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In the “E-learning” series





## Editorial

The Editorial Board of International Journal of Research in E-learning (IJREL) is privileged to present a new volume 10(1) 2024. The content of the current issue was divided into three chapters. The first chapter is devoted to Theoretical, Methodological and Practical Aspects and Psychological Determinants of ICT and E-Learning in Education and includes three articles. The second contains also three articles concerned with Innovative Methods and Technology in Education. The third concerns Research on Distance, Online and Blended Learning Before, During and After the Pandemic Time of COVID-19 and includes two articles.

The first article of the volume Chapter I: “Theoretical, Methodological and Practical Aspects and Psychological Determinants of ICT and E-Learning in Education”, was prepared by **Anna Ślószarz** from University of National Educational Commission in Krakow, and titled “**MOOCs: Global Business Goals and Local Educational Strategies**”. The Author stressed that MOOCs is a device with which academic centers spread the current state of knowledge, while business entities facilitate the development of competencies, particularly in business, economics and IT. Simultaneously, the paradox is that although MOOCs courses are open to global users, they contain distinctive features of their inventors’ and administrators’ culture because they have been created locally. In order to identify the cultural characteristics evident in the content of MOOC courses, 267 courses on creative writing posted on five platforms were analyzed: Coursera (USA), FutureLearn (UK), XuetangX (China), JMOOC (Japan) and Skill Academy (Indonesia). Skill Academy and Coursera were focused on business-marketing goals, although they represented different cultures. Chinese, Japanese and Indonesian courses reflected the responsiveness of those cultures and were people- and affiliation-oriented. They employed a holistic approach to teaching (emphasis on context), i.e., operated with live lectures, which had not happened on Western platforms. Among conclusions for a MOOC to be useful to representatives of another culture, not only translation into another language is needed, but also a proper modification of learning objectives and methods.

A team of Authors, **Iwona Mokwa-Tarnowska** from Gdansk University of Technology and **Viviana Tarnowska** from University of Sussex, presented the second text titled: “**Evaluating the Impact of Gamification on Learning**”

**Effectiveness in Technical Vocabulary Instruction**". They emphasize that with the rise of digital education, the integration of gamified elements has emerged as a potential strategy to enhance student engagement and comprehension in various academic disciplines. This study seeks to evaluate the impact of gamification on learning effectiveness in the domain of technical vocabulary instruction during an online course. A mixed-methods approach was employed, involving data collection from students enrolled on an online technical vocabulary program offered by the Language Centre at Gdansk University of Technology. A quantitative analysis of placement test scores, the frequency of using course material and final grades was conducted to understand their impact on learning outcomes, and data from surveys provided insights into students' perceptions and experiences with gamified activities. The study's outcomes contribute to the growing body of research on gamification's potential benefits in online learning environments, especially in the context of technical vocabulary instruction, and offer valuable implications for educators and course designers seeking innovative approaches to optimize learning experiences in virtual settings.

**Valeriia Necherda** from the Institute of Problems on Education of the National Academy of Educational Sciences of Ukraine, **Kateryna Bezruk** from the Institute of Problems on Education of the National Academy of Educational Sciences of Ukraine, **Zhanna Petrochko** from the Borys Grinchenko Kyiv Metropolitan University, Ukraine, **Valentyna Kyrychenko** from the Institute of Problems on Education of the National Academy of Educational Sciences of Ukraine, **Olena Denysiuk** from the Borys Grinchenko Kyiv Metropolitan University, Ukraine, prepared the article titled: **"Formation of Socially Successful Personality of Adolescent Pupils by Means of Gamification (Kyiv City, Ukraine)"**. The research highlights the essence of gamification and the results of teenagers' participation in the educational program with the elements of gamification called "Social successfulness" in the educational process of educational institutions. Theoretical methods applied involve analysis, synthesis, comparison, systematization, generalization of materials from psychological and pedagogical sources regarding the problem of social successfulness and the possibilities of its formation in adolescents in the conditions of out-of-school and general secondary education institutions, specification for harmonizing the content of the curriculum devoted to "Social successfulness". Empirical methods used involve observation, questionnaires for collecting empirical information, blitz surveys concerning the awareness of the characteristics of a successful personality. The article carried out a pedagogical reflection and found out that, according to the results of the blitz survey, teenagers verbalize the two most common portraits of a socially successful personality (based on external indicators of success and personal qualities). According to the results of the questionnaire, it was found out that the participation of teenagers in the "Social Successfulness" program contributes to their positive and optimistic attitude towards themselves and their life prospects.

