perhaps new versions have been created. Overall, the data suggest that course visibility does not appear to influence instructor login frequency, and other factors may be more relevant in determining instructor engagement. It is likely that teachers who no longer use the course forget to hide it or intentionally leave it visible to students for continuous access to the materials. Some of those courses might be prepared during the pandemic period without training, preparation and experience from the teachers and without sufficient time to prepare all digital materials.

Further study aimed to explore temporal trends in the development of e-learning courses and the engagement of instructors over a multi-year period. The primary objective was to determine whether there have been statistically significant changes in the number of courses and instructor activity over time.

To conduct this analysis, the dataset was first grouped by the year in which each course was initiated. Two key indicators were selected for evaluation: the total number of courses launched each year and the number of instructors actively involved in course editing. These metrics were chosen as proxies for institutional investment in e-learning and the degree of academic staff participation.

The statistical method applied was linear regression, a standard technique in time series analysis used to identify trends and assess their significance. For each variable, a regression line was fitted to the annual data points, and the slope and p-value were calculated. The slope indicates the direction and magnitude of the trend, while the p-value tests the null hypothesis that there is no trend over time.

The results revealed a positive slope for both variables. The number of courses increased at an estimated rate of 23.08 courses per year, with a p-value of 0.0593. Instructor activity showed a similar upward trajectory, increasing by approximately 30.28 instructors per year, with a p-value of 0.0564. Although both p-values are slightly above the conventional threshold of 0.05, they suggest a marginally significant trend that warrants attention.

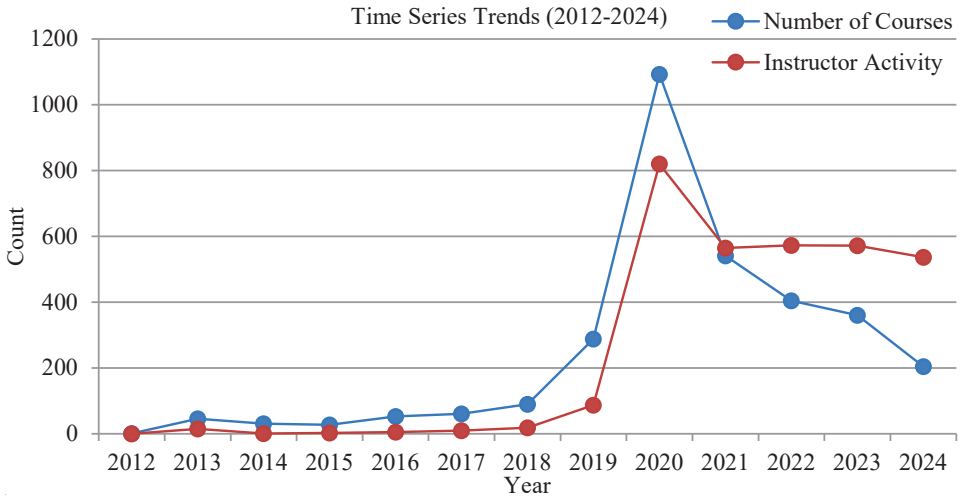

Figure 6. Trends in course creation and instructor enrollment (2012–2024)

These findings imply that the institution has experienced a gradual but consistent growth in its e-learning offerings and in the engagement of instructors in course development. While the statistical evidence is not strong enough to reject the null hypothesis with high confidence, the observed trends align with broader shifts in higher education toward digital learning environments, which confirms the H4 hypothesis.

In Figure 6, the trends in course creation and instructor engagement in the years 2012–2024 were presented. While the overall time series from 2012 to 2024 shows a gradual upward trend in both the number of courses and instructor activity, the year 2020 stands out as a clear anomaly. This spike is visibly distinct on the chart and corresponds with the onset of the COVID-19 pandemic, which forced educational institutions worldwide to rapidly transition to remote learning.

The data reveal a sharp increase in both course creation and instructor engagement during this period. This surge reflects the urgent institutional response to maintain academic continuity amid lockdowns and social distancing measures. Instructors who had not previously engaged with digital platforms were compelled to adapt quickly, resulting in a temporary but significant increase in online teaching activity.

This anomaly is not merely a statistical outlier – it represents a structural shift in how education was delivered. Although subsequent years show a slight normalisation, the post-2020 levels remain elevated compared to the pre-pandemic baseline, suggesting that some of the digital transformation initiated during the crisis has persisted.

From a strategic standpoint, this event underscores the importance of resilience and adaptability in educational systems. It also highlights the potential for crisis-

driven innovation to accelerate long-term change. Institutions should consider how the lessons learned in 2020 can inform future investments in digital infrastructure, training, and pedagogical flexibility.

The implications of this analysis are twofold. First, the upward trends suggest that e-learning is becoming an increasingly integral part of the academic landscape. Second, the growing involvement of instructors indicates a positive institutional culture around digital pedagogy. However, the variability across years and disciplines also highlights the need for tailored e-learning strategies that reflect the specific needs and dynamics of different academic programs.

In conclusion, the analysis supports the hypothesis that meaningful changes have occurred over time in both course creation and instructor participation. These insights can inform strategic planning, resource allocation, and professional development initiatives aimed at sustaining and enhancing the quality of online education.

Discussion

We interpret the institutional Moodle activity in this study using four complementary theoretical models to move beyond technical reporting.

First, the Technological Pedagogical Content Knowledge (TPACK) and Substitution Augmentation Modification Redefinition (SAMR) frameworks explain differences in course design by describing the level of technology integration and pedagogical knowledge. For example, our results show that programmes such as Computer Science and Biomedical Engineering have larger digital footprints and more frequent updates, which correspond to higher SAMR stages (modification/redefinition) and stronger TPACK integration (Koehler & Mishra, 2009; Puentedura, 2012).

Second, the Technology Acceptance Model (TAM) and its extension, UTAUT2, help explain variations in instructor engagement. The Mann–Whitney test revealed no significant difference in instructor recency between hidden and visible courses, suggesting that perceived usefulness and workflow factors – rather than visibility settings – drive adoption, consistent with TAM/UTAUT2 predictions (Venkatesh et al., 2012).

Third, the European Digital Competence Framework for Educators (DigCompEdu) provides a competence-based view. The wide dispersion in instructor login recency and resource size across disciplines indicates uneven digital competences in areas such as assessment and learner engagement, echoing Aiastui et al.'s (2021) emphasis on differentiated professional development needs.

Fourth, the EDUCAUSE Digital Maturity Model (Dx) situates these patterns within institutional culture and governance. The sharp increase in course provisioning during 2020, followed by stabilisation, reflects a reactive digital transformation triggered by the COVID-19 pandemic rather than incremental growth-precisely the resilience and strategic pivot described in EDUCAUSE Dx guidance (Brooks and McCormack, 2020).

Together, these models allow a theory-driven interpretation of our findings: design maturity explains resource intensity, acceptance models clarify behavioural patterns, competence frameworks highlight skill gaps, and digital maturity accounts for structural shifts during disruption.

Conclusions

This study provided an analysis of e-learning course activity on the Moodle platform at the Faculty of Science and Technology, University of Silesia. By examining key indicators such as student enrollment, instructor login frequency, and the volume of uploaded teaching materials, the research revealed significant variability in course activity and resource intensity across different academic disciplines. While the dataset does not include detailed information about internal course structure or content editing history, the analysed variables serve as proxies for course usage and instructor involvement, which may reflect broader patterns of course management and engagement.

The findings indicate that while some courses are actively managed and attract large numbers of students, others show signs of neglect, including long periods of instructor inactivity and minimal content. The Kruskal–Wallis test confirmed that these differences are statistically significant and closely tied to the field of study. Interestingly, the analysis also showed that course visibility (whether a course is hidden or visible to students) does not significantly influence instructor engagement.

Furthermore, the time series analysis revealed a gradual upward trend in both course creation and instructor participation over the years, with a notable increase in 2020 due to the COVID-19 pandemic. Although the post-pandemic period saw a slight normalisation, the overall levels of digital engagement remained higher than before, indicating a lasting shift in educational practices. The pandemic-driven spike in 2020 illustrates how external shocks accelerate technology adoption, aligning with EDUCAUSE Dx's emphasis on resilience and strategic agility. This suggests that universities should not only prepare for crisis-driven transitions but also embed sustainable digital practices into long-term planning.

The observed disciplinary differences in course activity align with findings by Baran et al. (2021) and Hacıoğlu & Gülhan (2021), who noted varying pedagogical

approaches across STEM and humanities fields. However, our data suggest even greater variability in instructor engagement and resource usage than previously reported. These disparities highlight the need for differentiated faculty development initiatives, as recommended by DigCompEdu, focusing on advanced digital competencies for some fields and foundational skills for others.

Our results show that many courses have not been updated for long periods, with some instructors inactive for over 1,200 days. Universities should set up automatic alerts and regular checks to keep courses current. Large differences in file sizes – some courses exceeding 2 GB while others have almost no materials – suggest the need for clear rules on resource use and archiving old files. Disciplines such as Informatics and Biomedical Engineering, which exhibit high activity and rich resources, can serve as examples for training programs. At the same time, fields with low engagement require additional support in creating interactive content. The sharp increase in 2020, during the pandemic, highlights the importance of planning for emergencies and maintaining strong digital practices after crises. Finally, using Moodle analytics to track enrollment, resource size, and instructor activity can help universities make better decisions about course design and support.

These insights underscore the importance of continuous monitoring and strategic planning in the development of e-learning environments. Institutions should consider implementing regular audits of course activity, providing targeted support for underperforming areas, and encouraging best practices in digital pedagogy. By doing so, universities can ensure that their online learning platforms remain effective, engaging, and aligned with the evolving needs of students and educators.

Data Availability Statement

The datasets generated during the current study are available from the corresponding author on reasonable request. None of the data or materials for the experiments reported here is available, and none of the experiments was preregistered.

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Małgorzata Przybyła-Kasperek, Jakub Sacewicz, Paweł Pawełczyk

Analiza aktywności kursów e-learningowych na platformie Moodle na Wydziale Nauk Ścisłych i Technicznych Uniwersytetu Śląskiego

Streszczenie

W artykule przedstawiono kompleksową analizę aktywności kursów e-learningowych prowadzonych na platformie Moodle na Wydziale Nauk Ścisłych i Technicznych Uniwersytetu Śląskiego. Głównym celem badania była ocena struktury, zaangażowania oraz wykorzystania zasobów cyfrowych w kursach online w różnych dyscyplinach akademickich. Zbiór danych, zebrany przed procesem archiwizacji platformy, obejmował takie zmienne jak liczba zapisanych studentów, częstotliwość logowania się prowadzących oraz rozmiar przesłanych materiałów dydaktycznych.

Do analizy różnic między kierunkami studiów oraz wpływu widoczności kursu na aktywność prowadzących zastosowano statystyki opisowe oraz testy nieparametryczne (Kruskal–Wallis, U Manna–Whitneya). Dodatkowo przeprowadzono analizę szeregów czasowych z wykorzystaniem

regresji liniowej w celu identyfikacji trendów w tworzeniu kursów i zaangażowaniu prowadzących w latach 2012–2024.

Wyniki ujawniły istotne różnice w aktywności kursów między dyscyplinami – niektóre kierunki charakteryzowały się dużą liczbą studentów i intensywnym wykorzystaniem zasobów, podczas gdy inne wykazywały długotrwałą nieaktywność prowadzących. Wbrew oczekiwaniom, widoczność kursu nie miała istotnego wpływu na aktywność nauczycieli. Zaobserwowano pozytywny, choć marginalnie istotny trend wzrostu liczby kursów i zaangażowania prowadzących w czasie, ze szczególnym wzrostem w roku 2020 w związku z pandemią COVID-19.

Wnioski z badania podkreślają potrzebę wdrażania zróżnicowanych strategii zarządzania kursami cyfrowymi oraz wspierania działań instytucjonalnych na rzecz poprawy jakości i trwałości środowisk e-learningowych.

S ł o w a k l u c z o w e: Moodle, e-learning, zaangażowanie prowadzących, analiza aktywności kursów, edukacja cyfrowa, szkolnictwo wyższe, statystyka nieparametryczna

Małgorzata Przybyła-Kasperek, Jakub Sacewicz, Paweł Pawełczyk

Análisis de la actividad de los cursos de aprendizaje en línea en la plataforma Moodle en la Facultad de Ciencias y Tecnología de la Universidad de Silesia

R e s u m e n

Este estudio presenta un análisis integral de la actividad de los cursos de aprendizaje en línea impartidos a través de la plataforma Moodle en la Facultad de Ciencias y Tecnología de la Universidad de Silesia. El objetivo principal fue evaluar la estructura, el nivel de participación y el uso de recursos digitales en los cursos en línea en diversas disciplinas académicas. El conjunto de datos, recopilado antes del proceso de archivado de la plataforma, incluyó variables como el número de estudiantes inscritos, la frecuencia de inicio de sesión de los docentes y el tamaño de los materiales didácticos subidos.

Se utilizaron estadísticas descriptivas y pruebas no paramétricas (Kruskal–Wallis, U de Mann–Whitney) para evaluar las diferencias entre áreas de estudio y el impacto de la visibilidad del curso en la participación del profesorado. Además, se realizó un análisis de series temporales mediante regresión lineal para identificar tendencias en la creación de cursos y la participación docente entre 2012 y 2024.

Los resultados revelan disparidades significativas en la actividad de los cursos entre disciplinas: algunas muestran un alto número de estudiantes y uso intensivo de recursos, mientras que otras presentan una inactividad prolongada por parte del profesorado. Contrario a lo esperado, la visibilidad del curso no influyó significativamente en la participación docente. Se observó una tendencia positiva, aunque marginalmente significativa, tanto en el número de cursos como en la implicación del profesorado a lo largo del tiempo, con un aumento notable en 2020 debido a la pandemia de COVID-19.

Estos hallazgos subrayan la necesidad de estrategias adaptadas para la gestión de cursos digitales y respaldan los esfuerzos institucionales por mejorar la calidad y sostenibilidad de los entornos de aprendizaje en línea.

P a l a b r a s c l a v e: Moodle, aprendizaje en línea, participación docente, análisis de actividad de cursos, educación digital, educación superior, estadística no paramétrica

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Анализ активности онлайн-курсов на платформе Moodle на факультете науки и технологий Силезского университета

Аннотация

В данной работе представлен всесторонний анализ активности онлайн-курсов, реализуемых на платформе Moodle на факультете науки и технологий Силезского университета. Основной целью исследования была оценка структуры, вовлеченности и использования цифровых ресурсов в онлайн-курсах по различным академическим направлениям. Набор данных, собранный до начала процесса архивирования платформы, включал такие переменные, как количество зарегистрированных студентов, частота входа преподавателей в систему и объем загруженных учебных материалов.

Для оценки различий между направлениями обучения и влияния видимости курса на активность преподавателей были использованы описательная статистика и непараметрические тесты (Краскела–Уоллиса, Манна–Уитни). Кроме того, был проведен анализ временных рядов с использованием линейной регрессии для выявления тенденций в создании курсов и участии преподавателей в период с 2012 по 2024 год.

Результаты показали значительные различия в активности курсов между дисциплинами: в некоторых направлениях наблюдалось большое количество студентов и интенсивное использование ресурсов, тогда как в других — длительная неактивность преподавателей. Вопреки ожиданиям, видимость курса не оказала существенного влияния на активность преподавателей. Была выявлена положительная, хотя и статистически незначительная тенденция увеличения количества курсов и вовлеченности преподавателей с течением времени, особенно заметная в 2020 году в связи с пандемией COVID-19.

Полученные данные подчеркивают необходимость разработки адаптированных стратегий управления цифровыми курсами и поддержки институциональных усилий по повышению качества и устойчивости онлайн-обучения.

Ключевые слова: Moodle, электронное обучение, активность преподавателей, анализ активности курсов, цифровое образование, высшее образование, непараметрическая статистика

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A Study on the Impact of Verse in the Metaverse: Exploring the Role of Avatars in Scientific Storytelling

Abstract

The current research focuses on the effects of Avatar-Based Storytelling within a metaverse-type environment on the learning performance, engagement, and emotional-social experience of primary school students within science education. In Poland, a quasi-experimental pre-test post-test control group design was used with 50 students aged between 8 and 12. Because it was conducted on an experimental basis, the first group experienced a two-week intervention, in which avatars used interactive science scripts, while the second group interacted with the same content via conventional digital media. The results of pre- and post-tests, as well as the engagement survey, showed that learning and engagement in the experimental group improved significantly ($p < .001$). Data from the focus group interviews in the form of qualitative results showed that the participants perceived avatars positively as credible and relatable characters that evoked emotions. The findings contribute to the positive view that short-term avatar-based narratives can support improvements in cognitive performance, motivation, and emotional bonding of

virtual learning contexts. Discussions on the implications of immersive pedagogy and directions for future longitudinal research are provided.

K e y w o r d s: Avatar-Based Learning, Metaverse Education, Storytelling, Virtual Learning

Introduction

The integration of virtual reality (VR) and augmented reality (AR) technologies into primary education has become a growing research trend. These immersive technologies are valued for their ability to enhance engagement, support experiential learning, and visualize abstract concepts (Elmqaddem, 2019; Villena-Taranilla et al., 2022). At the primary level, children's cognitive development is characterized by the transition from concrete to abstract thinking (Piaget, 1970), making VR/AR particularly suitable for bridging conceptual understanding through multisensory, interactive learning experiences (Wu et al., 2024).

Young learners often require multisensory stimulation and interactive environments to maintain attention and motivation. Studies show that AR and VR environments significantly increase student engagement and intrinsic motivation in primary school contexts (Sökmen, et al., 2024; Pahmi, et al., 2023). AR applications, for example, allow pupils to manipulate 3D objects overlaid on the physical environment, promoting curiosity and active participation (AlNajdi, 2022).

Background and Rationale

Immersive technologies create a sense of "being there" (presence) and allow learners to interact with 3D objects and simulations rather than only viewing static text or images. This aligns well with constructivist and experiential learning theories which emphasize active manipulation and situated practice. Conceptual work by Elmqaddem (2019) argues that recent advances in affordable hardware and software make VR/AR genuinely viable for mainstream education, offering new pedagogical models that better fit 21st-century learners. A large narrative review by Zekeik et al., (2025) synthesized 53 studies and concluded that both VR and AR are particularly promising for domains requiring spatial reasoning, complex procedure training and multimodal representations, because they can simulate environments that would otherwise be dangerous, expensive or impossible to access (e.g., surgery, hazardous industrial contexts, remote locations).

Primary students frequently face challenges in understanding abstract ideas such as geometry, scientific processes, or historical time. AR can make invisible phenomena visible, allowing learners to "see" magnetic fields, molecules, or geometric relationships (Wu et al., 2024). In a controlled experiment, Wu and co-researchers (2024) found that AR mathematical picture books improved elementary students' geometric reasoning while reducing cognitive load compared with traditional books. Similarly, AR-based math tools foster better spatial understanding and conceptual change in early STEM learning (Alibraheim et al., 2023). VR offers a safe and controllable environment for simulations, virtual field trips, and skill practice. Primary school students can explore a rainforest or human anatomy virtually without logistical or safety constraints. Villena-Taranilla et al. (2022), in a meta-analysis of VR in K-6 education, reported moderate-to-large learning effects (Hedges' $g \approx 0.66$) when VR was used for exploratory, guided, or inquiry-based learning tasks. Introducing immersive technologies early contributes to the development of digital literacy and spatial reasoning-key components of future digital competence frameworks (Maryani, et al., 2024). By engaging with VR/AR, pupils also begin to understand responsible, creative, and collaborative uses of technology, essential for 21st-century learning (Jiang et al., 2025). Empirical evidence suggests positive learning outcomes. Sökmen et al. (2024) found that AR interventions in mathematics significantly improved achievement and motivation among 4th-grade students compared with control groups. Pahmi et al. (2023) also demonstrated that AR applications helped overcome math anxiety and increased problem-solving confidence in primary learners. A recent meta-analysis by Sandoval-Henríquez et al., (2025) revealed that immersive technologies in primary education yield a moderate overall effect ($g = 0.52$) on learning outcomes, confirming their pedagogical value when effectively implemented.

Beyond cognitive benefits, VR/AR positively affect learners' enjoyment, engagement, and flow. Wu et al. (2024) reported that AR picture books produced higher flow experiences and lower extraneous cognitive load. These findings suggest that the immersive and interactive nature of AR/VR enhances students' emotional connection to learning tasks, an important factor in early education (AlNajdi, 2022). Despite clear benefits, challenges persist. Teachers often report barriers such as lack of infrastructure, insufficient training, and time constraints (Villena-Taranilla et al., 2022; Jiang et al., 2025). Studies emphasize that effectiveness depends heavily on pedagogical integration—VR/AR must be aligned with learning goals and scaffolded with teacher guidance (Elmqaddem, 2019). For younger children, simplicity of interface and age-appropriate content are also critical to prevent cognitive overload (Wu et al., 2024).