Chapter II contains three texts. The article on **“Interactive RShiny Reports – Independence and Autonomy in Medical Data Visualization”** prepared by **Justyna Marcinkowska and Magdalena Roszak** from Poznan University of Medical Sciences, Department of Computer Science and Statistics, discusses the use of the R language, especially the RShiny tool, to create interactive reports in the field of medical data analysis. The Authors emphasize the need for an interdisciplinary approach to teaching statistics among medical students. An alternative to traditional static reports was presented, proposing the creation of interactive web applications that enable exploration, analysis and visualization of medical data changing in real time. The use of the R language as an open source tool allows for the development of medical students’ competences in the field of data analysis and the adaptation of research tools to individual needs. A draft lesson plan using sample medical data on cervical cancer was also presented, along with a proposal for specific analyzes of these data and their visualization using interactive RShiny reports. The article ends with a discussion on the role of learning the R language in the education of students of Polish medical universities and the need to expand the educational offer for them with courses in data analysis in an open source environment.

Bulgarian Authors, **Todorka Glushkova and Anna Malinova** from University of Plovdiv, Bulgaria, presented the text on: **“Artificial intelligence is increasingly entering all spheres of our lives, including the sphere of education”**. These technologies offer numerous advantages and opportunities to perform various activities and tasks throughout the educational process. This article discusses some aspects of the application of AI technologies to improve personalization, accessibility, and interactivity in school education, and especially in learning STEAM subjects. The Authors aim to propose approaches to successfully integrate AI into the work of teachers and facilitators during the preplanning phase of lessons, the preparation of personalized tasks for students, the process of testing and assessing knowledge, as well as in group and project-based learning. The article shares the experience of teaching a compulsory computer science course as well as working in an interest club related to artificial intelligence and robotics with 6th grade students in secondary school, highlighting the potential of certain chatbots to support and enrich the process of programming.

Polish team of Authors, **Małgorzata Przybyła-Kasperek, Rafał Doroz, Agnieszka Lisowska, Grzegorz Machnik, Arkadiusz Nowakowski, Krzysztof Wróbel, Beata Zielosko** from the University of Silesia in Katowice, Institute of Computer Science, Poland, wrote the manuscript titled: **„Exploring the Educational Efficacy and Potential of 24-Hour Hackathon Programming Marathon – HackEmotion”**. This article addresses the issue of modern didactics and student motivation for self-learning as well as tackling significant practical challenges. In technical and STEAM (Science, Technology, Engineering, and Mathematics) education, achieving high levels of motivation is particularly

important, as students often become overwhelmed by the vast amount of information and opportunities which lead to diminished interest. At the Institute of Computer Science at the University of Silesia in Katowice, a Hackathon – a 24-hour programming marathon – was organized to enhance student engagement. During this event, students confronted a critical problem in modern society, i.e., emotion recognition. The main research questions posed during the research were: RQ1: At what level of quality was the Hackathon event organized? Were students well informed and felt cared for during this event? RQ2: What aspects and properties did motivate students most to take part in events organized at the university like Hackathon? RQ3: What competencies, knowledge and skills were developed by participants in the Hackathon? RQ4: Do students consider issues related to recognizing emotions important and the created applications possible to use in practice? In this paper, the answer to these questions using statistical analysis as well as simple machine learning models was given.

Chapter III includes two papers.

**Roman Solecki and Anna Mróz** from University of National Education Commission in Krakow, Poland, prepared the article titled: **“Relationship with Parents, Symptoms of Depression, and Internet Addiction among Adolescents During the Pandemic Period”**. The research presented in this article aimed to answer the following question: what is the role of social support and quality of family relationships in the context of depressive symptoms and abuse of the Internet during the COVID-19 pandemic and remote learning by adolescents? The study was conducted among 619 adolescents aged 11–15. The survey questionnaire was constructed from standardized research tools. The study showed that 40.0% of the students who took part in the study had increased depressive symptoms. Heavy Internet use affected 16.0% of the respondents, and there was 9.2% of those who had aggravated symptoms of depression and addiction at the same time. Simultaneously, it was noted that girls, compared to boys, were more often found among adolescents experiencing symptoms of depression. The results proved that the quality of family relationships is the most important for the normal functioning of adolescents without depressive symptoms, also in a pandemic situation.