The Metaverse is a digital space, appearing as a part of the physical reality in specific places and moments. It is based on state-of-the-art technologies, including VR, AR, 3D simulation and AI. Within it, users can interact not only with each other but also with digital objects in real time. This is known as "parallel digitalized

world' containing economic, social and cultural systems like the real-life physical world that offer intelligent applications and services for extending human experiences beyond their capabilities (Shi et al., 2024; Riva & Wiederhold, 2022). Thus, the metaverse emerged as a promising paradigm that may potentially change cognitive phenomena of embodiment, social presence and emotional engagement in learning. With leading technology companies investing heavily in its development, application-based learning is fast making inroads on education communication, and daily life, promising new opportunities for experiential activity-based learning.

The Metaverse represents a parallel digitalized world in which virtuality and reality converge. It mirrors economic and social structures of the real world and provides intelligent applications and services (Shi et al., 2024). The Metaverse is designed to expand connectivity, provide information and services to users, and offer limitless benefits and opportunities for innovation. Its use is changing our lives and allowing us to experience immersive and fantasy elements (Raad & Rashid, 2023).

By enabling students to generate their avatars in an online learning environment, the Metaverse promotes collaboration, success, and helps students "see" and get to know their classmates. According to Gavaldon et al. (2022), VR learning activities involving self-avatars and immersion resulted in higher knowledge, understanding, objective programming ability, presence, and attitudes toward computer science and computational thinking in middle school students. Using avatars and distance simulation as effective adjuncts to realistic face-to-face simulation, especially when assessing communication and leadership skills, can reduce travel distance and cost improving accessibility (Löllgen et al., 2022) as educators face persistent restrictions to face-to-face education of medical students and healthcare professionals.There is paucity of published data regarding the benefits and barriers of distance and avatar simulation training modalities.MethodsFollowing a 2-day virtual pediatric simulation competition facilitated by Netzwerk Kindersimulation e.V., using remote human avatars and distance simulation, we conducted a multicenter survey to explore the advantages and challenges of avatar and distance simulation among participants. We used a modified Delphi approach to draft and develop the 32-item online questionnaire with 7-point Likert-like scales (7 being the highest rating).

Digital storytelling provides students with tools that enhance their learning by encouraging them to explain engineering concepts while tinkering, and later recall what they learned during these activities (Pagano et al., 2024).

Çetin (2021) found that digital storytelling significantly enhanced the digital literacy of students, with the highest gains observed in the creation phase. Similarly, Wu and Chen (2020) note that while digital storytelling has become an increasingly popular pedagogy across countries and educational levels, it still faces challenges such as linguistic barriers, overly optimistic expectations, and the need for further research.

In conclusion, although both the metaverse and digital storytelling have shown great promise to learn, limited evidence is available regarding their combined use through avatar-based narratives in primary science education. Accordingly, this study explores how metaverse-based avatars affect students' cognitive learning, engagement, and emotional-social development.

In this context, the study *aims* to address this gap and contribute to a better understanding of how immersive technologies can support learning in ways that are meaningful and effective.

Methodology of research

Objectives of the Study were:

1. To assess the impact of avatar-driven storytelling on student engagement in the metaverse.
2. To evaluate knowledge retention and cognitive comprehension when students learn through Avatars.
3. To explore the role of Avatars in emotional and social learning within virtual environments

Research Questions were identified:

RQ1: In what ways does Avatar-based storytelling shape student engagement in virtual learning environments?

RQ2: How does knowledge retention differ between students experiencing Avatar-based learning and those using traditional digital methods?

RQ3: How do students perceive Avatars as guides and educators in immersive learning environments, and what factors do influence these perceptions?

Hypothesis H1-H3 were formulated adequate to RQ1-RQ3:

H1: Storytelling using avatars in the metaverse resulted in higher cognitive learning outcomes as compared to traditional digital learning.

H2: Avatar-based storytelling enhanced student interest as compared to other non-immersive teaching-learning provisions.

H3: Avatar-based narration helped improve emotional and social attachment to the learning process for students.

Methodology

Using a quasi-experimental pre-post-test control group design (Somuncu & Aslan, 2022), this study investigated the effects of the avatar-based storytelling in a metaverse on students' recall knowledge, engagement, and perception of learning

outcomes. The participants were completely randomized into two groups: the experimental group and the control group. The experimental group interacted with scientific stories through avatars on the Verse metaverse platform, where avatars served as interactive guides to explain and demonstrate critical scientific processes using stimulating storytelling (Dudley et al., 2023). On the other hand, the control study group had the same scientific content presented through traditional digital methods of videos, PowerPoint, and text materials, without avatars and interactive narrative.

All participants completed a pre-test measuring existing knowledge before the intervention (Shahzad et al., 2024). A similar post-test was conducted after a two-week intervention to assess cognitive, emotional, and social attachment. Supplementary data included an engagement survey, teacher observations, and focus group interviews to assess emotional and social reactions to the intervention. The mixed-methods approach allowed for an in-depth analysis of the learning experiences of the two groups and offered general conclusions on the power of avatar-based storytelling as a means of promoting science education (Xu et al., 2024; Popa et al., 2020).

Students in the experimental group learned science through avatar-performative stories using audio narration and the Verse platform (VERSE, 2025). VERSE (Virtual Environment) is a metaverse-based educational tool that helps provide immersive, narrative-driven education. Within this virtual world, learners interacted with animated avatars who explained science-related concepts through dialogue, visuals, and built-in tasks.

Participants Selection Criteria and Sample Size

This study involved children aged 8–12 years from the Primary School No. 1 in Ustroń, Poland. A total of 50 students participated, with 25 assigned to the experimental group and 25 to the control group. This sample size is consistent with the recommended sample for studies (Zheng et al., 2020). The participants were selected using stratified random sampling to ensure diversity in cognitive ability, prior digital exposure, and experience with virtual environment, providing a balanced representation across groups (Chang et al., 2021; Triveni et al., 2024). Parental consent was obtained, and all participants received orientation to ensure basic digital literacy.

Data Collection Methods

Data were collected through pre- and post-tests assessing knowledge retention (Stratton, 2019) , Likert scale questionnaires (Koo & Yang, 2025) measuring engagement and motivation, and teacher observations monitoring participation. Focus group interviews provided qualitative insights (Adler et al., 2019) into students' experience with avatar-based storytelling. The mixed-methods design provides rigorous testing of the learning intervention (Mulili et al., 2025).

Assessment Implementation

Evaluation was continuous via a systematic process to evaluate learning effectiveness and progress (Miller et al., 2020). Formative evaluation occurred dur-

ing lessons via quizzes, immediate feedback, and student reflection with avatars. Summative evaluation took place after the intervention via pre- and post-tests to evaluate knowledge retention and conceptual understanding. Engagement surveys were used to evaluate students' interest and motivation levels in the metaverse-enabled learning environment.

Systematic evaluation techniques were used to quantify student learning outcomes through assessment. Quizzes, feedback, and avatar-mediated interactive discussions were used to track students' development during the intervention as formative assessments (Nauta et al., 2023). Pre- and post-tests assessed knowledge retention, comprehension, and problem-solving capabilities via summative assessments. Student engagement questionnaires assessed motivation and interest levels in avatar-mediated storytelling classes.

Evaluation was comprised of formative and summative methods (Svensäter & Rohlin, 2023). Formative evaluation included immediate instructor feedback and interactive quizzes in the metaverse. Summative evaluation was based on pre- and post-conceptual understanding tests, levels of engagement, and student reflections (Divjak et al., 2024; Holmes, 2018). Performance metrics were examined to ascertain the efficacy of avatar-based storytelling in learning.

Scenario-Based Lesson Design

Adoption of a scenario-based teaching methodology was a fundamental instructional strategy used in this study to engage students, promote critical thinking, and apply real-world problem-solving (Wang et al., 2024). Scenarios were created in a fictional or semi-realistic setting for students to interact with the characters or avatars. These practice-based scenarios presented a central problem or focus for the students to investigate and work on together in groups to propose a resolution to be solved through various creative means (Hosseinzadeh et al., 2022) predominantly from India (40.5%). The learning process was divided into steps, involving narrative exploration, group tasks, presentations, and reflective conversations. The method was designed to support deep learning through the contextualization of academic material. Tasks addressed both cognitive processing (retention and conceptual understanding) and affective engagement (motivation, presence, and emotional connection), in accordance with the Cognitive Affective Model of Immersive Learning (CAMIL) (Makransky & Petersen, 2021). Student learning and participation were assessed through the observation of small group work, formative assessment of group products, peer review of these products, and student reflection at both the individual tool-mediated level as well as the cognitive (and affective engagement and social presence) one.

Pre- and Post-Tests

Pre- and post-tests were designed corresponding to CAMIL (Makransky & Petersen, 2021), which aims to assess the cognitive development at a suitable level for 8–12-year-olds. Test content covered three main cognitive categories based on which the contents of the exams were prepared: remember, understand, and apply. The pre-test (in which students were provided an instructional storytelling session) assessed their background, prior knowledge of basic science concepts such as plant growth requirements, photosynthesis, and reproduction. It included recognitional multiple-choice items (e.g., asking about what plants need to grow) and short-answer response items that were designed to get students to articulate their preliminary understanding of the critical terms and concepts (e.g., "photosynthesis") and to tell what they currently know about plant reproduction. Those items represented the lower levels of Bloom's revised taxonomy – Remember and understand (Anderson, et al., 2001). The post-test was given immediately after the lesson and was designed to measure the level of understanding and transfer of information. It consisted of both multiple-choice and open-ended questions. Requirements involved explanatory writing (e.g., students needed to make meaning by explaining scientific language and processes (e.g., how chlorophyll works, what leaves do during photosynthesis)). Several open-ended questions (Hauer et al., 2020; Nedjat-Haiem & Cooke, 2021) were also included to assess whether learners could use information in context, e.g., they were asked to explain pollination, the start of plant life, and the significance of photosynthesis to organisms. Reflective questions, however, were integrated to stimulate personal reflection and conclusion regarding the story information.

Data Analysis

A mixed-methods study design (Hoffman et al., 2022; Biwer et al., 2020) was utilized to examine the effectiveness of avatar-based storytelling within the Verse metaverse. Python was used to analyze quantitative data (pre-posttests and engagement surveys). Data cleaning was conducted through libraries such as Pandas and NumPy, and statistical analysis through libraries such as Matplotlib and Seaborn sponsored by the Library of Science (Shepherd, Edo, Parasta, Van Vu, & Burke, 2016). Differences between control and experimental groups were evaluated by statistical tests, such as paired t-tests and ANOVA.

NVivo was used for qualitative data (open-ended survey responses and interviews) (Dixon-Woods et al., 2020) collate, and analyze routine patient data have prompted optimism about the potential of learning health systems. However, real-life examples of such systems remain rare and few have been exposed to study. We aimed to examine the views of design stakeholders on designing and

implementing a US-based registry-enabled care and learning system for cystic fibrosis (RCLS-CF). This program facilitated systematic coding and thematic analysis by assisting in identifying patterns and understanding themes regarding students' experiences and perceptions. Triangulation of quantitative and qualitative analyses resulted in a holistic view of the intervention effect (Dixon-Woods et al., 2020) collate, and analyze routine patient data have prompted optimism about the potential of learning health systems. However, real-life examples of such systems remain rare and few have been exposed to study. We aimed to examine the views of design stakeholders on designing and implementing a US-based registry-enabled care and learning system for cystic fibrosis (RCLS-CF; McGregor et al., 2022).

Quantitative Data Analysis

The internal consistency of the pre-test and post-test instruments was analyzed using Cronbach's alpha (α). The pre-test, administered to 10 students, 5 from each group, had 0.723 Cronbach's alpha, indicating acceptable reliability (George & Mallery, 2003).

The posttest consisted of 10 items and was applied to the same 50 students in pretreatment. Although there were only 50 samples, Cronbach's alpha was computed from a total of 158 responses, encompassing responses on all the test items. The final alpha value of 0.789 indicates a good internal consistency."

To evaluate the effectiveness of the instructional intervention, total test scores were compared before and after the two-week learning period. As shown in Table 1, students' scores improved notably. Before the intervention, the mean total score was M = 4.24 (SD = 0.84), while post-intervention scores increased to M = 7.22 (SD = 1.89). These results suggest a positive impact of the instructional approach on student learning outcomes.

Table 1
Descriptive Statistics: Total Score (Before vs. After)

Statistic	Mean (Before)	SD (Before)	Mean (After)	SD (After)
Total Score	4.24	0.84	7.22	1.89

S o u r c e: Own elaboration.

To compare mean scores of post-tests in the experimental (avatar-based) group and control group, an independent samples t-test was used. The analysis showed a significant difference in performance levels, $t(48) = 9.84$, $p < 001$, and the experimental group scored significantly higher than the control group. This may suggest that the learners who were first exposed to avatars enjoyed and remembered the story content more effectively and possibly maintained positive memories about avatars than those in the traditional essay-based condition. Statistical significance was set at an alpha level of 0.05.

Table 2
Independent Samples t-Test: Post-Test Scores by Group

Comparison	T	Df	p-value
Post-Test (Experimental vs. Control)	9.84	48	< .001

S o u r c e: Own elaboration.

Paired samples t-tests were conducted for each group (n = 25). The experimental group showed a significant increase in scores from pre- to post-test, t (24) = –9.39, p < .001. The control group also demonstrated significant improvement, t (24) = –4.53, p < .001. Degrees of freedom (df) reflect n-1 for each paired sample group. These results suggest the avatar-based instructional method had a stronger effect on student learning outcomes.

A two-way mixed-design ANOVA was conducted to examine the effects of instructional group (Experimental vs. Control) and time (Pre-test vs. Post-test) on students' total test scores. The analysis revealed a significant main effect of time, F (1, 198) = 959.62, p < .001, indicating that student scores improved overall following the intervention. The main effect of group was not statistically significant, F (1, 198) = 2.99, p = .086. However, there was a significant interaction between group and time, F (1, 198) = 243.14, p < .001, suggesting that the experimental group showed a greater improvement in test scores compared to the control group.

Table 3
Paired Samples t-Test Results for Pre- and Post-Test Scores

Group	t	Df	p-value
Experimental	–9.39	24	< .001
Control	–4.53	24	< .001

S o u r c e: Own elaboration.

A two-way mixed ANOVA was conducted on students' total test scores to evaluate the effects of both instructional group factor (Experimental vs. Control) and time factor (Pre-test vs. Post-test). The analysis indicated a significant group main effect, F (1, 96) = 157.94, p < 001, indicating the experimental group achieved higher overall scores than the control group. A significant main effect of time was also observed, F (1, 96) = 32.95, p < 001, indicating that the scores improved greatly from pretest to post-test. Most importantly, there was a strong interaction effect between group and time, F (1, 96) = 67.70, p < 001; that is, the experimental group exhibited more improvements with scores across time than the control group. It can be inferred that the error bars are comparatively smaller in the post-test scores of the experimental group, which indicates less variation in performance.

Table 4
Mixed-Design ANOVA Results (Group × Time)

Effect	F	Df	p-value
Group	157.94	1, 96	< .001
Time	32.95	1, 96	< .001
Group × Time	67.70	1, 96	< .001

S o u r c e: Own elaboration.

A Wilcoxon signed-rank test was performed to evaluate whether students' total engagement scores significantly differed from the neutral midpoint value (24), based on eight Likert-scale items (1–5 scale). The test indicated a statistically significant difference, W = 0.00, p < .001, suggesting that students reported significantly higher engagement levels compared to a neutral expectation. The mean engagement score was 32.28 (SD = 2.26), with scores ranging from 28 to 36 out of a maximum possible of 40.

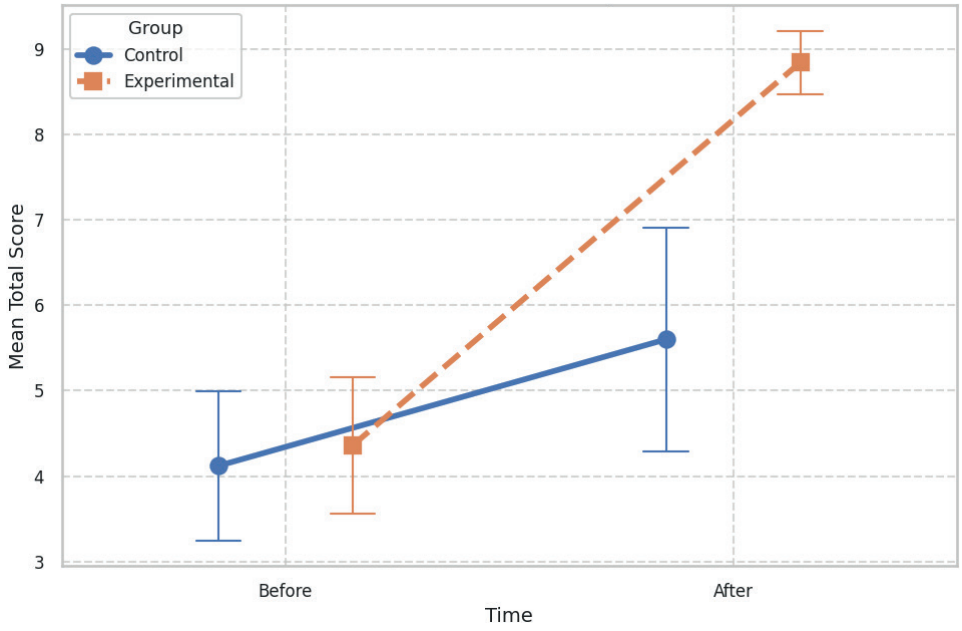

Figure 1. Interaction Plot: Mean Total Scores Before and After by Group

S o u r c e: Own elaboration.

Table 5
Descriptive Statistics for Engagement Scores (n = 25)

Metric	Value
Mean	32.28
Standard Deviation	2.26
Minimum	28.00
25th Percentile	31.00
Median	32.00
75th Percentile	34.00
Maximum	36.00
Wilcoxon W	0.00
p-value	< .001

S o u r c e: Own elaboration.

Engagement scores were calculated from eight 5-point Likert-scale items (maximum score = 40). The neutral midpoint score was 24. W = Wilcoxon signed-rank test statistic. $p < .05$ was considered statistically significant.

Qualitative Analysis of Focus Group Interviews

Table 6
Frequency of Themes Identified in Focus Group Responses

Theme	Frequency
Uncoded	10
Engagement	5
Understanding	3
Avatar Preference	3
Confusion	2
Total	10

S o u r c e: Own elaboration.

Frequencies represent how many responses under each theme were coded by participants. Uncoded responses refer to answers that were uncertain, off-topic, or unrelated to the study's aims.

A second theme, Engagement, was strong across comments to this question, with students invariably reporting the avatar activities were ‘‘fun”, ‘‘game-like,” and ‘‘more interesting than normal lessons”. This theme was the most prevalent (n = 5), implying that avatar-based storytelling may increase emotional engagement

and motivation. Some students highlighted that the narrative and interactive aspects helped them feel immersed. “I felt like I was a part of the story, not just learning”.

The study findings suggest that an avatar-based storytelling approach can contribute to students’ intrinsic motivation through the process of engaging routine course content in meaningful and personally relevant ways, in accordance with constructivist and narrative-driven approaches to learning.

The same (n = 3) was found concerning students’ understanding that avatar learning influenced cognitive achievement. According to students, the avatars helped remember key concepts, especially in complex areas like ecosystems or food chains. “It helped me to remember things better when I hear the voice and the mission,” said one student. Some mentioned a better understanding because of the visual and interactive nature. These observations are consistent with the notion that instruction with avatars can scaffold learning, particularly through multimodal reinforcement that contributes to memory encoding and recall.

This research question directly relates to Avatar preference (n = 3). The students described the avatar as “funny,” “like a teacher,” or “cool to follow.” This feedback indicates that avatars were not only entertaining but also considered credible and relatable guides. For example, one participant said, “The avatar was explaining better than the videos because it was speaking like a person.”

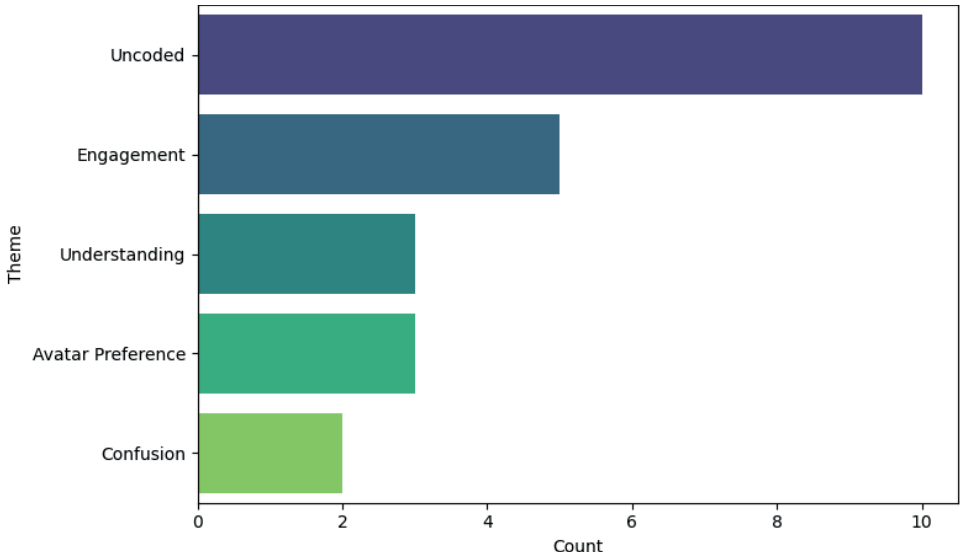

Figure 2. Theme Frequency from Thematic Analysis. The frequencies reflect the number of participant responses coded under each theme

S o u r c e: Own elaboration.

Moreover, the theme of Confusion (n = 2) emerged, indicating technical difficulties and accessibility burdens. Some students reported that the avatar was

"too fast" or "hard to understand," revealing opportunities for better designing the voice and pacing.

Ten responses (n = 10) were not categorized, mostly because they were unclear or off-topic (e.g., I do not know, or it was okay). These represent different levels of engagement and suggest that clearer qualification questions should be formulated in the future focus group protocol.

Results and Discussion

H 1: Cognitive Learning Outcomes

An independent-samples t-test was used to compare the post-test scores of the experimental group (M = 7.22, SD = 1.89) with those of the control group (M = 4.24, SD = 0.84) to analyze whether the results of the avatar-based storytelling exercise were found to enhance cognitive learning. The difference was of a clear statistical significance ($t(48) = 9.84$, $p < .001$).

Within-group improvements were also confirmed by paired-samples t-tests. The test by the group engaged in the experiment has presented a very high increase in the score on the pre-test and post-test ($t(24) = –9.39$, $p < .001$). The control group also demonstrated improvement, albeit, with a modest effect, $t(24) = –4.53$, Also, a two-way mixed ANOVA demonstrated that there was a significant interaction effect between time (pre-test and post-test) and group (experimental and control), $F(1, 96) = 67.70$, $p < .001$, indicating greater gains in the avatar-based condition. This finding supports Hypothesis 1: the use of storytelling through avatars led to better performance among students compared to traditional digital classrooms.

H 2: Student engagement

Engagement was assessed in terms of an 8-item Likert scale (15 scale; the highest score = 40). The study group found the experiment engaging (M = 32.28, SD = 2.26). A Wilcoxon signed-rank test of this against the neutral midpoint (24) indicated again that there was a statistically significant difference, $W = 0.00$, $p <.001$. Hypothesis 2 was confirmed. Students in the avatar-based condition demonstrated engagement well above the neutral midpoint, highlighting the motivating effect of avatar-based storytelling in the learning environment.

H3: Perception of Emotional and Social Learning

Focus group interviews were analyzed thematically using NVivo. Some of the themes were emotional engagement, enhanced understanding, avatar preference, and immersion. Students reported that the activity was enjoyable, game-like, and easier to learn than typical lessons. Avatars were viewed as realistic, interactive, and emotive. These impressions reflected deeper emotional and social learning experiences.

The findings support Hypothesis 3: students exhibited higher emotional and social responses to storytelling when using avatars compared to traditional learning methods.

Across these reviews and meta-analyses, several consistent conclusions emerge:

1. Effect sizes are generally positive and often moderate-to-large for achievement, especially in STEM and science education, when VR/AR are used for hands-on practice, simulations and interactive tasks ($g \approx 0.4–0.9$ in many meta-analyses).
2. Motivational and affective benefits (engagement, enjoyment, interest) are robustly reported, even when test scores only modestly improve (Sviridova, et al., 2023).
3. Instructional design is crucial: the strongest effects occur when VR/AR are embedded in well-structured pedagogies (inquiry-based learning, collaborative learning, game-based learning, guided practice) rather than used as isolated "wow" demonstrations.
4. Challenges include cognitive overload, motion sickness, hardware cost, technical instability, and lack of teacher preparation. Reviews repeatedly note that poor interface design or insufficient scaffolding can neutralize or even reverse potential benefits (Sviridova, et al., 2023).

Overall, the literature suggests that VR/AR are important in education not simply because they are novel technologies, but because they enable forms of experiential, embodied, and contextualized learning that are difficult to achieve otherwise-and that, when appropriately designed and implemented, they can lead to meaningful gains in both learning outcomes and learner engagement.

Research to date supports the integration of VR and AR technologies in primary education as powerful tools for increasing engagement, facilitating conceptual understanding, and supporting experiential learning. Meta-analytic findings and classroom studies confirm moderate-to-strong effects on both cognitive and motivational outcomes when immersive technologies are pedagogically grounded (Villena-Taranilla et al., 2022; Sandoval-Henríquez, et al. 2025).

Nevertheless, sustainability and equity remain challenges. Implementation requires adequate teacher training, infrastructure, and thoughtful instructional design. When these conditions are met, VR and AR can meaningfully enrich primary school learning environments and foster digital competence from an early age.

Conclusion

This quasi-experimental study investigated how avatar-based storytelling in a metaverse environment affected science learning, engagement, and emotional-social development of primary school students over a two-week intervention. The results supported all three research hypotheses.

Statistical analyses showed that the learning outcomes and engagement levels of students who participated in the avatar-based storytelling activities were significantly higher than those of the control group. Thematic analysis of qualitative data also showed that students experienced greater emotional involvement, attachment, and interest in the avatars and the learning content.

These results indicate that even short-term interventions using avatars and narrative design in immersive virtual environments can produce quantifiable educational outcomes. This study reveals the pedagogical potential of avatar-based storytelling in digital learning, especially for STEM subjects among primary school learners. Future research should examine long-term retention and adaptive personalization, multi-site replication to ensure further scale, and validation of using metaverse-based learning interventions.

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Saima Mehboob, Alberto Fornasari, Eugenia Smyrnova-Trybulska

Badanie wpływu Verse w Metaverse: badanie roli awatarów w opowiadaniu historii naukowych

Streszczenie

Niniejsze badania koncentrują się na wpływie opowiadania historii opartego na awatarach w środowisku metawersum na efektywność uczenia się, zaangażowanie oraz doświadczenia emocjonalno-społeczne uczniów szkół podstawowych w ramach edukacji przyrodniczej. W Polsce zastosowano quasi-eksperymentalny schemat grupy kontrolnej, składający się z testu wstępnego i testu końcowego, obejmujący 50 uczniów w wieku od 8 do 12 lat. Ponieważ badanie miało charakter eksperymentalny, pierwsza grupa uczestniczyła w dwutygodniowej interwencji, w której awatary korzystały z interaktywnych skryptów naukowych, podczas gdy druga grupa korzystała z tych samych treści za pośrednictwem konwencjonalnych mediów cyfrowych. Wyniki testów wstępnych i końcowych, a także ankiety zaangażowania, wykazały znaczną poprawę w zakresie uczenia się i zaangażowania w grupie eksperymentalnej ($p < 0,001$). Dane z wywiadów grupowych w formie wyników jakościowych pokazały, że uczestnicy postrzegali awatary pozytywnie, jako wiarygodne i wiarygodne postacie, które wzbudzały emocje. Odkrycia te potwierdzają pozytywny pogląd, że krótkoterminowe narracje oparte na awatarach mogą wspierać poprawę sprawności poznawczej, motywacji i więzi emocjonalnych w kontekście wirtualnego uczenia się. Przedstawiono dyskusje na temat implikacji pedagogiki immersyjnej i kierunków przyszłych badań longitudinalnych.

Słowa kluczowe: uczenie się oparte na awatarach, edukacja metawersalna, opowiadanie historii, wirtualne uczenie się

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Estudio sobre el impacto del Verse en el Metaverse: Explorando el papel de los avatares en la narrativa científica

Resumen

La presente investigación se centra en los efectos de la narrativa basada en avatares, dentro de un entorno de tipo metaverso, en el rendimiento académico, la participación y la experiencia emocional y social de estudiantes de primaria en el ámbito de la educación científica. En Polonia, se utilizó un diseño cuasiexperimental de grupo de control con pre-test y post-test, con 50 estudiantes de entre 8 y 12 años. Dado que se realizó de forma experimental, el primer grupo experimentó una intervención de dos semanas en la que los avatares utilizaron guiones científicos interactivos, mientras que el segundo grupo interactuó con el mismo contenido a través de medios digitales convencionales. Los resultados de los pre-tests y post-tests, así como la encuesta de participación, mostraron que el aprendizaje y la participación en el grupo experimental mejoraron significativamente ($p < 0,001$). Los datos de las entrevistas de los grupos focales, en forma de resultados cualitativos, mostraron que los participantes percibieron positivamente a los avatares como personajes creíbles y cercanos que evocaban emociones. Los hallazgos refuerzan la visión positiva de que las narrativas a corto plazo basadas en avatares pueden contribuir a mejoras en el rendimiento cognitivo, la motivación y la vin-

culación emocional en contextos de aprendizaje virtual. Se presentan debates sobre las implicaciones de la pedagogía inmersiva y las directrices para futuras investigaciones longitudinales.

P a l a b r a s c l a v e: aprendizaje basado en avatares, educación metaversa, narrativa, aprendizaje virtual

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Исследование влияния Verse в Metaverse: изучение роли аватаров в научном повествовании

А н н о т а ц и я

Текущее исследование фокусируется на влиянии повествования с использованием аватаров в среде метавселенной на успеваемость, вовлеченность и эмоционально-социальный опыт учащихся начальной школы в рамках естественнонаучного образования. В Польше был использован квазиэкспериментальный план контрольной группы, включающий предварительное и последующее тестирование, с участием 50 учащихся в возрасте от 8 до 12 лет. Поскольку исследование проводилось на экспериментальной основе, первая группа прошла двухнедельное вмешательство, в ходе которого аватары использовали интерактивные научные сценарии, в то время как вторая группа взаимодействовала с тем же контентом через традиционные цифровые медиа. Результаты предварительного и итогового тестирования, а также опроса о вовлеченности показали, что усвоение материала и вовлеченность в экспериментальной группе значительно улучшились ($p < 0,001$). Данные фокус-групповых интервью, представленные в виде качественных результатов, показали, что участники положительно воспринимали аватары как достоверных и узнаваемых персонажей, вызывающих эмоции. Эти результаты подтверждают позитивное мнение о том, что краткосрочные истории с использованием аватаров могут способствовать улучшению когнитивных способностей, мотивации и эмоциональной связи в контексте виртуаиммерсивной педагогики и даны направления для будущих лонгитюдных исследований.

К л ю ч е в ы е с л о в а: обучение с использованием аватаров, образование с использованием метавселенной, научные и образовательные повествования, виртуальное обучение

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Carrying the Burden of Innovation in Education: Becoming Educational Events Organizers in Social Virtual Reality

Abstract

Recent laboratory-based research increasingly explores the use of virtual reality (VR) technology in education. While these studies confirm the potential of VR tools, they often overlook the challenges educators encounter in real-world implementation, potentially hindering the broader adoption of VR. Our study employs collaborative and analytic autoethnography of five educational event organizers in social VR to address this gap. We identified limitations in the use of social VR related to discomfort and low accessibility of head-mounted displays, the non-inclusivity of platform features, the risk of reduced educational content quality,

and the need to acquire new digital skills. Organizers experienced significant responsibility and stress from managing technical and formal issues, impacting their well-being and increasing workload. Nevertheless, they also reported a strong sense of purpose and personal development, which reinforced their academic identity. Despite the challenges of organizing events in this immersive environment, organizers experienced significant professional growth. Their involvement not only enhanced their skills but also fostered valuable collaborations across academic institutions, cultivated community, and promoted inclusivity in education. To address social VR limitations in higher education and mitigate negative impacts on organizers, the authors provide recommendations for educators.

K e y w o r d s: innovation, autoethnography, social VR, virtual reality, education

Introduction

In the face of dynamic technological shifts and the growing need for innovation in education, educators and professionals in this field are confronted with the challenges of implementing novel solutions (Mukul & Büyüközkan, 2023). Recent studies have increasingly highlighted the potential of utilizing virtual reality (VR) technology in education (Di Natale et al., 2020; Abramczuk et al., 2023). Its use can enhance the effectiveness of learning (Wu et al., 2020; Pyrkosz-Pacyna et al., 2024), engagement with content (Nesenbergs et al., 2021) and motivation (Allcoat & Mühlenen, 2018). These effects stem from the distinctive features of VR technologies, including an immersive 3D environment, the synchronization of users' physical bodies with their digital counterparts, a heightened sense of presence (defined as the illusion of unmediated existence within the virtual environment) enabled by a first-person 360-degree perspective, and the ability to share the same virtual space with other users (Mystakidis, 2019, 2022; Mystakidis et al., 2021; Wu et al., 2020). VR enables simulations of scenarios that are inaccessible in the physical world (due to the safety, economical, institutional or other constraints), thus enhancing the learning experience (Radianti et al., 2020).

Currently, especially since the COVID-19 pandemic, there is growing interest in the social aspects and educational potential of social VR platforms (Lin & Latoschik, 2022; Wei et al., 2024; Dey et al., 2024). Social VR platforms facilitate avatar-mediated communication, enabling meetings and collaboration in 3D virtual environments (Lin & Latoschik, 2022). Previous research shows that communication in social VR can enhance users' sense of social and spatial presence, facilitate their focus on conversations, and support individuals who are introverted, shy, or marginalized (Wei et al., 2024; Maloney et al., 2020). Avatar-

mediated communication in social VR allows for natural interactions between users by enriching communication with non-verbal cues (e.g., gestures, eye contact; Wei et al., 2024; Maloney et al., 2020) and facilitating informal interactions among users, such as the formation of smaller discussion groups, as noted by Mulders and Zender (2021). Social VR environments facilitate 'authentic, simulated, cognitively challenging experiences in engaging, motivating environments for open-ended social and collaborative interactions and intentional, personalized learning' (Mystakidis et al., 2021). These platforms can increasingly be accessed not only through head-mounted displays (HMDs) but also via desktop devices, making them more widely adopted in educational contexts (Mystakidis et al., 2021; Mystakidis, 2022; Waligórski et al., 2023).

Introducing technologies such as social VR into education represents a significant innovation. However, this complex process extends beyond developing new tools, requiring a critical analysis of their impact on educational structures, roles, and emerging challenges. Furthermore, innovation requires adaptation to new practices and the overcoming of technological, social, and psychological barriers. Identifying a solution that ensures both technical and economic accessibility is particularly challenging in the educational sector. This endeavor begins with an examination of the psychological determinants of effective and comfortable communication, which is essential for developing a viable solution. Despite the identified advantages and growing interest in VR in educational research, the widespread adoption of VR in this area remains limited (Al Farsi et al., 2021). We argue that this limitation might arise from the challenges associated with implementing these technologies by educators rather than from their inefficiency. To address these challenges, there is a critical need for research focused on the real-world practices of VR implementation. Moving beyond controlled laboratory settings, research must account for the actual conditions in which these technologies are applied.

This research aims to fill the existing research gap. We investigate the process of organizing two educational events in social VR from a participatory perspective , examining the challenges of their practical implementation. Drawing on our shared experiences and identified gaps in the literature, we posed the following research questions (RQs):

RQ1. What limitations do organizers perceive in using social VR platforms for organizing educational events?
RQ2. What strategies can help reduce these limitations?
RQ3. What challenges do organizers face when organizing educational events in social VR?
RQ4. How does organizing educational events in social VR affect the psycho-physical well-being of the organizers?
RQ5. What strategies can help reduce factors negatively affecting the organizers?

To address these research questions, we employ the collaborative and analytic autoethnography approach (CAAE) proposed by Acosta et al., (2015). Our findings offer both theoretical and practical contributions. On the one hand, they align with the principles of action research, which seeks to identify areas for improvement, actively engage in practices, and aim to enhance them. On the other hand, they advance knowledge by identifying discrepancies between empirical data on VR implementation practices and the theoretical understanding of VR's effectiveness. Ultimately, the choice of this method is driven by the need to fill the research gap concerning the experiences of those implementing VR tools in education, specifically the organizers of educational events, a highly underexplored topic in studies predominantly focused on participant and student experiences.

In the following section, we describe the framework of CAAE employed in this study. We provide context for our research by discussing the *Wirtualium* project and our roles as its organizers. Subsequently, we outline our research design, including data collection and analysis. In the Results section, we examine the experience of organizing the *Wirtualium* project in social VR, the challenges encountered during this process, and the impact of implementing these innovations on the organizers. In the final section, we offer recommendations for organizing educational events in social VR.

Methodology

In our study, we adapted CAAE framework (Acosta et al., 2015) to investigate the challenges and limitations experienced by us, the organizers, in the process of implementing social VR platforms for educational event organization. The CAAE framework is characterized firstly by its systematic nature, ensured through clearly defined research questions and transparent research methods. Secondly, it adopts a problem-based approach, focusing on real-world practices where practitioner-researchers become both the subject and the object of the research. Thirdly, it is cyclical, implying that solutions developed within one research cycle should be tested in future cycles. CAAE combines analytic (Anderson, 2006) and collaborative (Chang et al., 2013) approaches to autoethnography. This enhances research quality through methodological transparency and the dialogic conduct of autoethnography within a research team. In this framework, autoethnography serves as a technique used in participatory action research, enabling reliable investigations of the organizers' own experiences. The goal of practitioner-researchers is to leverage insider perspectives to improve the quality of future actions and advance academic theory.

We adopted this approach because it allows for a systematic and transparent examination of practices within a research team. The organization of educational events is typically a collaborative effort, where individuals in different roles perceive the process differently and encounter various challenges. CAAE facilitates dialogic autoethnographic research that, by incorporating multiple perspectives, captures a more comprehensive view of the phenomenon under study.

The Wirtualium Project

In our study, we collected data during the process of organizing the third edition of the educational project *Wirtualium*. Data was recursively collected and analyzed over the period of four months - April to July 2024. The *Wirtualium* project was initiated in 2022. Its aim was to create a space for academic discussion about VR among researchers from various scientific disciplines, to invite participants to a personal experiment related to attending a scientific event in VR, to explore the potential of these platforms in academic communication, and to popularize an evidence-based approach to using VR. In 2022, *Wirtualium 1.0* hosted the first entirely social VR-based scientific conference in Poland, on the AltspaceVR platform. This national event became one of the most significant VR-related conferences in Poland, earning the title of Conference of the Year 2022 in the national StRuNa (Student Scientific Movement) competition. The second edition was held on the Spatial (social VR) platform.

During the organization process of *Wirtualium 3.0* (17–18 May 2024), which is the subject of this study, two events were held entirely on the Spatial platform: the next edition of the scientific conference and educational workshops on VR and new technologies for high school students – Summer VR Academy (see Figure 1). The academic conference featured 25 presentations, with 7 keynote speakers delivering lectures, and around 90 participants attended the event. The Summer VR Academy hosted 9 teams, each consisting of 3 students and a supervisor. This event included two lectures, and three workshops conducted on the Spatial platform.

Spatial is a social VR platform that allows for the design and usage of VR environments. It enables social interactions and collaboration via customizable avatars in shared virtual environments. This platform supports voice and text communication as well as screen sharing. Typical usage of Spatial includes remote work, education, training, and entertainment. Spatial offers support for HMDs as well as access through desktop and mobile devices.

The authors of this study hold key roles in organizing *Wirtualium 3.0*, four of them have been involved in organizing the project in previous years (see Table 1). The motivations for conducting the *Wirtualium 3.0* project and previous experiences of organizers are described in the section *Motivations for Co-Creating the Project*.

Figure 1. Photographs from the Wirtualium 3.0 in auditoriums of Academia Electronica: (a) workshops during the Summer VR Academy, (b-c) presentations at the academic conference, (d) a social gathering by the bonfire following the conference.

S o u r c e: Own work.

Table 1
Basic information about the organizers-authors

Name	Role in the *Wirtualium* Project	Gender	Year Joined
Jan	Founder and head of the project. His responsibilities included coordinating the entire team's work, setting goals, representing the project, and handling formal matters. He was also the initiator and co-organizer of the entire process of organizing the *Wirtualium*.	Male	2022
Sylwia	Coordinator of administrative tasks, such as developing statute and application forms, designing schedules, and being involved from the beginning in the conceptual development of the project. She also served as a panel moderator during the conference.	Female	2022
Aleksandra	Coordinator of the team responsible for receiving participants' submissions, delivering certificates, and collaborating with the Scientific Committee during submission reviews. She also served as a panel moderator during the conference.	Female	2023
Zosia	Coordinator of the team responsible for collaborating with keynote speakers, from sending invitations to providing support during the conference. She also served as a panel moderator during the conference.	Female	2023
Jowita	Member of the Scientific Committee and head of the EduVR-GameLab research laboratory, which was a unit where *Wirtualium 3.0* project was affiliated. Her responsibilities included evaluating submissions and collaborating with university authorities. She also served as a panel moderator during the conference.	Female	2024

S o u r c e: Own work.