The last article titled: **“E-tutors’ Understanding and Level of Confidence in Using a Technological Pedagogical Knowledge Model in Open Distance E-Learning”** was written by **Mpipo Zipporah Sedio** from University of South Africa, South Africa. The article aimed to investigate the perspectives of e-tutors regarding the importance of Technological Pedagogical Knowledge in an Open Distance e-Learning Institution. The article employs a quantitative survey method to allow students to articulate their impressions of how e-tutors leverage their topic expertise to impart knowledge. The study includes 350 students who are enrolled in a module. Its objective was to gain insights, using quantitative analysis, into the techniques used by e-tutors in delivering content. During the delivery of content, e-tutors provided explanations and support for different viewpoints, taking into

account students' input on the choice, execution, and overall impact of teaching methods. E-tutors recognized the use of Technological Pedagogical Knowledge (TPK) to assist and enhance online student activities. Therefore, it was found that constructivism could help to incorporate the TPK framework, thereby enhancing students' understanding of the instructional design process. However, the study discovered a lack of comprehension among e-tutors regarding the TPK concept in relation to curriculum design.

We hope that studies and solutions in the present IJREL volume will be inspiring and encourage reflection on how to manage the increasing demand for online education in the current situation.

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## **MOOCs: Global Business Goals and Local Educational Strategies**

### **Abstract**

MOOCs are prepared by universities, research centers, business and governmental bodies. That is a device with which academic centers spread state-of-the-art knowledge, while business entities facilitate the development of competencies, particularly in business, economics and IT. The paradox is that although MOOCs courses are open to global users, they contain distinctive features of their inventors' and administrators' culture because they have been created locally. In order to identify the cultural characteristics evident in the content of MOOC courses, 267 courses on creative writing posted on five platforms were analyzed: Coursera (USA), FutureLearn (UK), XuetangX (China), JMOOC (Japan) and Skill Academy (Indonesia). Skill Academy and Coursera were focused on business-marketing goals, although they represented different cultures. Chinese, Japanese and Indonesian courses reflected the responsiveness of those cultures and were people- and affiliation-oriented. They employed a holistic approach to teaching (emphasis on context), i.e. operated with live lectures, which had not happened on Western platforms. Therefore, the conviction that MOOC is a mirror of the culture in which it was created should be considered a myth. It is the MOOC platform that presents the interests of the administrators and owners. Platform owners differ in their goals: academic (general knowledge transfer becoming a thing of the past after the commercialization of Coursera and edX), marketing (focused on gaining customers and employees) or economic-political (XuetangX). For a MOOC to be useful to representatives of another culture, not only translation into another language is needed, but also a proper modification of learning objectives and methods.

**Keywords:** MOOC, reactivity, individualism, collectivism, personal development, context

In all cultures, narrative discourse conveys patterns of thinking, acting, and feeling which are non-opportunistic and independent of power centers (Kaliszewski, 2011). It triggers psychological intimacy and empathy, deepens sensitivity, helps to understand the culture and one's own identity. It improves the quality of human life (Trzebiński, 2006). Therefore, the classic core messages of myths were rendered in the form of fiction. Today, narrative techniques are used in daily practice by missionary professions: teachers, priests, journalists, psychologists, and psychiatrists. They use narratives to practice linguistic forms and enrich the vocabulary of students, convey non-obvious truths, personify information to achieve the effect of empathy, and structure complex mental processes.

A narrative can also create a self-presentation of the author. Creative texts are often edited by talented amateurs. They share experiences and express their feelings. They produce publications using websites, social media and dedicated mobile applications, e.g. Storybird, Twine, WattPad.

*Creative writing* is skillful text-making, usually in the narrative mode, using cultural archetypes, literary tropes, and characters to tie together events. The forms of expression include novels, short stories, memoirs, biographies, dramas, and poems. *Creative writing* also includes learning how to write scripts for films, games, television, and web series, as well as transmedia stories. The first formal *creative writing* degree program at the Master of Arts level was launched at the University of East Anglia in 1970 by Malcolm Bradbury and Angus Wilson. At the undergraduate level, *creative writing* has been taught informally since the 1960s, and formally since 1995 (University of East Anglia 2020).