Research Design

We began by formulating research questions (RQs), which we posited collectively through discussions about our experiences with implementing VR in education and being VR researchers. The first author facilitated the entire research process, serving as the moderator and leader. We jointly established the course and scope of the research and developed a structured self-interview form to systematize the autoethnography process (Appendix S1). The first sheet of the form addressed retrospective experiences. It included questions about motivations for organizing the project, experience in organizing educational events, and the use of social VR platforms, as well as their impact on the individual's academic identity. The second sheet contained questions about the experiences related to the activities undertaken by the organizer in the previous week. These questions pertained to the tasks performed, identified limitations of social VR platforms, challenges associated with organizing the event, recommendations for reducing these challenges and limitations in the future, and the impact of these activities on the organizer. The second sheet was filled out weekly for six weeks (April–May 2024), with each version containing the same questions. Some individuals who did not engage in organizational activities in a given week did not complete the self-interview for that week. The collected data was in Polish.

We conducted data analysis utilizing the approach rooted in grounded theory (Oktay, 2012). An inductive coding method was applied. Thematic analysis was independently conducted by two researchers utilizing MAXQDA 24 software. Subsequently, the independently developed code trees were compared to establish the scaffold of the report. The synthesis of the two analyses' results was carried out during the report preparation stage. The report was then reviewed by the entire research team, followed by an asynchronous discussion on the conclusions. Based on this discussion, corrections were made to the report.

Data source triangulation was ensured through the use of structured autoethnographies conducted simultaneously by five researchers holding different roles in the project, second-person dialogic discussions during the project implementation, and continuous references to other scientific studies from the research design phase, through the self-interviews, to the report preparation. Additionally, to ensure high-quality data analysis, it was conducted independently by two researchers and subsequently verified by the entire team.

Limitations

Despite ensuring data triangulation and systematizing the autoethnography process, the generalizability of the conclusions in this article is limited by the exploratory and interpretative nature of the research and the study's scope, which

was confined to the organization of two related events. These conclusions pertain to the first-person experiences of five researchers situated in specific cultural, social, gender, and professional contexts. To mitigate this limitation, the report includes numerous references to studies conducted by other researchers. The cyclical feature of CAAE invites other researchers to examine the recommendations in different research contexts.

Our study focuses on the organization of national-scale events, which means some challenges related to the use of social VR for organizing international educational events may not have been identified. Additionally, certain formal challenges are specific to European Union member states and may differ in other parts of the world, or even within different institutional affiliations of events. The interviewers had other professional responsibilities, which affected the volume of the self-interviews across different weeks and among different individuals. To reduce the impact of this on the analysis results, an additional asynchronous discussion was conducted based on the report, where participants could supplement their perspectives.

Results

Becoming an Organizer of the *Wirtualium* Project

Our research team members played pivotal roles in the organization of the *Wirtualium 3.0* project, encompassing both organizational and substantive coordination (see Table 1). During the project's organizational process, we utilized telecommunication tools, including social VR platforms. We possessed extensive experience in organizing educational events. Members of our team had previously organized both in-person and online academic conferences. One of us had organized educational events within desktop virtual environments (Second Life), while the other had coordinated a discussion panel on a social VR platform (Big Screen). Our prior experiences, including those associated with organizing previous editions of *Wirtualium*, significantly influenced the organizational process of *Wirtualium 3.0*. These experiences aided us in planning and recognizing the differences in organizing and participating in educational events utilizing various organizational forms.

Motivations for Co-Creating the Project The primary source of motivation for organizing *Wirtualium* stemmed from our research interests in VR technology. We perceived the opportunity to co-create this project as a chance for both personal and social development. On a personal level, we recognized the potential to enhance our competencies in utilizing VR technology, expand our network of

contacts, and strengthen our academic identity. On a social level, we identified the event's transformative potential to improve communication quality and create a new space for interdisciplinary academic discourse on VR. Our desire to create the project was further influenced by its experimental nature. This experimental aspect was understood, on one hand, as an invitation for participants to engage in a personal experiment with social VR, and on the other, as an innovative attempt to adapt futuristic visions of VR technology into practical applications.

> "The opportunity to observe how technological concepts, which were previously the domain of futurists and science fiction literature, are becoming reality also compelled me to participate in the organization of *Wirtualium*" (Sylwia)

Recognizing the Potential of Social VR Platforms A crucial source of motivation for undertaking the organization of the *Wirtualium* project was our diverse reflections on both the potential of social VR platforms and the drawbacks of popular online communication tools, such as videoconferencing software. We perceived the greatest potential advantage of social VR platforms over video communicators in their ability to foster a sense of co-presence:

> "These types of meetings promote a feeling of 'community,' which can be particularly important for individuals who, for various reasons, cannot participate in academic life in the traditional manner." (Aleksandra)

> "Through the experience of embodiment and presence in a virtual space, participants can feel as though they are truly together with others, which enhances interaction." (Sylwia)

Similarly, Wei et al., (2024) highlights the stronger effect of social presence in social VR compared to video communicators. Co-presence mediated by avatars simultaneously allows to maintain the comfort of partial anonymity:

> "What I value most is that I can fully experience the conference (in the sense of feeling like I am together with other participants in one place) without the pressure to turn on my camera and sit 'on alert' – I feel that social VR can really facilitate the assimilation of educational content by alleviating some of this pressure." (Aleksandra)

Research by Barreda-Ángeles and Hartmann (2022) also suggests that avatars and nicknames can enhance the sense of anonymity, potentially increasing comfort and the willingness to interact with others.

In social VR, we can create virtual spaces tailored to the needs of our events, which are typically more cost-effective than renting physical venues. Moreover, we believe that social VR embodies the advantages characteristic of other forms of online events, such as the elimination of travel requirements, the associated reduction in carbon footprint, the lowering of participation costs, and increased accessibility for certain social groups (Bray et al., 2022; Niner & Wassermann, 2021). Recognizing the potential of social VR platforms, through introspective reference to our own experiences and knowledge, was an important source of motivation for organizing *Wirtualium*. However, the principal aim of this study is to identify the challenges inherent in the implementation of VR technology. Consequently, the following sections will predominantly concentrate on these challenges.

RQ1 & RQ2 | Limitations of Social VR Platforms in Organizing Educational Events

Comfort and Accessibility of HMDs A fundamental limitation and potential source of technological exclusion during events organized in social VR, in our view, is access to HMDs. The issue of technological exclusion related to access to VR technology in education has also been noted by Jensen and Konradsen (2018) and Alalwan et al., (2020). Within our research team, only two individuals had a consistent access to HMDs. However, this primarily represents a barrier to accessibility for event participants. Furthermore,

> "some social VR platforms are compatible only with specific HMDs (e.g., Spatial is compatible solely with Meta Quest 1, 2, 3, and Pro), which further reduces the accessibility of the event." (Jan)

The degree of this limitation may vary depending on the target audience. For instance, among individuals with an interest in VR, one might anticipate greater accessibility to HMDs. However, even within this demographic, studies have shown limited usage. Le et al. (2020) observed that only 19% of participants in the conferences they examined used HMDs, while Waligórski et al., (2023) reported a usage rate of merely 11.9% among their respondents.

A partial solution to this issue, which we implemented during *Wirtualium 3.0*, was the use of the Spatial platform, which is compatible with both HMDs and non-VR devices, such as smartphones and computers. We recommend this solution for another reason as well – using HMDs during multi-hour events can cause significant discomfort and fatigue (Moreira et al., 2022; Mulders & Zender, 2021). The ability to switch to a non-VR device can serve as a form of rest, as well as an alternative for those who either do not wish or are unable to use HMDs.

Sá et al., (2019) note that concentration problems are a major limitation of events conducted via video communicators. On the one hand, the immersiveness of HMDs reduces the influx of stimuli from the physical environment, which could address this issue (Wei et al., 2024). On the other hand, our experiences indicate that HMDs' immersiveness can become problematic in situations where multitasking is required. In our case, we observed that this presents a risk of excluding individuals who are unable to dedicate their full attention to the event's content, such as those with caregiving responsibilities. This feature of HMDs also creates difficulties in taking notes during events or using outlines during presentations (Waligórski et al., 2023).

We believe that using social VR platforms that support both VR and non-VR devices can reduce these barriers. However, we recognize that new problems may arise in communication between individuals using VR and non-VR devices. These issues begin with differences in platform interfaces. For example, VR users on the Spatial platform do not have access to text chat, which proved indispensable for desktop users in cases of microphone issues or reluctance to turn it on. Problems also arise directly in interactions:

> "I previously participated in a conference in VR. I noticed a significant difference between these situations [this year I used a PC]. It was difficult for me to fully engage, but the bigger problem was the sense of dissonance: I was aware that the keynote speaker of the session I was leading, who participated in the event in an HMD, perceived the event completely differently than I did. From his perspective, I was standing next to him, looking at him, sharing the space with him. Meanwhile, my perspective was entirely different: I viewed the situation as if 'from above.' I felt that there was something inauthentic about it, which hindered full communication." (Jowita)

In recent years, extensive research has been conducted on communication between users utilizing HMDs (Wei et al., 2024) and between users of desktop virtual worlds (Kim et al., 2012). However, the area of interaction between VR and non-VR users remains highly underexplored. Meanwhile, reflection on our organizational practices leads us to recommend implementing such solutions to enhance participant comfort and event accessibility. Further research employing alternative methodologies is essential in this area.

A Cascade of Issues Related to Technological Accessibility Our experiences, however, have demonstrated that the issue of accessibility in educational events conducted within social VR environments may, in practice, be considerably more extensive than initially anticipated, owing to a variety of latent factors. Internet-related problems arose consistently throughout *Wirtualium 3.0*. Reports of these issues came to us from both school teams and individual conference participants,

including those using VR and non-VR devices. These problems also directly affected us as organizers, despite numerous attempts to mitigate them:

> "Personally, as an active participant and panel moderator, I too experienced issues related to the Internet and microphone, despite prior tests and familiarity with the platform. (Sylwia). The poor quality of Wi-Fi in schools and public institutions complicates the use of HMDs in social VR – not to mention the lack of VR-dedicated routers." (Jan)

We used to understand VR as a technology that transcends geographical barriers in communication (Kenyon et al., 2023, Moreira et al., 2022). However, the process of organizing *Wirtualium 3.0* with a team whose members were located in different countries demonstrated that communication in social VR can also have limitations based on the user's location:

> "Until I traveled to China, I had not realized that there are regions where certain social VR platforms cannot be used. Previously, I believed that communication via VR was free of territorial restrictions. However, I discovered that there are technologically advanced places where using the platforms and Meta goggles we employ in online mode is impossible. Moreover, even the desktop version is difficult to use." (Jowita)

The creators of the Spatial platform recommend the use of high-specification equipment. However, during *Wirtualium 3.0*, we did not encounter significant problems in this regard, either from individual participants or school teams, who often lacked access to fully compliant devices. We are aware, though, that hardware requirements on some social VR platforms are significantly higher compared to video communicators.

> "In previous editions of the conference, I encountered technical issues related to the limited RAM of my computers. I frequently had to switch computers to connect to the platform, facing numerous input device problems, such as microphones, which greatly hindered my communication and the smooth conduct of the conference. It was only during the latest edition, when I used the newest, optimized version of the Spatial platform via a browser, that the platform did not strain most of the computers I used, which greatly facilitated the organization and flow of the event." (Sylwia)

When organizing educational events in social VR, attention must also be given to the accessibility of available HMDs and VR platforms for individuals with disabilities (Wei, et al.,2022; Maloney & Freeman 2020). The full VR experience excludes individuals with complete visual and hearing impairments, but also those

with partial sensory impairments (e.g., limited stereoscopic vision or auditory processing disorders). Interaction with VR platforms predominantly rely on finger, hand, arm, and head movements, or posture tracking, which can be a barrier for individuals with mobility impairments (Hamilton, 2018). Both hardware and social VR platforms rarely integrate assistive technologies such as text-to-speech readers or voice control and do not offer features like audio description. They also limit the comfort of using assistive devices, even those as common as corrective glasses. The insufficient development of hardware and VR platform accessibility can result in the exclusion of individuals with varying degrees of disabilities, which presents a challenge for organizers striving to maximize inclusivity in educational events. It is essential to recognize these barriers and mitigate them to the extent possible.

Limitations of Avatars Participants in *Wirtualium 3.0* could create personalized avatars using the Spatial avatar creator or the synchronized Ready Player Me extension, a cross-platform application for avatar creation in social VR. However, certain limitations of these tools raise our concerns regarding inclusivity. For instance,

> "Users are required to choose whether their avatar is male or female, which can be exclusionary for non-binary individuals." (Jan)

Additionally, these creators do not allow for avatars with visible disabilities or representing older individuals. The exclusion of these groups from virtual events poses a significant risk to their inclusivity.

Avatar-mediated communication can be unfamiliar and challenging for some participants.

> "Individuals who accidentally walk onto the stage may feel uncomfortable knowing their 'mistake' is visible to everyone". (Jan)

> "I'm not very skilled at navigating Spatial. This year, while moderating a presentation, I accidentally walked onto the stage after the speaker had already started. I was worried I might have distracted him and inadvertently interrupted the presentation." (Zosia)

Such situations can potentially hinder the focus on educational content.

Recent studies have explored the impact of avatar visibility on the sense of co-presence in virtual spaces (Freiwald et al., 2021; Heidicker, 2017). From an organizational perspective, however, we recognize an additional, underexplored aspect of this phenomenon. When fewer participants attend a social VR event than expected, the sense of emptiness or lack of presence can be more visible compared to videoconferencing. This might be linked to the feeling of spatial presence

without corresponding social presence and the visibility of unoccupied chairs and empty spaces. Further research is needed to address this gap.

Limited Number of Participants In familiarizing ourselves with the specific features of various social VR platforms, we noted significant limitations regarding the number of individuals who can simultaneously inhabit a single virtual world. On Spatial, a maximum of 50 users can occupy the same virtual space, a common constraint on other social VR platforms as well. Additionally,

> "our experience organizing the *Wirtualium* highlighted that events in social VR must cater to much smaller groups compared to those on videoconferencing platforms. This is not only due to platform limitations but also because organizers must provide more extensive support to participants. We could only accommodate 10 teams (3 persons each) for the planned scientific workshops, as inviting more participants could have jeopardized the workshops if numerous technical issues arose." (Jan)

Limitations of Educational Content In theory, using VR tools and social VR platforms should enrich the educational content. However, our experience has shown that social VR also poses significant risks to the quality of content. Many social VR platforms lack built-in tools for screen sharing, which are common in videoconferencing software. Often, these platforms require speakers to install additional software, complicating the process of sharing content. As a result, some speakers may opt not to share presentations during their talks.

This was one reason why we chose the Spatial platform, which features an intuitive interface for screen sharing. Presentations were displayed as a virtual screen on the auditorium stage. However, this functionality is available only to desktop users, and sharing presentations via HMDs is impossible. VR users must log in simultaneously from a desktop to share a presentation.

> "Some speakers encountered issues with playing multimedia content during their presentations – quality was reduced, and media playback was choppy." (Sylwia)

Studies highlight interactivity as a key advantage of VR in education (Hamilton et al., 2021). Unfortunately, a significant limitation of using interactive solutions in social VR is the restricted ability to integrate external sites and applications (e.g., for quizzes), especially since HMD users would not be able to access them. For example, during the conference, one keynote speaker wanted to conduct a poll, but Spatial lacked that capability. As a workaround, we set up three objects in the auditorium for participants to approach and indicate their choice.

The novelty effect associated with the innovative format of academic events in social VR might initially attract participants but could lead to a scenario where

they focus more on the impressive virtual environments than on the substantive content. We recognize the risk that after the initial excitement, participants might lose interest in the educational material. Most studies on the effectiveness of VR in education utilize short-term interventions (Hamilton et al., 2021), however, we emphasize the need to also conduct longitudinal studies to assess the long-term effectiveness of these tools.

RQ3 & RQ4 | Challenges Faced by the Organizers

The Sense of Responsibility and the Need to 'Defend' the Event's Format

The use of social VR for organizing educational events remains relatively uncommon, a factor that significantly influences the perception and reception of such events.

> "For many, social VR is not fully understood; despite its recognition as a 'modern' approach, some may view it as less scientific or more 'casual' compared to traditional, in-person academic events." (Aleksandra)

Consequently, during the organization of *Wirtualium 3.0*, we experienced additional pressure, both personal (a sense of responsibility for the event's success) and social (the perception of the conference by participants and the broader academic community). Organizing a conference in social VR required us to invest more effort and time to uphold impeccable academic standards, ensuring the event's scholarly rigor despite its unconventional format.

> "I feel a greater responsibility in organizing this conference due to its atypical format, as my team must 'prove' that this mode of organization is a viable choice. This pressure is absent in traditional solutions such as videoconferencing." (Jan)

Digital Competencies and Technological Stress

Preparing educational events in social VR demanded that we acquire the necessary digital competencies. We had to devote considerable time to mastering the use of the Spatial platform to ensure the smooth execution of *Wirtualium 3.0* and to provide technical support for participants. Despite our efforts, recurring issues with platform functionality, microphones, and internet connectivity became a continual source of stress, as was reported to us by the conference participants.

> "These technical difficulties posed significant limitations during the event, fostering feelings of anxiety and frustration over a lack of control or concerns about being perceived as unprofessional. […] I fear the

> possibility of technical issues, such as a presenter being unable to share their presentation." (Aleksandra)

Anxiety and fear related to the use and management of technological tools are often described within the framework of technological stress, or *technostress* – an adverse psychological reaction to the inability to adapt to technology (Tarafdar et al., 2015). In our experience, educational events in social VR may induce greater technological stress than videoconferencing tools, which we have generally become accustomed to.

> "Once this initial barrier is overcome, people tend to recognize the value of social VR events; however, I worry that many choose not to participate due to the technical challenges involved." (Jan)

Consequently,

> "organizing an educational event in social VR necessitates much more consideration of 'what could go wrong' and the preparation of numerous operational instructions." (Aleksandra)

On the one hand, learning to use social VR can be a challenge for participants, but on the other hand, we believe it also offers them valuable practical insights into these platforms. Unfortunately, social VR platforms are frequently updated or closed over the years. This requires participants to relearn their use, and we, as organizers, to prepare updated instructions, as has been the case annually with *Wirtualium*.

Before the conference and workshops, we decided to organize instructional meetings. These sessions allowed us to provide appropriate support tailored to the individual needs of participants, but they also required additional time from both the participants and us. As a result, we were unable to organize such meetings for all conference attendees, focusing instead on the presenters. Additionally, we provided instructions on the project's website.

> "While preparing these instructions, I realized that participants in educational events in social VR have vastly different needs. Some require only a few simple guidelines with links and key steps, preferring concise instructions. Others need a wealth of information, not only on the specific platform but on the entire system, such as how to use the scroll wheel to zoom out or how to navigate using an HMD." (Jan)

Unclear Formal Issues

The innovative nature of events in social VR introduces new formal challenges which we encountered during the organization of *Wirtualium*. Some universities are bound by agreements with specific videoconferencing platforms, often preventing the use of alternative platforms for hosting online events. Within the European Union, GDPR-related issues arise if the servers of social VR platforms, such as Spatial, are located outside its borders. The absence of established templates for regulations and procedures frequently compelled us to consult with legal advisors and data protection officers. The predominance of English-language terms of service across most platforms further complicates their accessibility for legal departments at Polish universities which require certified translations by sworn translators.

Additionally, the matter of obtaining necessary consents from the legal guardians of non-adults participating in educational events in social VR remains unclear. In the case of the Summer VR Academy, the required consents were collected by the school teachers; however, we did not provide standardized content, which may have created challenges for them. The formal challenges associated with using social VR platforms for educational events required extra effort on our part and added to the stress of making responsible decisions. This presents a significant barrier to the implementation of VR solutions in education, a topic that has yet to receive sufficient attention in academic literature.

Time-Consuming

The challenges inherent in the innovative nature of social VR platforms result in the organization of educational events within social VR being a process that demands significantly more effort and attention to detail compared to events utilizing videoconferencing tools.

> "This week, the conference organization increasingly encroached upon my personal life, due in part to the need for preparation (both in terms of equipment and mentally) for panel moderation. While the effort involved can be seen as an opportunity to hone organizational skills, it does not negate the fatigue it entails." (Sylwia)

A Happy Ending

Despite the challenges we faced during the organization of *Wirtualium 3.0*, we received feedback indicating a highly positive reception of this innovative project format. Participants frequently expressed their appreciation for the concept and execution of the event, acknowledging the efforts made to create a space conducive to discussion and networking.

> "Numerous positive accounts of the conference were shared on social media by both participants and the organizations that sponsored the event, as well as the university units involved in its organization." (Sylwia).

Sense of Development

The organization of *Wirtualium 3.0* significantly contributed to the enhancement of our competencies in project coordination and utilization of social VR. This process offered an opportunity for action-based reflection on the application of new technologies in education.

> "I improved my ability to address various technical and logistical issues. Each of these challenges contributed to my growth as an organizer and allowed me to better understand the needs of participants and the specificities of working in virtual educational environments." (Sylwia)

Sense of Social Purpose

We all felt that we were participating in a significant social and academic endeavor, with a strong sense of pioneering in this field. We believe that social VR platforms possess the potential to eliminate certain barriers to knowledge dissemination that are rooted in traditional social and academic hierarchies (e.g., through the use of pseudonyms in communication, regardless of academic titles) as well as physical barriers (e.g., geographical location). Despite the challenges and obstacles associated with utilizing social VR for conducting educational events, we perceive VR as having the potential to foster community building and enhance the engagement of individuals who, for various reasons, cannot participate in physical events. Also, Maloney and Freeman (2020) note that social VR enables meaningful interactions for individuals facing barriers in physical settings

Psychophysical Well-being of Organizers

The organization of the project had a significant impact on our psychophysical well-being. During the intense preparation period, we faced difficulties in balancing organizational tasks with numerous professional and personal responsibilities. These intense preparations were a source of considerable stress, mental fatigue, and anxiety.