Thus, the teaching of *creative writing* has become widespread in Western culture. This is because *creative writing* is needed in the creative economy, where intellectual property counts more than material goods, and the most valued capital is creative thinking, giving a competitive advantage within the copyright works, patent industries, trademark and design industries, such as the game and film industries (Howkins, 2002; Florida, 2005). According to Richard Florida, universities have become centers of creativity, where creative and talented people make up the so-called creative class. The super-creative core includes professors, engineers, writers and poets, copywriters, editors, actors, architects, cultural figures and other people who influence public opinion. According to the creative economy (Howkins, 2002), creative professionals work in knowledge-intensive industries such as high-tech, business, financial, legal, and medical services. Other people perform routine activities, creating low-paid service and working classes.

The creative class is created globally to develop the creative economy also known as intangible industries. Programs of study in philology, journalism, or even economics with a marketing focus, thus consequently MOOCs, often refer to *creative writing*, and its techniques are used in journalism, business, and marketing (Avramova, 2022), education, personal development (Bauer-Maglin 2017) and even psychotherapy (Woźniak, 2005). Therefore, *creative writing* has been expanded to include practical skills, such as writing research papers, creating content for business, journalistic, and academic purposes, e.g., a resume, business correspondence, a portfolio of journalistic proposals, an application to study at an English-speaking university.

In Western culture, *creative writing* has become essential for effective communication, human development and professional success. The creative class works flexible hours (including nights, weekends), and for this reason, MOOCs have become a suitable tool for them to improve their professional skills.

## **Problem of Research**

When and to what extent are MOOCs mirrors of the culture in which they were developed?

MOOCs platforms are being developed in different regions of the world. They are suited to the needs, habits, communication practices and educational strategies of local audiences. *Creative writing* courses are a novelty in Asia. In China, Japan or Indonesia, they are being organized because of the close connection to learning English, which is necessary for global business interactions.

Still, we should bear in mind that the Internet originated in the US and bears the stigma of the American culture: it promotes egalitarianism, individualism, liberalism and competition (Hongladarom, 2001) and a cosmopolitan culture inherent in the technology. Western MOOCs, despite translation into other languages, remain distinct from local educational and cultural practices. MOOC platforms, therefore, are springing up around the world so that the needs of local users and the interests of platform owners are met.

## **The Research Focus**

Samuel Huntington distinguished nine global civilizations (1996) and stated that their differences lead to religious-cultural conflicts. The cultures of the West are

different from the Oriental ones located in East Asia and represented by Chinese, Japanese and Arabic, among others. Each is derived from a distinct civilization (Huntington, 1996). The Chinese recognized the superiority of their own culture and defended their identity, which resulted in expelling missionaries from China in 1722 in accordance with Tsi-Yong's slogan „Chinese learning for the fundamental principles, Western learning for practical use.” In later times, Oriental countries established contacts with the West; they retained traditional organizations of society and ways of teaching, though.

Geert Hofstede, Gert Jan Hofstede, & Michael Minkov (2010) recognized the dimensions by which cultures differ, and these are: power distance, individualism and collectivism, femininity and masculinity, uncertainty avoidance. The Chinese Value Survey added short-term orientation and long-term orientation. The authors focused on American and Chinese cultures as representing Western and Oriental cultures. They also mentioned indicators of the dimensions of the cultures of Arab countries, such as Indonesia, which is made up of many diverse cultures. These indicators were related to education and are summarized in Table 1.

Table 1.

*Educational indicators of cultural dimensions according to Hofstede et al. (2010).*

Country	Individualism / collectivism	High / low context	Power Distance Index (PDI)	Short / long term orientation
United States	Individualism: Pronoun „I”, task groups. Student treated individually. Taking the floor and expressing opinions.	Low context: detailed and literal explanation, instructions.	Low power distance: partnership with the teacher, encouragement to ask questions and to initiative. Knowledge as universal laws and facts.	Short term orientation: 26
United Kingdom				Long term orientation: 51
China	Collectivism: formation of particular groups. Student as representative of the group.	High context: the assumption that some information is obvious and needs no explanation.	High power distance: respect for the teacher as an organizer of the educational process. Knowledge as wisdom of the teacher.	Very long term orientation: 87
Japan				Long term orientation: 80
Indonesia				Reluctance to speak up.

Source: Own work based on G. Hofstede et al., (2010).