> "I felt some anxiety about whether everything would go smoothly, particularly due to issues such as my unreliable internet connection. I was uncertain whether I would be able to assist the expert whose lecture I was moderating if technical issues arose" (Aleksandra)

Moreover, we experienced physical discomfort from a prolonged use of HMDs and desktop setups, such as eye strain, neck pain, and fatigue.

Sense of Support

Mutual support within the organizing group significantly impacted our work efficiency and sense of safety. A fundamental aspect of team support was effective communication, especially in crisis situations. Support and good organization are particularly important in an academic context, where individuals often struggle with an overload of responsibilities and difficulties in maintaining a work-life balance. This is especially crucial given the substantial demands associated with organizing educational events in social VR, which may be significantly more challenging to master due to their non-standard, novel character.

Development of Academic Identity

Involvement in the organization of *Wirtualium 3.0* had a positive impact on our academic identity and reputation. It allowed us to voice our perspectives in university media and establish new relationships with representatives of various academic institutions, which could foster the development of our academic careers. Although some individuals not involved with VR technology may not fully understand this form of event organization, its innovative nature and the help organizers craft an image as advanced and competent experts in new technologies. However, it is crucial to emphasize that this image must be grounded in genuinely possessed competencies.

Conclusions & Recommendations

Our autoethnographic study enabled a critical examination of the challenges educators encounter when utilizing VR technology to organize educational events. In this research, we identified significant limitations in the educational use of social VR platforms, aspects that remain underexplored in the existing literature. These limitations primarily involve the limited accessibility and comfort of HMD devices, the potential risk of reducing inclusivity of these events, and concerns regarding the quality of educational content. Our study emphasizes that the processes involved in implementing innovative VR technologies in education may lead to increased workload, a heightened sense of responsibility, and technological stress, which could negatively impact the well-being of organizers. However, organizing such events in social VR can also provide educators with a sense of personal growth and purpose. To address the challenges related to implementing social VR for

organizing educational events and to reduce the negative experiences of organizers, we present the following recommendations (RQ5 & RQ2):

1. *Utilizing Platforms that Support Both VR and Non-VR Devices.* Given the discomfort associated with prolonged HMD use and the limited accessibility and inclusivity of this technology, we recommend selecting social VR platforms for educational events that also allow connections from desktop and/or mobile devices (e.g., Spatial, Rec Room).
2. *Preparing Platform Usage Instructions.* We recommend providing instructions tailored to different levels of users' digital competencies and organizing instructional meetings to enhance comfort and reduce barriers to participation and providing a Code of Conduct to ensure appropriate behavior of participants. Preparing contingency plans and operational instructions for organizers/moderators in case of unforeseen issues is also advisable.
3. *Informing Participants of Event Barriers.* We suggest informing participants about potential barriers related to using social VR (e.g., hardware requirements, internet speed) so they can adequately prepare.
4. *Organizing Events for Smaller Groups.* When planning events, it is important to consider the user limits imposed by the chosen social VR platform (e.g., 50 users in Spatial).
5. *Enhancing the Scientific Image of Social VR Events.* We recommend maintaining a balance in media communication about the event between its educational and innovative nature.
6. *Mutual Support.* Ensuring internal team support is crucial for the effective organization of educational events in social VR, which involves increased effort and stress.
7. *Expanding the Team.* For events planned for larger audiences, we suggest engaging additional personnel to provide adequate technical support and reduce the stress associated with overburdening individual organizers.
8. *Integrating the Social VR Event Organizer Community.* Given the heavy workload of organizers, the need to expand teams, and for problem-solving support, we emphasize the importance of developing a community of social VR event organizers. To this end, we invite interested individuals to join our Discord server https://discord.gg/jeKmT4BM.

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Dźwiganie ciężaru innowacji w edukacji – stawanie się organizatorami wydarzeń edukacyjnych w społecznościowej wirtualnej rzeczywistości

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

Najnowsze badania laboratoryjne coraz częściej eksplorują zastosowanie technologii wirtualnej rzeczywistości (VR) w edukacji. Chociaż badania te potwierdzają potencjał narzędzi VR, często pomijają wyzwania, z jakimi mierzą się edukatorzy podczas ich wdrażania w rzeczywistych warunkach, co może ograniczać szersze zastosowanie VR. Nasze badanie wykorzystuje kolaboratywną analityczną autoetnografię pięciu organizatorów(-ek) wydarzeń edukacyjnych w społecznościowej VR, aby wypełnić tę lukę. Zidentyfikowaliśmy ograniczenia związane z wykorzystaniem społecznościowej VR, takie jak dyskomfort i niska dostępność urządzeń VR, nieinkluzywność funkcji platform, ryzyko obniżenia jakości treści edukacyjnych oraz konieczność zdobycia nowych umiejętności cyfrowych. Organizatorzy(-rki) doświadczali znacznej odpowiedzialności i stresu związanego z zarządzaniem kwestiami technicznymi i formalnymi, co wpływało na ich samopoczucie i zwiększało obciążenie pracą. Niemniej jednak zgłaszali również silne poczucie celowości i osobistego rozwoju, które wzmacniało ich tożsamość akademicką. Pomimo wyzwań związanych z organizacją wydarzeń w tym immersyjnym środowisku, organizatorzy(-rki) raportowali poczucie znaczącego rozwoju zawodowego. Ich zaangażowanie nie tylko zwiększyło ich umiejętności, ale także sprzyjało nawiązywaniu cennych współprac między instytucjami akademickimi, budowaniu społeczności oraz promowało inkluzywną edukację. Aby przezwyciężyć ograniczenia społecznej VR w szkolnictwie wyższym i złagodzić negatywne skutki dla organizatorów(-ek), autorzy(-rki) przedstawiają rekomendacje dla edukatorów(-ek).

S ł o w a k l u c z o w e: innowacje; autoetnografia; społecznościowa VR; rzeczywistość wirtualna; edukacja

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Cargando con el peso de la innovación en la educación: Convertirse en organizadores de eventos educativos en la realidad virtual social

Resumen

Recientes investigaciones en el laboratorio exploran cada vez más el uso de la tecnología de realidad virtual (VR) en la educación. Si bien estos estudios confirman el potencial de las herramientas de VR, a menudo pasan por alto los desafíos que enfrentan los educadores en la implementación en el mundo real, lo que podría dificultar la adopción más amplia de la VR. Nuestro estudio emplea una autoetnografía colaborativa y analítica de cinco organizadores de eventos educativos en VR social para abordar esta brecha. Identificamos limitaciones en el uso de la VR social relacionadas con el malestar y la baja accesibilidad de los cascos las gafas de realidad virtual, la falta de inclusividad de las plataformas, el riesgo de reducción en la calidad del contenido educativo y la necesidad de adquirir nuevas habilidades digitales. Los organizadores experimentaron una responsabilidad significativa y estrés al gestionar cuestiones técnicas y formales, lo que afectó su bienestar e incrementó su carga de trabajo. Sin embargo, también reportaron un fuerte sentido de propósito y desarrollo personal, que reforzó su identidad académica. A pesar de los desafíos de organizar eventos en este entorno inmersivo, los participantes experimentaron un crecimiento profesional significativo. Su participación no solo mejoró sus habilidades, sino que también fomentó valiosas colaboraciones entre instituciones académicas, fortaleció la comunidad y promovió la inclusión en la educación. Para abordar las limitaciones de la VR social en la educación superior y mitigar los impactos negativos en los organizadores, los autores ofrecen recomendaciones para los educadores.

Palabras clave: innovación; autoetnografía; VR social; realidad virtual; educación

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Ношение бремени инноваций в образовании: Становление организаторами образовательных событий в социальной виртуальной реальности

Аннотация

Недавние лабораторные исследования всё чаще изучают использование технологий виртуальной реальности (VR) в образовании. Хотя эти исследования подтверждают потенциал инструментов VR, они часто упускают из виду трудности, с которыми сталкиваются преподаватели при их внедрении в реальных условиях, что может препятствовать более широкому применению VR. Наше исследование использует коллаборативную и аналитическую автоэтнографию пяти организаторов образовательных мероприятий в социальной виртуальной реальности для устранения этого пробела. Мы выявили ограничения использования социальной VR, связанные с дискомфортом и низкой доступностью гарнитур, недостаточной инклюзивностью функций платформ, риском снижения качества образовательного контента и необходимостью освоения новых цифровых навыков. Организаторы столкнулись с высокой степенью ответственности и стрессом из-за необходимости управления техническими и формальными вопросами, что повлияло на их благополучие и увеличило рабочую нагрузку. Тем не менее, они также отмети-

ли сильное чувство цели и личного развития, что укрепило их академическую идентичность. Несмотря на сложности организации мероприятий в этой иммерсивной среде, участники испытали значительный профессиональный рост. Их участие не только улучшило их навыки, но также способствовало развитию ценных сотрудничеств между академическими учреждениями, укреплению сообщества и продвижению инклюзивности в образовании. Чтобы устранить ограничения социальной VR в высшем образовании и смягчить негативное воздействие на организаторов, авторы предоставляют рекомендации для педагогов.

К л ю ч е в ы е с л о в а: инновации; автоэтнография; социальная VR; виртуальная реальность; образование

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ChatGPT in Philology Education: A Pilot Study on AI-Supported Language Learning

Abstract

This pilot study investigates the use of ChatGPT by university students in the context of foreign language learning. Drawing on a mixed-methods approach, the research examines how English and Romance Philology students incorporate the AI tool into their academic routines, both within and beyond the classroom. Quantitative data collected *via* questionnaire reveal that students most frequently use ChatGPT in out-of-class contexts, particularly for writing, vocabulary development, and grammar correction. Statistical analysis shows a significant preference for autonomous use over classroom-based application. Qualitative responses further indicate that while students appreciate the tool's versatility and efficiency, they remain critically aware of its limitations, including occasional factual inaccuracies, mechanical style, and ethical concerns. The findings are interpreted through the lenses of Self-Directed Learning Theory, the Technology Acceptance Model, and Constructivist Learning Theory, suggesting that ChatGPT functions primarily as a complementary learning-support tool. The study concludes with pedagogical recommendations and proposes directions for future research, highlighting the need for AI literacy and teacher guidance in contemporary language education.

K e y w o r d s: ChatGPT, foreign language learning, AI in education, self-directed learning, technology acceptance, constructivism, university students

Introduction

In the era of rapid advancements in Artificial Intelligence (AI), ChatGPT (Chat Generative Pre-Trained Transformer) emerges as a pivotal tool that is reshaping educational practices, particularly in the context of language learning (Gałan, 2022). For students of foreign languages, ChatGPT serves not only as a source of information retrieval but also as a platform for generating ideas, correcting texts, enhancing vocabulary, and receiving on-demand feedback (Rudolph et al., 2023). Recent international research reflects a growing scholarly interest in ChatGPT's educational applications and implications. Systematic reviews in language education, and higher education more broadly, consistently report that ChatGPT supports personalized learning, adaptive feedback, and increased student engagement, with particularly strong evidence for writing-focused activities (Baig, 2024; Lee, 2022). However, these studies also note that its use in developing speaking, listening, and critical thinking skills remains underexplored. Research on student motivations and behavioral outcomes highlights both academic benefits and potential risks, including procrastination and reduced information retention. Concerns echoed in cognitive studies suggest that over-reliance on AI may impede long-term learning (MIT, 2024). Ethical and assessment-focused investigations (Abbas et al., 2024; University of Reading, 2024) reveal that AI-generated work can pass undetected in real-world grading scenarios, prompting calls for redesigned assessment strategies. Collectively, these findings position ChatGPT as both a valuable pedagogical aid and a disruptive force, emphasizing the importance of its critical, ethically informed integration into teaching and learning practices.

In addition to the international perspectives, recent Polish scholarship provides important national context for understanding AI integration in education. Tytko, Roszkowski, and Malucha (2023) explore the potential of ChatGPT in language education, detailing classroom applications such as generating gap-fill exercises, synonym and paraphrase prompts, and tailoring tasks to different proficiency levels. Their findings suggest that AI tools can support both routine practice and creative, learner-centred activities. Owoc, Sawicka, and Weichbroth (2021) examine AI adoption in higher education more broadly, outlining the technological, organizational, and pedagogical conditions necessary for effective implementation, as well as challenges related to infrastructure, training, and ethical use. Complementing these, Czerski (2023) provides a cautionary perspective, while acknowledging ChatGPT's potential as a teaching aid, and argues that unrestricted use without prior cultivation of critical thinking skills may be counterproductive, potentially undermining educational goals (Czerski 2023). Zaorski-Sikora (2023) adds a philosophical layer, emphasizing that technology should serve human values, and warning that AI – even when beneficial – poses ethical and identity challenges if not guided by principles of technological and environmental ethics. Together, these

studies show that the Polish higher education context is actively engaging with both the opportunities and limitations of AI-assisted learning. Incorporating these insights not only strengthens the theoretical and practical framing of the present study, but also situates its findings within ongoing national discussions on how to balance innovation, pedagogical quality, and academic integrity in an AI-enriched educational environment.

This pilot study explores the role of ChatGPT among English and Romance philology students at the University of Silesia in Katowice, Poland, with a focus on the tool's application both in and outside the classroom. Given the growing reliance on digital tools by Generation Z learners, students born between 1997 and 2012, understanding how AI integrates into their academic routines is critical for designing relevant, future-facing curricula.

The study is guided by three interrelated theoretical frameworks: Self-Directed Learning (SDL), Constructivist Learning Theory, and the Technology Acceptance Model (TAM). These perspectives provide a lens through which we analyze students' behaviours, motivations, and perceptions regarding the use of ChatGPT.

Theoretical Framework

ChatGPT in Foreign Language Learning

ChatGPT has garnered attention as a versatile tool in foreign language education due to its capacity to scaffold learners' writing, grammar practice, vocabulary development, and translation exercises. Several researchers have noted that the model can also support reading comprehension, summarization, and genre-specific composition (Srinivasa et al., 2022; Grobelna, 2023). In academic settings, it facilitates not only task completion but also the personalization of learning pathways and real-time feedback, both of which are highly valued by today's learners.

Self-Directed Learning (SDL) and the Technology Acceptance Model (TAM)

The present study draws on two complementary frameworks: Self-Directed Learning (SDL) and the Technology Acceptance Model (TAM), alongside Constructivist Learning Theory. SDL, as conceptualized by Knowles (1975) and Garrison (1997), emphasizes learner autonomy in identifying learning needs, setting goals, selecting strategies, and evaluating progress. In language learning, SDL aligns well with digital-native students who value flexibility and self-paced study. AI tools such as ChatGPT support SDL by providing on-demand feedback,

personalized explanations, and access to a wide range of language resources, enabling learners to take control of their own progress.

The Technology Acceptance Model (TAM) proposed by Davis (1989) offers a framework for understanding technology adoption through two primary constructs: perceived usefulness and perceived ease of use. In educational contexts, TAM helps explain why students choose to integrate tools like ChatGPT into their learning routines. When learners perceive the tool as effective in enhancing performance and easy to use, they are more likely to adopt it for regular use. This perspective is especially relevant for Generation Z students accustomed to seamless digital experiences. Together, SDL and TAM provide a coherent lens through which to analyze students' motivations, usage patterns, and perceptions of ChatGPT. While SDL focuses on the learner's agency in managing their learning, TAM addresses the practical conditions influencing technology adoption. These frameworks, combined with Constructivist Learning Theory described below, guide both the design and interpretation of the present study.

ChatGPT and Constructivist Learning

Constructivist Learning Theory posits that knowledge is actively constructed by learners through interaction with their environment rather than passively received from a teacher (Vygotsky, 1978; Jonassen, 1991). In the context of language learning, constructivism emphasizes meaningful engagement with linguistic input, problem-solving, and the co-construction of understanding through dialogue and feedback. Tools like ChatGPT can serve as digital scaffolds, enabling learners to experiment with language, test ideas, and receive instant clarification, thus facilitating the kind of interaction and reflection that constructivist pedagogy encourages. While lacking the social dimension of peer collaboration or teacher mediation, ChatGPT, nonetheless, supports individual cognitive construction by allowing students to manipulate language in real-time, explore alternatives, and refine their outputs. This makes it a potentially valuable supplement in constructivist learning environments, particularly in tasks involving writing, vocabulary expansion, and comprehension.

From a constructivist perspective, learning is an active process where learners build knowledge through experience, interaction, and feedback (Vygotsky, 1978; Jonassen, 1991). ChatGPT can serve as a digital mediator in this process, providing students with opportunities to test hypotheses, ask clarifying questions, and refine their understanding through conversational interaction. Particularly in writing and comprehension tasks, the tool mimics aspects of dialogic learning by scaffolding learners' efforts and extending their cognitive reach.

Research Aim and Questions

This pilot study investigates the extent to which English and Romance philology students use ChatGPT in their academic work, both during classroom activities and independently. Framed within the theories of SDL, constructivism, and TAM, the research aims to uncover patterns of AI adoption and perceptions of its educational value, thus informing broader pedagogical and institutional strategies. The primary aim was to determine whether English and Romance Philology students make use of ChatGPT in the context of their academic studies and, if so, how the tool supports their learning both **within the classroom** and **in independent, out-of-class contexts**. To address this aim, the following research questions were formulated:

1. Do English and Romance Philology students use ChatGPT as part of their university-level language studies?
2. Is the tool employed during classroom activities? If so, in which specific types of courses?
3. How frequently is ChatGPT used in the classroom context?
4. Do students also use ChatGPT outside formal classes? If so, what specific language-related activities does it support?
5. How do students evaluate ChatGPT's usefulness and relevance to their language learning?

Methodology: Research Design

This study employed a quantitative, survey-based research design aimed at gathering data on students' use of ChatGPT in the context of university-level foreign language education. Given the exploratory nature of the inquiry and its focus on behavioral patterns and user perceptions, a structured questionnaire was chosen as the primary research instrument. The questionnaire in focus was designed by the authors of the study and followed the principles of both validity and reliability. The former was ensured by including content directly related to the purpose of the study, while the latter was achieved through the composition of a vast majority of closed questions requiring clear-cut responses. The study followed a non-experimental, cross-sectional approach, with data collected at a single point in time to identify trends and associations among variables, such as frequency of use, learning context, and user evaluation.

Participants

The study sample consisted of 66 students enrolled in English and Romance Philology programmes at the University of Silesia in Katowice. As the study was of a pilot nature, the sample represented approximately 5% of the target population the authors intend to research in the future.

The participants represented three academic cohorts: second-year (n = 42), third-year (n = 7), and fifth-year (n = 17). The gender distribution was skewed towards female students (78.8%), reflecting the general demographic pattern of philological faculties. Most respondents (69.7%) were aged 19–22, with smaller representations from older age groups. Academic specializations included Linguistics (47.0%), TEFL Methodology (42.4%), and Literature (10.6%). The participants were recruited through convenience sampling. An invitation to take part in the study, containing a link to an online questionnaire created in Google Forms, was distributed *via* the official group email lists used by English and Romance Philology cohorts. Participation was entirely voluntary, and no incentives were offered. Respondents could access the questionnaire at their convenience and submit the answers anonymously. Informed consent to take part in the study and further process the data for the purposes of the research was obtained from each of the respondents digitally at the beginning of the questionnaire. No personal data were collected, and participants could withdraw at any point without consequence. The study followed institutional guidelines for research involving human subjects. In line with these, this type of research – consisting of voluntary participation in an anonymous online questionnaire and involving no collection of personal, sensitive, or health-related data – does not require formal approval from an institutional ethics committee. Ethical considerations were, nevertheless, observed throughout the study, including obtaining informed consent and ensuring participants' right to withdraw at any stage without consequence.

Instrument

The primary data collection tool was an online questionnaire created using Google Forms. It consisted of three sections:

1. **Demographic information** (e.g. age, gender, major, year of study).
2. **Closed-ended questions** focused on the frequency and context of ChatGPT use, divided into:
   - **In-class usage** (e.g. writing, reading, grammar, phonetics, translation).
   - **Outside-class usage** (e.g. homework support, test preparation, vocabulary development).

   Responses were collected on a binary scale (Yes/No) for frequency mapping.

3. **Open-ended questions** allowed participants to express opinions about the perceived benefits and limitations of ChatGPT.

The questionnaire was anonymous and all responses were collected between January–February 2025.

Data Analysis

Descriptive statistics were used to determine frequencies and percentages related to ChatGPT use across various instructional contexts. To explore associations between selected variables, such as gender, year of study, and course type, a series of chi-square tests of independence were conducted. These tests allowed for the identification of statistically significant differences in usage patterns among student subgroups. Qualitative responses from open-ended questions were analyzed thematically to capture common perceptions of the tool's usefulness and limitations.

Results

In-Class Usage of ChatGPT

Figure 1 provides an overview of ChatGPT usage across different types of university classes attended by the study participants. The data reflect how students have integrated the tool into various instructional settings, offering a general sense of which language-related activities are most and least supported by AI assistance.

As shown in Figure 1, the integration of ChatGPT within classroom settings varies significantly depending on the course type. The tool is most commonly used in writing (31.8%) and grammar (31.8%) classes, where students likely benefit from the model's capabilities in generating, correcting, or refining texts. Lower usage in listening (4.5%) and phonetics (9.1%) classes may reflect ChatGPT's limitations in audio or pronunciation-focused tasks. These patterns suggest that the chatbot's perceived usefulness (TAM) is tied to its text-processing strengths, and that it is adopted more readily in tasks compatible with constructivist knowledge-building through textual feedback.

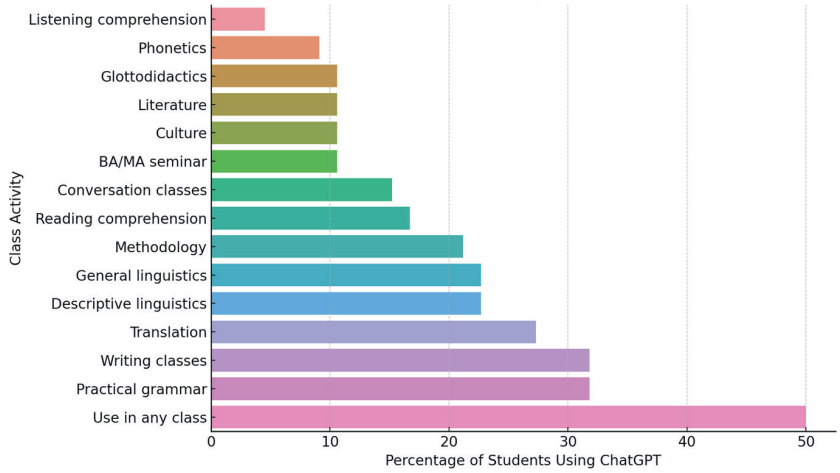

Figure 1. Percentage of Students Using ChatGPT During Specific Types of University Classes (Source: authors' own elaboration)

Out-of-Class Usage of ChatGPT

Figure 2 illustrates the range of academic activities for which students reported using ChatGPT outside the classroom. The data highlight patterns of self-directed engagement with the tool across different tasks, setting the stage for a more detailed analysis of learner preferences and usage habits beyond formal instruction.

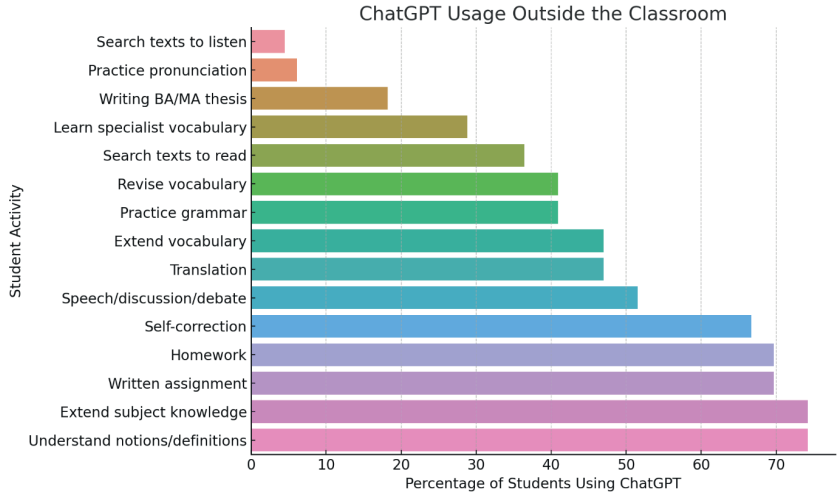

Figure 2. Percentage of Students Using ChatGPT for Academic Tasks Outside the Classroom

(S o u r ce: authors' own elaboration)

Figure 2 illustrates a broader and more intensive use of ChatGPT in independent study contexts. A majority of students reported using the tool for tasks such as completing homework (69.7%), clarifying academic concepts (74.2%), and preparing written assignments (69.7%). Notably, 66.7% used it for self-correction, underscoring ChatGPT's role in supporting Self-Directed Learning (SDL)**.** These findings highlight students' preference for AI assistance in personalized and autonomous study contexts, consistent with the SDL framework and the increasing acceptance of user-friendly technology (TAM) in informal learning settings.

Statistical Patterns in ChatGPT Usage

To supplement the descriptive findings, several chi-square tests of independence were conducted to explore whether ChatGPT usage differed significantly across various demographic and instructional contexts.

A chi-square test comparing ChatGPT usage for writing classes (in-class) versus homework support (outside-class) revealed a statistically significant result: $\chi^2(1) = 17.46$, $p < 0.001$. This indicates that students were significantly more likely to use ChatGPT for homework analysis than during in-class writing activities, underscoring the tool's role in supporting autonomous, self-directed learning.

Another test assessed whether gender was associated with in-class ChatGPT usage. The result was not statistically significant: $\chi^2(1) = 0.82$, $p = 0.366$. This suggests that male and female students were equally likely to adopt the tool for in-class tasks.

Chi-square analysis of ChatGPT usage by year of study also yielded no significant result: $\chi^2(2) = 2.47$, $p = 0.291$, which implies that usage patterns were relatively consistent across second-, third-, and fifth-year students, regardless of academic experience.

Finally, a comparison between ChatGPT usage in writing classes and reading comprehension sessions revealed a marginally non-significant difference: $\chi^2(1) = 3.34$, $p = 0.068$. Although not definitive, the result points towards a possible trend of higher engagement with ChatGPT in text-production activities compared to passive comprehension tasks.

These statistical findings strengthen the descriptive insights and confirm that ChatGPT is more heavily used in informal, self-regulated learning contexts than in classroom environments governed by instructor expectations or constraints.

Student Reflections on ChatGPT Usage

In addition to the quantitative data, open-ended responses provided by participants offer valuable insight into students' perceptions of ChatGPT. The responses to the open-ended questions were reviewed to identify recurring ideas and experiences related to ChatGPT use. Both authors read all the responses independently several times to ensure familiarity with the content and to note key points. Similar comments were then grouped into broader themes, including practical benefits, challenges and limitations, ethical concerns, and suggestions for responsible use. These themes were compared with patterns observed in the quantitative results to identify areas of convergence or divergence between the two data sources. Representative quotations were selected to illustrate the range of perspectives expressed by participants. These qualitative findings can serve as an illustration of both the strengths and limitations of the tool as experienced in everyday academic practice.

Positive Aspects

The students generally viewed ChatGPT as a highly versatile and time-saving resource that supports a wide range of academic and self-directed learning activities. Many respondents emphasized its usefulness in clarifying difficult concepts, organizing ideas, and accessing structured answers quickly, thereby eliminating the need for extensive manual research. The tool was frequently praised for its language-related assistance, particularly in correcting grammar and punctuation, suggesting synonyms, and improving vocabulary. It was also seen as beneficial for various writing tasks, including essays, translations, and summaries, and in more creative contexts such as debate preparation, lesson material development, or mock test construction.

The respondents also highlighted ChatGPT's value in simplifying complex topics and polishing written output, suggesting that it serves as a productive thinking partner. Notably, several respondents recognized its potential in promoting independent learning when used responsibly. While acknowledging the tool's benefits, some students cautioned against overreliance, emphasizing the importance of maintaining critical thinking skills and academic integrity:

COMMENT 1: "It helps me organize my thoughts and get started on assignments, but I always double-check what it says."

COMMENT 2: "It's great for brainstorming and language support, but you have to use your own brain too."

Negative Aspects

Despite the overall positive reception, students also expressed critical concerns regarding the tool's limitations. A number of respondents pointed out that ChatGPT sometimes generates inaccurate, outdated, or overly general information, particularly when dealing with specialized topics or when asked for academic references. The tool was also criticized for producing awkward or mechanical language, making it unreliable for crafting polished academic essays without substantial revision.

Some students reported that ChatGPT could present biased or superficial answers, often reflecting popular rather than scholarly content. Others noted that its effectiveness depends heavily on the quality of the prompt. Imprecise input could result in incoherent or irrelevant output. Specific issues were also mentioned regarding its performance in phonetics, creative writing, and the production of visual materials, where ChatGPT's capabilities remain limited.

Ethical concerns also surfaced, with some students warning that unchecked use of AI could undermine human creativity, learning motivation, and academic integrity. Several comments reflected anxiety over the possible negative impact of excessive reliance on AI tools, particularly among students less inclined to verify information or engage deeply with learning materials:

COMMENT 1: "Sometimes it gives me nonsensical information or fake sources. I wouldn't use it for serious academic work without checking everything."

COMMENT 2: "It's a helpful tool, but it's not a replacement for thinking or proper research."

These reflections underscore the need for critical engagement with AI-based tools in education. While ChatGPT offers tangible benefits in terms of accessibility, speed, and linguistic support, students also recognize the importance of human oversight, ethical responsibility, and ongoing skill development in its use.

Discussion

The results of this pilot study can be meaningfully interpreted through the three theoretical frameworks guiding the research**:** SDL**,** TAM**,** and Constructivist Learning Theory. This approach highlights how each framework contributes to understanding the observed patterns of ChatGPT use among philology students.

Self-Directed Learning (SDL)

The significantly higher use of ChatGPT outside the classroom ($\chi^2(1) = 17.46$, $p < 0.001$) reflects the central tenets of SDL, whereby learners independently determine when and how to engage with resources to meet their goals. Qualitative responses support this pattern, with students noting the tool's value for clarifying complex concepts, organizing ideas, and refining written work. Such activities indicate that ChatGPT is perceived as a flexible, learner-controlled support mechanism. Importantly, students' caution about overreliance demonstrates metacognitive awareness – a key component of SDL. These findings suggest that ChatGPT may foster autonomous learning when used alongside critical evaluation skills.

Technology Acceptance Model (TAM)

Patterns of adoption observed in this study are consistent with TAM's emphasis on perceived usefulness and ease of use. Students reported high satisfaction in areas where ChatGPT was seen as effective (e.g. essay writing, translation, vocabulary development), while its use was minimal in domains where it was perceived as less helpful (e.g. phonetics, oral practice). The absence of significant differences in usage by gender or year of study suggests broad acceptance across demographic groups. The intuitive interface and rapid feedback provided by ChatGPT likely contribute to its perceived ease of use, reinforcing its appeal for self-directed applications.

Constructivist Learning Theory

From a constructivist perspective, ChatGPT functions as a form of digital scaffolding, enabling learners to build knowledge through iterative interaction and reflection. The tool's ability to rephrase explanations, generate alternative formulations, and offer immediate textual feedback aligns with constructivist principles of active knowledge construction. However, the lack of social and embodied interaction – critical in communicative competence – remains a limitation. This underscores the need to integrate ChatGPT with peer collaboration and instructor-led activities for a balanced constructivist approach.

Summary

Taken together, the three frameworks provide a coherent explanation for the study's findings. SDL captures the strong preference for autonomous use, TAM explains the selective adoption patterns, and constructivism highlights the cognitive processes facilitated by ChatGPT. This integrated theoretical interpretation supports the view that AI tools, when critically and strategically employed, can enhance language learning by complementing rather than replacing traditional pedagogical methods.

At the same time, the critical reflections voiced by students point to growing awareness of the ethical and intellectual implications of AI in education. Concerns about misinformation, lack of source credibility, and the dangers of passive reliance reflect a maturing attitude towards digital tools – one that values their benefits but also recognizes the importance of human oversight, critical thinking, and academic integrity. These insights suggest that students are ready to engage with AI in a more structured and pedagogically informed way, provided that appropriate guidance is available.

Taken together, the findings call for a re-evaluation of language teaching practices. Rather than banning or ignoring tools like ChatGPT, educators should help students use them responsibly and strategically. This includes explicit instruction on the design of prompts, source verification, and the appropriate integration of AI outputs into original academic work. Curricula should begin to incorporate AI literacy as a necessary component of digital-era education, particularly in the development of writing, reading, and language analysis skills. Teacher training programs must also be updated to include practical and ethical dimensions of AI-enhanced learning.

In sum, the findings of this study indicate that ChatGPT is already reshaping how students engage with language learning – most effectively when it supports autonomy, productivity, and reflection. However, its educational potential will only be fully realized if it is embedded within a thoughtful, theory-informed, and ethically grounded pedagogical framework.

Conclusions and Implications

This study explored the emerging role of ChatGPT in university-level foreign language education, revealing that philology students primarily use the tool to support autonomous, writing-focused learning outside the classroom. While these patterns confirm predictions derived from Self-Directed Learning (SDL), the

Technology Acceptance Model (TAM), and Constructivist Learning Theory, the originality of this work lies in moving beyond a functional account of AI use to document students' critical engagement with the tool.

Participants demonstrated not only an ability to exploit ChatGPT for practical academic tasks, but also nuanced awareness of its ethical limitations**,** cognitive risks, and potential threats to academic integrity**.** Concerns about misinformation, overreliance, and the erosion of independent thinking reveal that students are actively negotiating the boundaries between technological assistance and responsible scholarship.

Theoretically, these findings extend the application of SDL, TAM, and constructivism into the AI-assisted learning domain, illustrating how these frameworks can account for both adoption patterns and reflective resistance to uncritical use. Practically, they underscore the need for explicit AI literacy training in higher education – addressing not only prompt design and source verification, but also the cultivation of ethical reasoning and self-regulation in digital learning environments.

While this study provides meaningful insights, it is exploratory in nature and subject to certain limitations. The sample size was relatively small and confined to one academic institution, limiting generalizability. Moreover, the data reflect a single point in time and do not capture longer-term patterns of AI adoption or its direct effects on learning outcomes.

Further research is, therefore, needed to build on these findings. Larger, longitudinal studies could investigate how sustained use of ChatGPT influences language development, academic performance, and learner autonomy over time. Comparative research across faculties, institutions, or national contexts could offer a broader understanding of how AI tools are being integrated into different educational environments. Additionally, future studies should incorporate instructor perspectives, as teachers play a key role in shaping students' awareness, attitudes, and ethical engagement with emerging technologies. Finally, mixed-method research combining performance-based measures with learner narratives would offer a more holistic view of how ChatGPT affects the learning process.

In conclusion, this study indicates that ChatGPT is already playing an active role in how students approach foreign language learning. Its impact will likely continue to grow, making it essential for educators, researchers, and institutions to engage critically, constructively, and proactively with the opportunities and challenges it presents.

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Aleksandra Kalaga, Marzena Wysocka-Narewska

Badanie wykorzystania ChatGPT wśród studentów filologii: Badanie pilotażowe cyfrowych praktyk edukacyjnych w szkolnictwie wyższym

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

Niniejsze badanie pilotażowe bada wykorzystanie narzędzia ChatGPT przez studentów uczelni wyższej w kontekście nauki języków obcych. Opierając się na podejściu mieszanym, badanie analizuje w jaki sposób studenci filologii angielskiej i romańskiej włączają narzędzie AI do swoich rutynowych zajęć akademickich zarówno w klasie, jak i poza nią. Dane ilościowe zebrane za pomocą kwestionariusza ujawniają, że studenci najczęściej używają aplikacji ChatGPT poza zajęciami, w szczególności do pisania, rozwijania znajomości słownictwa i poprawiania gramatyki. Analiza statystyczna pokazuje znaczącą preferencję dla autonomicznego korzystania z aplikacji w porównaniu z ich użyciem w klasie. Odpowiedzi jakościowe wskazują ponadto, że choć studenci doceniają wszechstronność i wydajność narzędzia, pozostają krytycznie świadomi jego ograniczeń, w tym sporadycznych nieścisłości faktograficznych, mechanicznego stylu i kwestii etycznych. Wyniki są interpretowane przez pryzmat teorii samokształcenia, modelu akceptacji technologii i konstruktywistycznej teorii uczenia się, co sugeruje, że ChatGPT funkcjonuje przede wszystkim jako uzupełniające narzędzie wspierające naukę. Badanie kończy się zaleceniami pedagogicznymi i proponuje kierunki przyszłych badań, podkreślając potrzebę znajomości sztucznej inteligencji i poradnictwa dla nauczycieli we współczesnej edukacji językowej.

S ł o w a k l u c z o w e: ChatGPT, nauka języków obcych, AI w edukacji, samodzielne uczenie się, akceptacja technologii, konstruktywizm, studenci uniwersytetu

ChatGPT in Philology Education: A Pilot Study on AI-Supported Language Learning

Aleksandra Kalaga, Marzena Wysocka-Narewska

Exploración del uso de ChatGPT entre estudiantes de filología: Un estudio piloto de las prácticas de aprendizaje digital en la educación superior

Resumen

Este estudio piloto investiga el uso de ChatGPT por estudiantes universitarios en el contexto del aprendizaje de lenguas extranjeras. Basándose en un enfoque de métodos mixtos, la investigación examina cómo los estudiantes de Filología Inglesa y Románica incorporan la herramienta de IA en sus rutinas académicas, tanto dentro como fuera del aula. Los datos cuantitativos recogidos a través de un cuestionario revelan que los estudiantes utilizan ChatGPT con mayor frecuencia en contextos fuera del aula, en particular para la escritura, el desarrollo del vocabulario y la corrección gramatical. El análisis estadístico muestra una preferencia significativa por el uso autónomo frente a la aplicación en el aula. Las respuestas cualitativas indican además que, aunque los estudiantes aprecian la versatilidad y eficacia de la herramienta, siguen siendo conscientes de sus limitaciones, como las inexactitudes ocasionales, el estilo mecánico y los problemas éticos. Los resultados se interpretan a través de la teoría del aprendizaje autodirigido, el modelo de aceptación de la tecnología y la teoría constructivista del aprendizaje, lo que sugiere que ChatGPT funciona principalmente como una herramienta complementaria de apoyo al aprendizaje. El estudio concluye con recomendaciones pedagógicas y propone orientaciones para futuras investigaciones, destacando la necesidad de la alfabetización en IA y la orientación del profesorado en la enseñanza contemporánea de idiomas.

Palabras clave: ChatGPT, aprendizaje de lenguas extranjeras, IA en educación, aprendizaje autodirigido, aceptación de la tecnología, constructivismo, estudiantes universitarios

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Изучение использования ChatGPT среди студентов-филологов: Пилотное исследование практики цифрового обучения в высшем образовании

Аннотация

В этом экспериментальном исследовании изучается использование ChatGPT студентами университета в контексте изучения иностранных языков. Опираясь на смешанный метод, исследование изучает, как студенты факультетов английской и романской филологии используют инструмент искусственного интеллекта в своей учебной деятельности, как в аудитории, так и за ее пределами. Количественные данные, собранные с помощью анкеты, показывают, что студенты чаще всего используют ChatGPT во внеаудиторное время, в частности для написания текстов, расширения словарного запаса и коррекции грамматики. Статистический анализ показывает значительное предпочтение автономного использования по сравнению с применением в классе. Качественные ответы показывают, что, хотя студенты ценят универсальность и эффективность инструмента, они критически относятся к его недостаткам, включая случайные фактические неточности, механический стиль и этические проблемы. Полученные результаты интерпретируются через призму теории самонаправленного обучения, модели принятия технологий и конструктивистской теории обучения, что позволяет предположить, что ChatGPT функционирует в основном как дополнительный инструмент поддержки обучения. В заключение

исследования даются педагогические рекомендации и предлагаются направления будущих исследований, подчеркивающие необходимость грамотного использования ИИ и руководства преподавателей в современном языковом образовании.

К л ю ч е в ы е с л о в а: ChatGPT, изучение иностранных языков, ИИ в образовании, самонаправленное обучение, принятие технологий, конструктивизм, студенты университета

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Attitudes of Czech and Polish Teachers Towards the Use of Artificial Intelligence in Schools

Abstract

The aim of the research study was to examine the subjective feelings of Polish and Czech teachers regarding the introduction of artificial intelligence in school. The partial goal of the research study was to find out whether there is a difference between the views of Czech and Polish teachers on the introduction of the use of artificial intelligence in schools.

To achieve the research goal, we decided to use a qualitative research. The semi-structured interview method was used with Czech and Polish primary and secondary school teachers.

As part of the research, it was found that Czech teachers fear the advent of artificial intelligence and its use in education, especially that students will "abuse" AI to cheat and plagiarize. This phenomenon was not detected among Polish teachers. They rather perceived artificial intelligence as a help for teachers; respondents from the ranks of Polish teachers already had their first experience with the use of artificial intelligence. Among Czech teachers, there are also those who work with chatbots and perceive them as a tool that helps them reduce their workload and make their work more efficient. Most Czech teachers see the introduction of artificial intelligence in schools as inevitable and realize that their task is to teach pupils to use AI effectively. Also, Polish teachers believe that with the advent of artificial intelligence, the role of the teacher is changing; the teacher

is expected to be a guide for the student to learn about the effective use of artificial intelligence. Teachers, both Czech and Polish, are also aware that the teaching system will also have to change with the arrival of AI in schools. Pupils will need to be assigned different types of tasks than before, i.e., ones that AI will not create for them.