## Methodology of Research

### General Background of Research

On a wave of enthusiasm, the belief arose that MOOCs would help reduce cultural differences between Western and Arab worlds (Adham & Lundqvist, 2015, p. 134). However, the way we learn, especially in terms of educational imperatives, peer relationships and attitudes to a teacher, are culturally conditioned (Waard et al., 2014). That is why the enthusiasm for American MOOCs worried teachers, especially in developing countries, because of a different kind of pedagogy and the „top-down nature of the material being offered on MOOCs by professors from elite Western universities” (John 2013). They stated the *digital neocolonialism* (Altbach 2014; Adam 2019) because learning outcomes offered on MOOCs can distort cultural awareness and impede learning by transmitting Western lifestyles and neoliberal values, especially when it comes to MOOCs on literary, historical, political or artistic topics – the most culturally sensitive subjects. Lisa Rafferty Portmess concluded that participants’ activities recorded in MOOCs are used for educational research in order to create a postcolonial educational project (2013).

Subsequently, some questions have arisen as to whether MOOCs should encourage participants to speak in forums and communicate with representatives of other cultures (Liu et al., 2016). As a consequence of the global reach of MOOCs, the need arose to design them in such a way as to accommodate cultural differences in user learning. From the statements of 152 MOOC instructors analyzed by Meina Zhu et al., (2020), it emerged that not all of them understood the issue of cultural diversity. However, many of them offered subtitled translations of videos and podcasts to participants, spoke slowly and clearly, limited text in favor of multimedia, encouraged facilitating peer access to content, and organized small groups of students.

Cultural characteristics of MOOCs were also studied in terms of interface design, and user experience (Liu et al., 2020). It turned out that MOOC interfaces from the Coursera and Chinese Universities MOOC (CUM) platforms were designed according to either American or Chinese culture, i.e. individualistic or collectivistic, low-context or high-context and short-term vs. long-term orientation, among others, as these cultural characteristics affect the design of content layout, predicted user behavior, and cultural awareness.

As a consequence of the administration of MOOC platforms by business entities emerged *business model* of MOOCs (Belleflamme et al., 2014; Kalman 2014; Burd 2015) potentially disruptive for higher education (Jacoby 2014).

Thus, differences in MOOC and MOOC platforms design concern not only language but also learning objectives and outcomes, teaching methods, interface, and axiology. They also pertain to the way certain topics are addressed or the reasons why certain topics are left out. One of these is *creative writing*.

## Instruments and Procedures

The purpose of the study was to analyze the content of MOOC course platforms in terms of some cultural features of the courses containing *creative writing* elements. The research questions were:

1. What practical applications do MOOC creators associate *creative writing* with?
2. Which cultural features of MOOC creators were reflected in the design of learning methods in the courses on *creative writing* ?

The method used was exploratory content analysis. Using internal search engines, the resources of each platform were browsed by entering the keyword *creative writing* and in the case of failure to obtain results, the password *writing* was entered. Once the results were obtained, course titles and keywords, audits (when available), syllabuses, characteristics of courses, module summaries, content layout and user reviews were analyzed. The results were filtered by removing courses unrelated to *creative writing* from the lists provided by the search engines. The data was coded in a Microsoft Excel spreadsheet for each course separately. The results were then analyzed quantitatively and qualitatively (Cresswell, 2009).

## Research Sample

Five platforms from MOOCs were selected to represent Western and Oriental cultures. The sample was purposively selected to include platforms that are important in both cultures and to see if the cultural dimensions highlighted by Gert Hofstede et al., are reflected in MOOC courses.

The American Coursera (2012, Stanford University) and British FutureLearn (2012, Open University) platforms were considered most representative of Western culture, as they have the most resources in the West and the most participants. On the other hand, China's first platform XuetangX (2013, Tsinghua University), Japan's JMOOC (2013, Japan Massive Open Online Education Promotion Council) and Indonesia's Skill Academy administered by the largest in Indonesia edtech startup Ruangguru (2014, Ruangguru) were singled out as representing Oriental culture.

The resources of these platforms were analyzed in August 2023.

## Limitations

267 MOOCs from five purposively selected platforms were analyzed, so the sample is not representative and the results cannot be referred to all MOOCs. In addition, due to cultural differences in the approach to the topic and in the provision of resources on the platforms, different ways of searching for courses were used: by typing „creative writing” into the internal search engines or „writing” in the absence of results, and as a last resort, by browsing the subject categories of the courses.

There were some difficulties noted in obtaining detailed information about selected courses. Complete information was posted on the FutureLearn platform, but on Coursera, some data could be obtained only after paying a high fee to participate in a series of courses, or in so-called Specialization.

Coding the proposed uses of *creative writing* and teaching strategies into four categories involved decision-making in the case of ambiguous situations. For example, when peer assessment or discussion forums were stipulated as optional or available only in the paid version, the course was qualified as interactive. The subject of the course *Make interesting Writing with Storytelling & Creative Writing* was qualified as business because of the addressees: novice writers of non-fiction and non-fiction articles in a storytelling style (Azzura, n.d.) for brands and career development rather than gaining theoretical and general knowledge by students.

## Results

### Ownership and Educational Goals

Among the most important five platforms with MOOC courses in both cultures, four of them had commercial types of ownership and management. Only China's XuetangX was administered by the government to implement the country's economic policies.

The Coursera platform, founded by Stanford University employees, was transformed into a joint-stock company in March 2021, leveraging its globally respected brand. In 2022, it had 118 million users and brought in revenue of \$524 million. The resources are created by employees of universities, research institutes, educational institutions, and business entities. An internal search engine found 478 courses on *creative writing*, but many of them turned out to be unrelated to the topic, such as *Introduction to Psychology* and *Fashion Systems*. 162 courses were analyzed. The over-representation of Coursera's offerings resulted from the reference of *creative writing* to practical skills developed within MOOCs by Coursera Network-affiliated IT and engineering business entities promoting their products (e.g. software programs) and paid educational services: courses, verified professional certificates, specializations and even degree courses in the form of bachelor's and master's qualifications.

The UK-based FutureLearn platform, with 17 million users in 2021, has been owned since December 2022 by a corporate group Global University Systems, managed by Aaron Etingen, who took it over from Open University and SEEK Ltd. Due to the platform's financial problems. It has introduced AI to guide learners' activities, facilitate their career development, and increase the platform's range

(Shah, 2022). A temporary access to courses is free of charge. For a small fee, access to thousands of courses and even printed materials can be purchased. An internal search engine indicated 46-course results on *creative writing*. After excluding unrelated ones (e.g., *Become a Musician*, *Essentials in Arts Fundraising*), 27 courses were analyzed.

China's XuetangX platform was established in 2015 at the initiative of the Chinese Ministry of Education in response to the growth of US MOOCs. In April 2020, it had 58 million users. By 2030, there will be about 3,000 National Elite Online Courses – selected as the best in China, funded by the government, free of charge, and open to the general public (Zhang et al., 2021, p. 7). An internal search engine indicated one course devoted to *creative writing*. However, when „writing” was typed in, it listed 56 courses, 37 of which had topics similar to those included on the Coursera and FutureLearn platforms. These were subjected to analysis. However, 19 courses unrelated to *creative writing* were eliminated, such as *Basic Science in Nursing*, or *Medicinal Botany*.

Japan's most important platform with MOOC courses is JMOOC, established in 2013 and administered by the Japan Open Online Education Promotion Council. JMOOC had more than 1,620,000 users in 2023 and provided Japanese and English: titles, educational texts, and subtitles for movies. The completion rate is 38.7% (Keskin, 2017). 610 courses recommended by institutions, academic or educational organizations, and businesses were available on the JMOOC platform. MOOC courses on *creative writing* were not posted. Entering the keyword „writing” into the internal search engine also did not yield results. The 14 courses related to *creative writing* were therefore found by browsing through categories such as *Digital / IT Tools*, and *Education*.

The Indonesian Skill Academy platform was created in 2014 by Ruanggur, the largest edtech startup in Indonesia. During the COVID-19 pandemic, it noticed a 3000% increase in traffic and a fivefold increase in active users, with nearly 750,000 of them in 2023. It addresses courses not to students, but to employees since there are three times as many of them as there are K-12 students (Florene, 2021). Access to materials from purchased courses is for life. The search engine identified 49 courses. Twenty-seven of them were considered related to the topic of *creative writing*, discarding e.g. *Graphic Design: Creating Motion Graphics*.