K e y w o r d s: artificial intelligence, chatbot, schools, teachers, readiness, Poland, the Czech Republic

Introduction

Artificial intelligence is gradually entering our lives, including school. Nowadays, many people use AI for various activities such as translations, calculations, information generation, image generation, etc. Artificial intelligence checks spelling and grammar for us when writing texts. Although artificial intelligence can be an excellent teacher's helper, its use also brings about many problems (generation of erroneous information, plagiarism). Therefore, it is necessary to keep in mind not only the possibilities of artificial intelligence, but also its limits.

Since we are aware that the given topic is current and has not yet been sufficiently explored, especially in the area of Czech and Polish schools, we decided to carry out a research focusing on the attitude of Czech and Polish teachers towards artificial intelligence.

The presented research study focuses on the examination of the introduction of artificial intelligence in Czech and Polish schools, the readiness of Polish and Czech teachers to use artificial intelligence in schools. The aim of the research study was to examine the subjective feelings of Polish and Czech teachers regarding the introduction of artificial intelligence in school. The partial goal of the research study was to find out whether there is a difference between the views of Czech and Polish teachers on the emergence of artificial intelligence and its use in education. To achieve the research goal and answer the research questions, we decided to use a qualitative research, and the semi-structured interview method was used with Czech and Polish primary and secondary school teachers.

We assume that this research can show whether and, if so, how teachers use AI tools in teaching. We assume that we will reveal teachers' concerns regarding the introduction of AI into the education sphere. We assume that we will find out what problems teachers may face when using AI in teaching. We also assume that we will find out whether AI helped them to enrich or improve the quality of teaching.

In the research, we focused mainly on Czech and Polish teachers, not only because the attitude of Polish and Czech teachers towards artificial intelligence

is not sufficiently researched, but also because, in connection with the use of AI in society, the Czech Republic and the Polish Republic are among the countries that use artificial intelligence the least compared to other European countries ((Evropský účetní dvůr, 2024).

1. Artificial Intelligence

Artificial intelligence (AI) focuses on creating computer systems that teach, analyze, create various texts, generate information, evaluate data, and provide solutions to various problems (Kaplan, 2019). Artificial intelligence is able to answer questions and even hold a conversation with users (Vanian, Leswig, 2023). Although these systems are capable of simulating human intelligence and, in addition, they are more accurate and faster when making decisions than humans (Cejnarová, 2018), we must always remember that it is a robot, therefore texts generated by artificial intelligence lack human creativity, and in addition, information generated by artificial intelligence may not always be true (Tłuczek, 2023). Artificial intelligence does not think like a human, it only follows our instructions (Gerrish, 2020) and answers our questions based on available data (Afzaal, Nouri, Zia, Pappetrou, Wu, Li, Weegar, 2021). Moreover, the more relevant data the artificial intelligence has, the more accurate the results of its work or the answers to our questions will be (Spector, Ma, 2019). The accuracy of the generated results and answers also depends on the quality of the so-called text prompts, that is, the commands or instructions that we enter. The more precisely the prompts are formulated, the better the answers of the artificial intelligence appear. (Adams, Pente, Lemermeyer, Rockwell, 2021).

2. Use of Artificial Intelligence in Education

In the field of education, we are experiencing rapid changes thanks to the constant development of modern technologies. One of the key innovative modern technologies that are transforming the world's education systems is the use of artificial intelligence.

The breakthrough came mainly with the advent of artificial intelligence tools such as ChatGPT and Microsoft Bing, which, like other artificial intelligence tools, can be valuable helpers in the education process. Artificial intelligence enables the generation of text, audio, visual or audiovisual materials for teaching (Tapalova,

Zhiyenbava, 2022, Pokrivčáková, 2019). Artificial intelligence is able to stand in for the teacher in the evaluation of student work using automatic task evaluation and can thus provide immediate feedback to students, which enables faster identification of problems and provision of help when needed (Link, Koltovskaia, 2023). AI can also effectively represent the teacher when creating tests (Tapalova, Zhiyenbava, 2022), learning tasks (Chembe, Nasilele, Msendo, 2023), which are also "tailored to a specific student, their abilities and needs (Chen, li, Ding, Liu, 2021). Artificial intelligence converts text into spoken word (Southgate, Blackmore, Pieschl, Grimes, Guire, Smithers, 2019). AI is also capable of editing texts, correcting grammatical and stylistic errors in them. There are various models and tools based on artificial intelligence that are capable of editing and proofreading texts. AI models such as language correctors are designed to identify and correct errors in text, some AI tools not only correct errors such as bad word order or grammatical errors, but also suggest stylistic adjustments to the text. (Link, Koltovskaia, 2023). Artificial intelligence has long been used to translate texts (Čeňková, 2021, Du Sautoy, 2020). Artificial intelligence can be used to train conversational skills in different languages, develop the ability to argue. For these purposes, chatbots can simulate a real conversation, virtual assistants can help people develop the ability to argue as they provide feedback regarding the arguments of users and help them filter the logic, comprehensibility and validity of their arguments, or online platforms and applications, which use artificial intelligence to train argumentative skills. Artificial intelligence can also be used to create a simulated debate environment that provides feedback and helps develop users' argumentation skills through scenarios, questions, or artificially created situations in which users can practice their argumentation skills (Huang, Saleh, Liu, 2021). Artificial intelligence tools can thus become invaluable conversational partners, especially in the field of English teaching, because they are available at any time and, moreover, they help to eliminate the mental block from conversation in a foreign language, which is associated with the fact that we are afraid of what we will do when speaking in a foreign language a mistake in public or that we will not be able to find the right words.

With the help of AI, we can also make distance learning more efficient, as it is an excellent helper in supporting personalized learning that adapts to the individual needs and learning styles of students. Adaptive learning systems can provide materials and learning tasks appropriate to the level and pace of individual students. Based on data analysis, artificial intelligence then suggests personalized study plans to specific students (Chen, Li, Ding, Liu, 2021)

Although AI has many positives, we must not forget the risks associated with its use. AI is not always perfectly trained and can generate false information on different topics (Hlosta, Herodotou, Bayer, Fernandez, 2021) so it can be abused to generate disinformation content. Additionally, generative models such as GPT are capable of producing persuasive, authentic-feeling text (Al-tkhayneh, Alghazo,

Tahat, 2023, Khan, Fatima, Qureshi, Kumar, Hanan, Hussain, Abdullah, 2023). It can be easily exploited to create plagiarism that is hard to detect (Khan, Fatima, Qureshi, Kumar, Hanan, Hussain, Abdullah, 2023). The problem of using artificial intelligence to create plagiarism, which brings ethical and legal consequences, arose mainly with the advent of the generative language model ChatGPT, which can produce essays, homework, seminar or qualification papers (Bédi, Chiera, Chua, Cucchiarini, Ni Chiaráin, Rayner, Simonsen, Zviel-Girshin, C-Lara, 2023).

Artificial intelligence and its tools are constantly evolving, and new models are even more accurate, more powerful, and their outputs are of higher quality (Khan, Fatima, Qureshi, Kumar, Hanan, Hussain, Abdullah, 2023)

2.1. The onset of the Use of Artificial Intelligence in Schools in the Czech Republic

Czech teachers are currently gradually getting used to the advent of artificial intelligence, which is also penetrating the field of education and training. According to research by the Pedagogical Faculty of the Palacký University in Olomouc, 27.7% of Czech teachers use chatbots in preparation for teaching, 15.82% in teaching. As part of this research, it was found that most Czech teachers are convinced that artificial intelligence belongs in today's schools, 45.5% of Czech teachers are convinced of the positive contribution of artificial intelligence in the field of education. For that reason, 81.7% of teachers are aware that teachers must learn to work with artificial intelligence. Many teachers also perceive the risks associated with the use of artificial intelligence, especially chatbots. Almost half of the teachers (47.6%) are convinced that chatbots serve pupils to cheat, while 34% of Czech teachers have already discovered several pupils who misused ChatGPT to cheat – they had a report or other type of text homework generated for them (Kopecký, Szotkowski, Voráč, Krejčí, Dobešová, 2023).

And although the use of the term artificial intelligence dates back to 1956, when it was first used by the American computer scientist John McCarthy at a conference in Dartmouth (Kurp, 2023), it was only with the discovery of chatbots that Czech education began to be more concerned with these tools, to fear these tools and eagerly began to discuss the subject. The topic of artificial intelligence is also addressed by the Ministry of Education, Culture and Science, which is preparing to present a plan to support the use of artificial intelligence in education (so far, only a working version exists). The National Pedagogical Institute also offers teachers online webinars and face-to-face seminars dedicated to artificial intelligence tools and the issue of introducing artificial intelligence into schools. In the spring of 2023, a working group was established within the NPI CR, which published recommendations for schools on how to work with AI in order to prevent its unethical use (NPI, online).

The use of artificial intelligence in education is also dealt with by the European Commission, which in 2022 issued the document Ethical guidelines for the use of artificial intelligence within the European Union, which is the result of activities implemented as part of the Action Plan for Digital Education (2021–2027). This document contains guiding questions that teachers should ask themselves in connection with the use of AI, as they provide orientation and stimulate educators to think (European Commission, 2022).

The government of the Czech Republic also addresses the issue of artificial intelligence in the document National Strategy of Artificial Intelligence in the Czech Republic, in which it discusses the impact of AI on the labor market as well as legal, ethical and social aspects of the use of AI (Ministry of Industry and Trade, 2019).

2.2. The onset of the Use of Artificial Intelligence in Schools in Poland

Also in Poland, artificial intelligence is a topic that interests many teachers. They perceive its enormous potential, which, in their opinion, will certainly transform the Polish education system, but also the professional training of teachers and other professions. However, Polish teachers are aware that the use of artificial intelligence poses a risk to the privacy and safety of students and teachers (PARP, online). Therefore, it is important to protect the privacy and safety of teachers and students. It is for this reason that Polish education in the field of artificial intelligence is governed by the Ethical Guidelines for the Use of Artificial Intelligence within the European Union (European Commission, 2022).

In October 2023, a research study dealing with the topic of using artificial intelligence in Polish education was published. It was found that teachers currently use ChatGPT more often than students, with research showing that 51% of teachers and 40% of students use ChatGPT at least once a week in their work. The use of chatbots in teaching is also supported by the teachers themselves. As part of the research, it was found that 38% of teachers lead their students to use chatbots effectively. Both teachers (72%) and students (63%) are aware that the advent of chatbots leads to inevitable changes in the traditional concept of education. Both teachers and students are convinced that a chatbot can make the education process more efficient (PARP, online)

3. How do Czech and Polish Primary and Secondary School Teachers Perceive the Introduction of Artificial Intelligence in Schools? – the Methods of the Research Investigation

To find out how Czech and Polish school teachers perceive the introduction of artificial intelligence in schools, we decided to use a qualitative research to examine the subjective feelings of teachers regarding the introduction of artificial intelligence in schools.

The partial goal of the research study was to find out whether there is a difference between the views of Czech and Polish teachers on the onset of the use of artificial intelligence in schools.

The following research questions follow from the research objective:

RQ1 – Are Czech/Polish teachers concerned about the introduction of artificial intelligence into schools?

RQ2 – Do Czech/Polish teachers see artificial intelligence as a tool that will help them?

RQ3 – Do Czech/Polish teachers have experience with the use of artificial intelligence? What experience do Czech/Polish teachers have with artificial intelligence?

To achieve the research goal and answer the research questions, a qualitative method, a method of semi-structured interviews with primary and secondary school teachers, was used.

The research sample consisted of 20 Czech and 20 Polish teachers between the ages of 25 and 48. The first contact with the respondents took place by e-mail, with the help of which they were informed about the purpose of the research investigation and the topic of the interview, and later the date of the meeting itself was arranged. At the beginning of the meeting, the respondents were introduced to the research in more detail, the preservation of anonymity and consent regarding the recording and subsequent processing of the interview for the purposes of the research investigation were agreed upon. The interviews were recorded on a mobile phone and lasted about 15–40 minutes each. When collecting and clarifying data, we also used online interviews through electronic means of communication in some cases. All data were digitized so that they could be archived on a computer and continuously analyzed using the ATLAS/ti computer program.

3.1. Analysis of Qualitative Data

The methods used were based on open coding. The goal of open coding was the thematic disclosure of the analyzed text. The analyzed interviews were thus divided into units, meaning words, sentences or paragraphs determined according to meaning, the unit thus became a meaningful unit. A code has been assigned

to the specified unit. The code was named according to what the given sequence discusses, what phenomenon or theme it represents. Both technical terms and in vivo codes were used to indicate the codes. After the code hierarchy is created, the codes are categorized. Categorization is the process of grouping concepts that seem relevant to the same phenomenon (Strauss, Corbinová, 1999).

Using categorization, we identified five categories during the analysis of semi-structured interviews with Czech teachers:

- fear of cheating and plagiarism
- concerns that the use of artificial intelligence will suppress the "natural intelligence of students"
- fear of own unpreparedness for the advent of chatbots
- acceptance of artificial intelligence as a necessity
- artificial intelligence as help

As part of the analysis of semi-structured interviews with Polish teachers, four categories were identified:

- teachers believe that they are poorly informed about artificial intelligence
- artificial intelligence as an aid to teachers
- artificial intelligence will completely change the entire education system
- artificial intelligence has its limits

We have described and clarified the individual categories on specific cases.

4. How do Czech Primary and Secondary School Teachers Perceive the Introduction of Artificial Intelligence in Schools? – the Results of the Research Investigation

4.1. Fear of Cheating and Plagiarism

Some teachers fear that students will abuse AI tools to cheat and plagiarize.

"An artificial intelligence is associated with the risk of plagiarism and cheating of varying intensity." (respondent 7)

"I already have experience with this kind of cheating as an English teacher. The student handed in the work to me, a literal copy-paste work, which was obviously created for them by a chatbot. The text was perfect, I had no evidence of fraud, because the plagiarism created by the chatbot cannot be easily proven." (respondent 1)

Cheating, when a chatbot creates work for the student, is also associated with problems of how to evaluate this work. And there is also a problem in how to prove to the student that it is plagiarism, a fraud, because works created by a chatbot

can be more difficult to detect as plagiarism. This is because chatbots are able to generate content that is not a copy of an already existing text, i.e., the text created by a chatbot can be an original text, usually a compilation of several texts.

"An artificial intelligence will help the student with the perfect processing of homework, show him the way how not to study and copy homework or other written work anywhere and at any time." (respondent 9)

"It can write a paper, a seminar paper and a thesis. It can speak Czech and English. It's grease. There are even AIs that have figured out how to write something so that other AIs don't recognize that it was written by an AI." (respondent 20)

In connection with these skills that AI possesses, the respondents are afraid of using AI in education.

"And we have a problem. How to evaluate work that is obviously written by a chatbot? ... Yes, I tried face-to-face interviews with students about their work. It won't get you anywhere. If you get stuck on the argument: but I really wrote it myself, you have no chance to prove anything." (respondent 1)

"Artificial intelligence is very good at plagiarism. Basically, it is impossible to detect whether the text was written by artificial intelligence or not." (respondent 14)

One of the respondents also described a situation where they discovered that pupils had used artificial intelligence to complete their homework.

"My students had the task of making a presentation. However, I found their presentation strange. Then they explained to me that they created it an hour ago in tom.app. You enter a topic and artificial intelligence creates a presentation for you. They finally showed me how they did it. I couldn't help but wonder. I think this is another challenge for our education system." (respondent 14)

4.2. Concerns that the use of Artificial Intelligence will "Suppress the Natural Intelligence of Students"

In our interviews with teachers, we also come across views that the use of AI may eventually "suppress the natural intelligence of students." In particular, teachers are concerned that students will over-rely on AI, leading to their dependence on technology at every turn of their independent work.

"An artificial intelligence is actually always dangerous in the process of education. It does everything for the pupil, he doesn't teach them the necessary skills, the pupils simply don't have to think." (respondent 10)

Teachers fear that dependence on technology will lead to the suppression of the development of students' own thought processes, to the suppression of the development of knowledge and skills, to the suppression of creativity or independence. If students rely too much on artificial intelligence for each independent work, it will lead to insufficiently developed critical thinking in these students.

“For many morally weaker children, there will probably never be a reason not to use AI for everything, anything, when it’s a thousand times easier. These children may never write a style paper, any independent text. They also leave the calculation of math examples to some app… If they let artificial intelligence do everything for them, they will be completely lost without it at the end of their studies” (respondent 3)

„The problem is that if the students use it and it will write phrases and various elaborations for them, they will not be able to think and create meaningful sentences and ideas on their own.” (respondent 2)

„Thanks to the use of chatbots, students no longer have to think at all, because the robot will do all the work, or at least most of it, for the student. In the same way, giving the chatbot the task of creating a story takes all creativity out of the hands of the student. This is not the development of creative thinking, it is quite the opposite. I would certainly not recommend any teacher to give pupils this type of tasks.” (respondent 3)

If children rely too much on AI, it happens that they accept the wrong information that AI generates for them without any critical thinking.

“The chatbot can believably generate erroneous information and even logically justify this erroneous information.: (respondent 11)

4.3. Fear of Own Unpreparedness for the Advent of Chatbots

Many teachers may feel apprehension or fear related to the use of chatbots in education, because they are aware of their own unpreparedness to work with this technology.

“Using a chatbot is not entirely easy, we have to take into account that it is a machine, it can make mistakes and we have to be able to recognize and correct those mistakes.” (respondent 10)

“An artificial intelligence can help us a lot, but we must learn to use it fully and appropriately.” (respondent 19)

We encounter respondents who do not have sufficient personal experience of working with chatbots or artificial intelligence in general, and these teachers fear that they will not be able to integrate these tools into their teaching. If teachers are not clear about how they can use chatbots in teaching or in preparation for teaching, they also have concerns about how these tools will affect the quality of education and the quality of students’ knowledge. As part of the interviews, it was found that teachers feel that they do not receive sufficient support, training and education in this area.

“Why are teachers worried about chatbots? Firstly, because a huge number of people need someone to tell them something about it, to explain to them how the thing works and that is not happening.” (respondent 3)

We encounter teachers' fears that they could be replaced by artificial intelligence and would lose their jobs. These concerns are especially reinforced by various reports on the Internet, in which there is a debate about whether artificial intelligence can replace teachers.

"I think she is especially afraid of those who understand her less. In addition, I think that rumors like you will lose your job, you won't have a job, etc. also cause fear." (respondent 2)

"With the development of new technologies based on artificial intelligence, there is serious speculation about the replacement of human reason in other more sophisticated activities than belt production or storage. It is likely that sooner or later a smart robot will replace or at least be able to replace basically everyone who works with computers, data, and information. From accountants and economists to teachers, test makers, journalists..." (respondent 11)

4.4. Acceptance of Artificial Intelligence as a Necessity

According to the interviews, it is clear to most teachers that the introduction of artificial intelligence cannot be avoided, and therefore they try to accept it.

"When it comes to artificial intelligence, one thing is for sure, AI is here and it is already changing the world. It is therefore essential that teachers understand their possibilities and implications." (respondent 6)

Teacher realize that the task of education in the coming years will be to teach students to use AI as a normal tool, to explain to them the risks and pitfalls of using AI.

„Artificial intelligence will now improve rapidly, it needs to be included and used creatively in teaching. Just as handwritten final theses are no longer handed in, and even the stupid Word helps us with basic proofreading by underlining typos. We don't even notice it anymore, but it's a technological aid to what we do." (respondent 4)

„So it's like a calculator, the Internet or Wikipedia. You have to learn to work with it, use it and not blindly ban it. And in this sense also to assign tasks." (respondent 5)

"Pupils will need to be taught how to use artificial intelligence well because it can help them." (respondent 7)

Teachers also realize that along with the introduction of artificial intelligence into schools, the system of teaching, testing, and assignments will also have to change. Pupils will need to be assigned tasks that AI will not help them with or that AI will not do for them.

„We need to change the education system, the way we currently train students. In relation to the pupils, I see the biggest problem with workbooks, because there the pupils will use it quickly and well, and I simply won't be able to enter these things at home and there is so little space for it at school. Some of them cheated

before, but it was easier to tell. One of the ways will be to specify and personalize the assignment as much as possible, of course to move most of the assignments and tasks to school, to appeal that the chatbot will no longer write it for them at the graduation." (respondent 5)
„Don't be afraid that he will do tasks for children, but come up with tasks where it doesn't matter, where, on the contrary, the emphasis will be placed on the pupils/students solving a problem with the help of AI. They will critically assess her answers and include her in their work. They just learn to use it to their advantage as another tool." (respondent 4)

4.5. Artificial Intelligence as an Aid to Teachers

Many respondents see artificial intelligence as a tool that can greatly help teachers, especially when preparing for teaching.
"An artificial intelligence can provide relevant information about the given topic, logically structure the text." (respondent 13)
"Chatbot as a large language model is developed so that it can generate natural and understandable answers to various questions. In this way, it can help people find solutions to various problems or gain information on various topics." (respondent 15)

Teachers see it as a tool that will help them reduce their workload and save time.
"Although artificial intelligence is not flawless and often makes mistakes, it can do incredible things. It creates and solves physics problems for you in a few seconds and offers an explanation of the individual steps that lead to the correct result." (respondent 8)
"Today she created a Gap Fill exercise for me in the past tense using the verbs I assigned to her. Perfect. (respondent 4)
"I use it in style – suggest words for a topic." (respondent 12)
"I asked the chatbot how to creatively enrich the music lessons and it immediately brought up quite interesting activities". (respondent 5)
"Artificial intelligence can pre-prepare a presentation on a given topic." (respondent 13)
"It can be used to generate worksheets on a given topic." (respondent 14)
"I use artificial intelligence to create texts, for example texts summarizing the topic" (respondent 18)

And although teachers perceive artificial intelligence as a useful tool, a helper in preparing for teaching, they realize that it is only able to support teachers in cognitively undemanding tasks that do not require much creativity and that can be time-consuming.