Thus, the design of MOOCs on the largest platforms is dictated not by educational considerations but by the strategy of the platform owner. Commercial entities are focused on profit from the sale of educational services, while the government is focused on the implementation of the state's economic policies – including the conquest of Western markets. MOOC platforms, founded by university entities and focused on disseminating quality education, have become business products (Coursera, FutureLearn) or tools for implementing internal state policy (XuetangX).

### ***Creative Writing Usage***

Course developers have suggested the use of *creative writing* in philology (learning the rules of character construction, composition, literary genres, etc.), business and marketing (writing marketing texts for social media, writing skills for engineering leaders, etc.), personal development (preparation for writing a thesis or research paper, shaping one's own identity in stories, etc.), and popular culture (preparing pilot episode for a TV or Web Series, narrative development for video games, etc.). The percentage of these applications on particular platforms is shown in Table 2.

Table 2.  
*Applications of creative writing in the MOOCs under study (%)*

	Philology	Business, marketing	Personal development	Popular culture
Coursera	35	49	12	15
FutureLearn	41	19	33	7
XuetangX	16	8	76	0
JMOOC	50	7	36	7
Skill Academy	0	96,3	0	3,7

Source: Own work.

Table 2 shows that the Coursera platform courses are dominated by business and marketing usages, while on FutureLearn dominate philological applications. The two platforms, which represent Western culture, are therefore radically different. Coursera dominates in business applications, as many professional courses have been developed by Meta, Google and IBM. However, Indonesia's SkillAcademy offers the most business courses, as it is administered by a commercial entity and offers courses for employees rather than students.

Philological aspects of *creative writing* are discussed primarily in the courses from the JMOOC platform, relating e.g. to linguistics theory, pictograms, kanji – i.e. local, reactive culture, as opposed to Western culture. The two Western platforms also have a relatively large number of philology courses, due to their close ties to universities. By contrast, on the XuetangX and Skill Academy platforms, philological training has been virtually eliminated in favor of personal development (XuetangX) and professional preparation (Skill Academy). This is because Oriental cultures are characterized by a long-term orientation to new technologies and deferred results subsequent from their use (Hofstede, 2010).

The collectivist personal development focus was primarily on China's XuetangX, preparing users to find their way in the world of Western culture in order to run international businesses (e.g. *Writing for General Academic Purposes, Business Correspondence for International Trade*). In the second place, in terms of personal

development participation, was JMOOC with courses like *Avoiding offenses in English* or *Practical communication course to deepen trusting relationship*. These courses, in turn, fit training into the traditional Oriental culture, which is characterized by far-reaching politeness and building lasting relationships (Mikułowski-Pomorski 2003, p. 142). On the FutureLearn platform, on the other hand, the user's personal development, was treated as preparation for study (*Academic Writing for Healthcare Students in Higher Education*) or perception of cultural messages (*Fairy Tales: Meanings, Messages, and Morals*).

On the Coursera platform, on the other hand, business entities offered communication skills development through storytelling by engineering leaders, business and technical professionals, e.g. *Writing Skills for Engineering Leaders*. These courses were linked to personal development understood here in an individualistic way, as career advancement, especially when co-created by private companies, such as: Google, IBM, Amazon Web Services and Coursera Project Network affiliates.

The application of *creative writing* to the preparation of popular culture texts has been strongest on the US platform due to the dominant role of the US in the global entertainment market. Here, *creative writing* has been associated with transmedia storytelling and content marketing. Many MOOC courses have been profiled for media, including *Story and Narrative Development for Video Games*, *Script Writing: Write a Pilot Episode for a TV or Web Series*. In contrast, the Chinese platform does not provide for similar applications, focusing on practical preparation of users for *creative writing* applications for business and academic purposes, such as *Hospitality English* and *Comparative poetics*.

Thus, the proposed applications of *creative writing* are determined not so much by cultural considerations but by business (Coursera, Skill Academy), academic (FutureLearn by 2022), branding (JMOOC) and political-economic (XuetangX).

## Learning Design

In order to analyze the proposed ways of learning, four criteria for cultural differences in the educational design of MOOCs were specified. They are summarized in Table 3.