"For me, artificial intelligence is useful in trivial but time-consuming things, for example, it quickly writes down X words for the required vocabulary, from which I then create a Wordwall for students to practice. It is an invaluable helper in the production of various cards and activation aids for teaching, I also managed to use ChatGPT to do a great activity for a conversation in a foreign language, when X pupils had partial information on their piece of paper and they had to find out who had the rest of the information. So it takes a good idea, the most cognitively demanding activities still remain with people. You can also ask ChatGPT, but the output is not always of high quality, in terms of content, such an answer is often about nothing." (respondent 4)
"An artificial intelligence will significantly save time in administrative tasks." (respondent 17)

Respondents also perceive artificial intelligence as a great tool in preparing for differentiated teaching, where the chatbot is able to create graded tasks.
"You can turn a chatbot into an assistant, as it is able to generate a lesson, depending on what the teacher wants to discuss. In addition, he can suggest to the teacher, for example, three variants of how the subject matter can be discussed. It makes the teacher's work fantastically easier, leads to greater efficiency and, moreover, does not spend so much time on preparations." (respondent 4)
"She also generated questions about the field ecosystem for the 4th grade, then I had it modified for weaker students and for gifted students, and it's good!" (Respondent 5)
"As part of differentiated teaching, I work with pupils with AI tools such as GoogleLens, ChatGPT or Duolingo." (respondent 19)

As part of the research, it was found that teachers believe that the chatbot can also be a great helper for beginning teachers, which can provide them with many ideas for teaching, help them create teaching materials that are appropriate for the age of the students. The chatbot can show the teacher how to explain the subject matter and concepts to students in a comprehensible and age-appropriate manner. It can offer teachers various tasks for pupils on the topic of the lesson.
"It can be a great helper for beginning teachers, because it can show the teacher how he can explain different concepts to students of different ages, which many times a beginning teacher does not know, he fumbles, he does not know how to present the given things in a comprehensible manner, appropriate to the age of the students." (respondent 16)

5. How do Polish Primary and Secondary School Teachers Perceive the Implementation of Artificial Intelligence in Schools? – the Results of the Research Investigation

5.1. Teachers are Poorly Informed about Artificial Intelligence

Many Polish teachers, like their Czech colleagues, struggle with their own unpreparedness for working with this technology.

“Teachers work with artificial intelligence very little, they do not know how to use it properly” (respondent 14)

Polish teachers also feel that they do not receive sufficient support and training in this area. But compared to their Czech colleagues, they also want to have the opportunity to publicly discuss their role as a teacher in connection with the introduction of artificial intelligence into schools.

“I am not able to use artificial intelligence in my classes on a daily basis, I would need training in this area.” (respondent 18)

“ Pupils are better at using chatbot than me, I would need some training in this area to keep up with the times.” (respondent 16)

“We would need courses, seminars or webinars to show us how we can use artificial intelligence to make our work more efficient.” (respondent 15)

“I see the problem primarily in the fact that we teachers are poorly informed about artificial intelligence. Teachers don’t even know that there are some discussions about artificial intelligence that could replace teachers in routine activities, and that’s because no one invites them to such a discussion.” (respondent 20)

5.2. Artificial Intelligence as an Aid to Teachers

Polish teachers are not afraid of artificial intelligence, on the contrary, they try to use it, because they see it as a tool that can greatly help teachers in the planning and implementation of teaching, replace them in routine activities, in administrative tasks, when correcting tests, etc. They see it as a tool which will help them reduce their workload and save time. So they see it as a tool that will help make their work more efficient.

„I would like it if artificial intelligence replaced me in routine activities, for example correcting papers.” (respondent 1)

“I use artificial intelligence to generate images.” (respondent 8)

An artificial intelligence helps me create different texts, for example relaxing fairy tales, which I use in teaching. (respondent 11)

"I have already used the chatbot several times when preparing for an English language lesson. Once the chatbot generated various games for me, which I then used in my teaching. Other times simple children's songs on the given topic." (respondent 6)
"It is necessary to realize that technology does not harm us, on the contrary, it helps us, makes our work easier." (respondent 17)

Polish teachers realize that if they do not have to deal with routine tasks, which are often time-consuming, they will have much more time for what is really important, direct work with pupils.
"If artificial intelligence takes over some routine tasks for teachers, teachers will have more time for their students and will be able to pay more individual attention to them, there will be more opportunities for personalized learning, for individual work with specific students." (respondent 2)
"The teacher will no longer have to perform various routine tasks, such as correcting papers and tests or various other administrative tasks, this role can easily be performed by robots. Thus, teachers will have more time that they can devote to the creative part of their work, interaction with pupils, direct work with pupils." (respondent 12)

Some teachers are also using artificial intelligence tools to enhance their teaching.
"Pupils enjoy assigning tasks in which they have to work with artificial intelligence." (respondent 13)

5.3. Artificial Intelligence will Completely Change the Education System

Teachers realize that with the introduction of AI in schools, the entire education system will change, the role of the teacher will change, which will be more of a mentor, a guide, not the one who transmits information, but the one who teaches students to search for information, analyze it, critically to think, to work creatively and independently.
"The advent of artificial intelligence will change the role of the teacher, the role of the teacher is already changing. A teacher must be a guide to the world, not one who merely reproduces information. The teacher must also be a guide who can introduce students to how they can most effectively use various technologies, including chatbots. The student needs a different teacher than before, he especially needs a coach, a mentor." (respondent 1)
"However, we must teach students to think critically, to critically accept what artificial intelligence presents them, because it does not always generate true data. We have to teach students that they can use artificial intelligence as a tool, but that they can't rely on it completely, it can't replace them, it can't replace their work. They have to verify what the artificial intelligence has generated, they have

to introduce creative elements, it is not possible to take only what the artificial intelligence has generated, it can only be used as a basis, as a research with which I will continue to work, to which they will bring their potential." (respondent 4)

Polish teachers, just like Czech teachers, are aware that along with the development of the use of artificial intelligence in schools and among pupils, they will have to approach homework in a completely different way, assign pupils other types of homework, other types of independent work.

New technologies in the form of artificial intelligence enable interactive and personalized education which must also be reflected in the types of tasks and independent work that teachers assign to students. Tasks that support critical thinking and creativity, such as various projects, must be more widely promoted . As artificial intelligence proves to be a great helper in the creation of graded tasks, homework or other independent work can also be more personalized to better match the level of a particular student.

"With the advent of artificial intelligence in schools, we will also have to assign different independent work and homework to students than before. It must be one that the chatbot will not generate for them, that will require creativity, originality, independent thinking from them." (respondent 3)

"Artificial intelligence will lead us to assign graded tasks, in this way we will avoid cheating and, moreover, we will adapt the teaching to the needs of a specific student. Today, a chatbot can already help us with graded tasks." (respondent 6)

"Perhaps it will force some teachers to reconsider assigning what they consider to be creative homework such as homework reports or presentations." (respondent 11)

"It can write essays, homework reports one must realize that nowadays essays and reports are a relic." (respondent 13)

"Maybe it will speed up the transition from thoughtlessly copying from Wikipedia to thinking in context ." (respondent 14)

"Examination should focus on problem-solving skills rather than mere memorization." (respondent 16)

Compared to Czech teachers, however, their Polish colleagues are not worried that artificial intelligence will deprive them of their jobs.

"Artificial intelligence will certainly change our entire education system, but it certainly cannot and will not be able to replace a living person, certainly not in education. A robot will never replace a live person when it comes to working with children. He lacks that humanity, children need a living teacher. The school as an institution will not disappear and the teachers will certainly not lose their jobs, but their work will change, their work will be completely different." (respondent 5)

"Today's teacher realizes that he will have to greatly expand his professional knowledge and didactic knowledge and skills to cope with the emerging demands, to maintain a valuable dialogue with the inquisitive student for whom AI is becoming a natural part of life." (respondent 19)

Polish teachers believe that they will not lose their jobs themselves, as artificial intelligence will not be able to replace them.

"Teaching is not just about presenting the learning material. The teacher must have a lively discussion with the pupils, conveying information to them in a form that they are able to understand. And only a man can do that." (respondent 11)

"Artificial intelligence lacks creativity, human intuition, emotional intelligence, therefore it can never replace a living person." (respondent 10)

Polish teacher think that it will be able to replace teaching assistants to some extent, whose number, according to Polish teachers, will decrease with the development of the use of artificial intelligence in schools.

"What will change in education will be the number of teaching assistants. If we start to fully use artificial intelligence and if that tool develops and improves, such a number of teaching assistants will no longer be needed. Artificial intelligence will become the best teacher's assistant." (respondent 9)

"The work of teaching assistants can be partially or completely represented by artificial intelligence." (respondent 8)

5.4. Artificial Intelligence has its Limits

Polish teachers are more aware of the limits of artificial intelligence and chatbots when it comes to helping them prepare for class. They perceive that the chatbot is a robot, it lacks creativity. They appreciate the chatbot as a helper that is able to inspire the teacher, show him good ideas, generate a song or a poem, but is not able to create a well-structured, thought-out, original preparation for the lesson.

"A chatbot is just a tool that works with algorithms, it's not creative. Therefore, he can generate songs and poems, but in my opinion he is not able to create a really successful preparation for teaching, his preparations are not very imaginative, they lack something. You can use them as inspiration, but you can't teach purely according to them. A chatbot cannot replace a live person." (respondent 3)

"In order to be able to prepare well for a lesson, you must have at least minimal knowledge of pedagogical psychology, didactics, pedagogy. And you also have to prepare the lesson so that it meets the needs of your students. And a chatbot is not capable of that. A well-structured, thought-out, original preparation for a lesson, which also fully meets the needs of your students, cannot be created by a chatbot. On the other hand, if you only expect the chatbot to help you plan your lesson, give you ideas, then it's a really good helper. " (respondent 5).

"As an English language teacher in the 1st grade of elementary school, I have already read the statements of several teachers on the Internet who claim that a chatbot is able to suggest preparation for a lesson. I also wanted to try it. But I was very disappointed with the chatbot's response. What he suggested didn't strike me as entertaining, nothing that would interest children. A chatbot cannot think through

several aspects as we teachers do when preparing lessons for children. They do not think about the educational goal, the specific children for whom we prepare the teaching. The chatbot disappointed me in this respect, I expected more from it. However, it can give us a good idea." (respondent 6)

Teachers realize that artificial intelligence often makes mistakes.
"Artificial intelligence sometimes generates text based on a prompt that contains factual errors or artificial intelligence-invented data." (respondent 7)

Conclusion

Presented research study focuses on the question of the introduction of artificial intelligence in Czech and Polish schools, the readiness of Polish and Czech teachers to use artificial intelligence in schools.

The aim of the research study was to examine the subjective feelings of Polish and Czech teachers regarding the introduction of artificial intelligence in school. The partial goal of the research study was to find out whether there is a difference between the views of Czech and Polish teachers on the introduction of the use of artificial intelligence in schools.

To achieve the research goal, the method of semi-structured interviews with primary and secondary school teachers was used.

In the search for an answer to RQ1 – " Czech/Polish teachers concerned about the introduction of artificial intelligence into schools?" it was found that many Czech and Polish teachers are struggling with their own unpreparedness to work with this technology. Polish teachers, similarly to their Czech colleagues, feel that they do not receive sufficient support, training and education in this area. But Polish teachers, compared to their Czech colleagues, also want to have the opportunity to publicly discuss their role as teachers in connection with the introduction of artificial intelligence into schools.

Czech teachers fear the introduction of artificial intelligence and its use in education. Above all, that students will "abuse" AI to cheat and plagiarize. They believe that the use of artificial intelligence will lead to the suppression of their natural intelligence, that they will begin to rely entirely on artificial intelligence for solving tasks and completing assignments. This phenomenon was not detected among Polish teachers.

In the search for an answer to RQ3 – "Do Czech/Polish teachers have experience with the use of artificial intelligence? What experience do Czech/Polish teachers have with artificial intelligence?" it was found that Polish teacher rather perceived artificial intelligence as a help for teachers, respondents from the ranks of Polish teachers already had their first experience with the use of artificial

intelligence. Among Czech teachers, there are also those who work with chatbots and perceive them as a tool that helps them reduce their workload and make their work more efficient.

In the search for an answer to RQ2 – "Do Czech/Polish teachers see artificial intelligence as a tool that will help them?" it was found that, compared to Czech teachers, Polish teachers are more aware of the limits of artificial intelligence and chatbots when it comes to helping them prepare for class. They perceive that the chatbot is a robot, it lacks creativity. They appreciate the chatbot as a helper that is able to inspire the teacher, show them good ideas, generate a song or a poem, but is not able to create a well-structured, thought-out, original preparation for the lesson. Although Czech teachers believe that the chatbot is not able to represent them in more cognitively demanding activities, they consider the preparations for lessons, exercises, test questions or tasks generated by the chatbot to be successful. Most Czech teachers see the introduction of artificial intelligence in schools as inevitable and realize that their task is to teach pupils to use AI effectively. Czech teachers are aware that their current task is to teach pupils to use AI as a normal tool, to explain to them the risks and pitfalls of using AI.

Also, Polish teachers perceive that with the advent of artificial intelligence, the role of the teacher is changing, the teacher is expected to be a guide for the student, who also learns about the effective use of artificial intelligence. Compared to Czech teachers, Polish teachers specify even more how the role of the teacher will change with the development of the use of artificial intelligence in schools. In their opinion, the teacher will be more of a mentor, a guide, not the one who transmits information, but the one who teaches students to search for information, analyze it, think critically, work creatively and independently.Teachers, both Czech and Polish, are also aware that the teaching system will also have to change with the arrival of AI in schools. Pupils will need to be assigned different types of tasks than before, i.e. ones that AI will not create for them. Among Czech teachers, we also encounter fears of teachers in connection with the fact that they could be replaced by artificial intelligence, that they would lose their jobs. Their Polish colleagues are not worried about that. Polish teachers believe that they will not lose their jobs themselves, as artificial intelligence will not be able to replace them, but they think that it will be able to replace teaching assistants to some extent, whose number, according to Polish teachers, will decrease as the use of artificial intelligence in schools develops.

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Lucie Zormanová, Hana Vavříková

Postawy czeskich i polskich nauczycieli wobec wykorzystania sztucznej inteligencji w szkołach

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

Celem badania było zbadanie subiektywnych odczuć polskich i czeskich nauczycieli dotyczących wprowadzania sztucznej inteligencji do szkół. Celem szcegółowym badania było ustalenie, czy istnieje różnica między poglądami czeskich i polskich nauczycieli na temat wprowadzania sztucznej inteligencji do szkół. Aby osiągnąć cel badawczy, zdecydowaliśmy się na zastosowanie badań jakościowych, zastosowano metodę wywiadu półustrukturyzowanego z czeskimi i polskimi nauczycielami szkół podstawowych i średnich.

W ramach badań ustalono, że czescy nauczyciele obawiają się pojawienia się sztucznej inteligencji i jej wykorzystania w edukacji, zwłaszcza tego, że uczniowie będą „nadużywać" SI do oszukiwania i plagiatu. Zjawiska tego nie zaobserwowano wśród polskich nauczycieli. Postrzegali oni raczej sztuczną inteligencję jako pomoc dla nauczycieli; polscy nauczyciele mieli już pierwsze doświadczenia z wykorzystaniem sztucznej inteligencji. Wśród czeskich nauczycieli są również tacy, którzy pracują z chatbotami i postrzegają je jako narzędzie, które pomaga im zmniejszyć obciążenie pracą i uczynić swoją pracę bardziej efektywną. Większość czeskich nauczycieli uważa wprowadzenie sztucznej inteligencji do szkół za nieuniknione i zdaje sobie sprawę, że ich zadaniem jest nauczenie uczniów skutecznego korzystania z SI. Również polscy nauczyciele dostrzegają, że wraz z pojawieniem się sztucznej inteligencji zmienia się rola nauczyciela; oczekuje się od niego, że będzie przewodnikiem dla ucznia, a także nauczy skutecznego korzystania ze sztucznej inteligencji. Nauczyciele, zarówno czescy, jak i polscy, są również świadomi, że system edukacji będzie musiał się zmienić wraz z pojawieniem się SI w szkołach. Uczniom trzeba będzie przydzielić inne typy zadań niż dotychczas, tzn. takie, których sztuczna inteligencja nie będzie dla nich tworzyć.

S ł o w a k l u c z o w e: sztuczna inteligencja, chatbot, szkoły, nauczyciele, gotowość, Polska, Czechy

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Actitudes del profesorado checo y polaco hacia el uso de la inteligencia artificial en las escuelas

R e s u m e n

El objetivo del estudio fue investigar los sentimientos subjetivos de los profesores polacos y checos con respecto a la introducción de la inteligencia artificial en las escuelas. El objetivo específico del estudio fue determinar si existe una diferencia entre las opiniones de los profesores checos y polacos sobre la introducción de la inteligencia artificial en las escuelas. Para lograr el objetivo de la investigación, decidimos utilizar una investigación cualitativa; se utilizó el método de entrevistas semiestructuradas con profesores de escuelas primarias y secundarias checas y polacas.

El estudio reveló que los profesores checos están preocupados por la aparición de la inteligencia artificial y su uso en la educación, especialmente porque los estudiantes "abusarán" de la IA para hacer trampa y plagiar. Este fenómeno no se ha observado entre los profesores polacos. Tendían a ver la IA como una ayuda para los profesores; Los profesores polacos ya han tenido sus primeras

experiencias con el uso de la inteligencia artificial. Entre los profesores checos también hay quienes trabajan con chatbots y los ven como una herramienta que les ayuda a reducir su carga de trabajo y hacer su trabajo más efectivo. La mayoría de los profesores checos consideran que la introducción de la inteligencia artificial en las escuelas es inevitable y son conscientes de que su tarea es enseñar a los estudiantes a utilizar la IA de forma eficaz. Los profesores polacos también observan que con la aparición de la inteligencia artificial el papel del profesor está cambiando; Se espera que guíe al estudiante y le enseñe cómo utilizar la inteligencia artificial de manera efectiva. Los profesores, tanto checos como polacos, también son conscientes de que el sistema educativo tendrá que cambiar con la aparición de la IA en las escuelas. A los estudiantes habrá que asignarles tipos de tareas diferentes a las anteriores, es decir, aquellas que la inteligencia artificial no creará para ellos.

P a l a b r a s c l a v e: universidad abierta, educación a distancia, sistema electrónico, aprendizaje permanente, modelos organizativos de la educación a distancia

Lucie Zormanová, Hana Vavříková

Отношение чешских и польских учителей к использованию искусственного интеллекта в школах

А н н о т а ц и я

Целью исследования было изучение субъективных ощущений польских и чешских учителей относительно внедрения искусственного интеллекта в школы. Конкретной целью исследования было определить, существует ли разница во взглядах чешских и польских учителей на внедрение искусственного интеллекта в школы. Для достижения цели исследования мы решили использовать качественное исследование, метод полуструктурированного интервью был использован с чешскими и польскими учителями начальных и средних школ.

Исследование показало, что чешские учителя обеспокоены появлением искусственного интеллекта и его использованием в образовании, особенно тем, что учащиеся будут «злоупотреблять» ИИ для списывания и плагиата. Среди польских учителей такое явление не наблюдалось. Они были склонны рассматривать ИИ как помощника учителям; Польские учителя уже получили первый опыт использования искусственного интеллекта. Среди чешских учителей также есть те, кто работает с чат-ботами и видит в них инструмент, помогающий им снизить нагрузку и сделать свою работу более эффективной. Большинство чешских учителей считают внедрение искусственного интеллекта в школы неизбежным и понимают, что их задача — научить учеников эффективно использовать ИИ. Польские учителя также замечают, что с появлением искусственного интеллекта роль учителя меняется; Ожидается, что он будет направлять студентов и обучать их эффективному использованию искусственного интеллекта. Учителя, как чешские, так и польские, также понимают, что с появлением ИИ в школах система образования должна будет измениться. Студентам необходимо будет поручать другие типы задач, чем раньше, то есть те, которые искусственный интеллект не будет создавать для них.

К л ю ч е в ы е с л о в а: искусственный интеллект, чат-бот, школы, учителя, готовность, Польша, Чехия

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