Table 3.  
*Cultural characteristics of educational design MOOCs*

Western cultures	Oriental cultures
<b>Individualistic</b> culture – focus on individual success, work	<b>Collectivist</b> culture - focus on collective action, other people
<b>Low</b> importance of <b>context</b> , large role of record	<b>High</b> importance of <b>context</b> , dialogue, face-to-face contact
<b>Low index of power distance:</b> discussions with the teacher, co-creation of course content	<b>High power distance</b> index: authority of the teacher, live lectures and live webinars
<b>Short-term</b> orientation. Orientation to the present and the past, to quick results, individual achievements.	<b>Long-term</b> orientation. Orientation to belonging, future, new technologies, deferred results. Persistence, perseverance.

S o u r c e: Own work based on G. Hofstede et al., (2010).

MOOCs are available to students from different cultures. Socrates and Confucius linked education with the development of autonomy, virtues and spirituality (Tan et al., 2015, p. 4). Despite this recently Western and Oriental MOOCs design is often subordinated not only to educational purposes, but also to business ones. Therefore, cultural characteristics are not always reflected in educational practices.

Sarah Judith Stager’s research showed that students’ activity in MOOCs (participation in discussion forums, submitting assignments, peer assessment, ability to process course content, etc.) has a statistical relationship with individualism versus collectivism, but long- / short-term orientation showed no relationship (Stager 2016, p. 34–35). Fernanda Francielle de Oliveira Malaquias et al., (2020) conducted a multivariate regression analysis and found that only individualism has a significant and positive impact on the breadth of MOOC offerings in 55 countries. Other cultural factors proposed by Hofstede et al. do not show any significant impact.

Bjarke Lindsø Andersen et al., (2018) using the method of cultural contrast showed that the worlds of the participants’ lives collide during MOOCs because of differences in perception of power. As a result, a cultural authority is created that imposes appropriate practices and preferential treatment of certain students.

Therefore, it was checked to what extent the dimensions of culture proposed by Hofstede are reflected in the design of the analyzed courses. The percentages of criteria met on each platform are summarized in Table 4 and explained in the following sections of the article.

Table 4.  
*Cultural features of teaching creative writing on the MOOCs platforms under study (%)*

	Learning		Teaching		Outcomes		Lectures	
	Individual	Social	Interactive	Lectures	Fast	Deferred	Recorded	Live
Coursera	67	33	98	2	99	1	100	0
FutureLearn	4	96	30	70	22	78	100	0
XuetangX	22	78	76	24	14	86	97	3
JMOOC	43	57	57	43	0	100	71	29
Skill Academy	37	63	63	37	100	0	37	63

Source: Own work.

### Learning – individual or social?

The highest percentage of courses for users working individually (67%) was found on the Coursera platform. Analysis of user evaluations showed that peer assessment enforced, as a condition for passing an assignment, was here not supportive of learners. Peer reviews were sometimes vague and unhelpful, and it was not possible to interact with them, observe the development of the selected work, or make self-corrections after receiving a review. The forums also included off-topic content about problems and frustrations:

Non-existent content, lack of usable feedback from peers, writers' group mechanism is not workable on this platform, and long periods of time that a section cannot be completed (if at all) because there is nothing to review. (Leonie, 2020).

But in contrast, on the FutureLearn platform, peer assessment played a positive role. After logging in to the course, assignments for assessment were systematically sent. Reviews of peer work were also made available. These were kind and insightful. The user was notified by e-mail about new observers or when someone responded to comments. The high level of discussion in the forums was due, among other things, to the fact that they were placed under videos rather than in separate places as on Coursera. Social learning was designed in 96% of the surveyed courses, including discussion forums and peer assessment. So there were big differences between Western platforms in the use of interactivity and social learning. In this case, such a dramatic difference is probably due to the fact that Coursera has been a commercial platform from the beginning, while FutureLearn has only been a commercial platform since December 2022. Therefore, Coursera

focuses on low-cost, independent learning, while FutureLearn continues the British tradition of university debating.

Platforms representing the Orient's educational culture have also relied on social learning. On the government's XuetangX platform, 78% of courses were based on it. However, interactivity is an organizational challenge. Therefore, in some of the courses on this platform, the free version did not include it – lectures were summarized with tests. The introductory *Creative writing* course created and conducted by Juan Wang et al., of Hunan Normal University (2014) taught, among other things, how to create a bond with the reader, characteristic of Oriental, collectivist cultures, and how to tie poetry to music in the traditional manner. It included the creation of open-ended poetic forms and visual poetry, as Oriental cultures are open to new technologies. Also, learning to write creative non-fiction there included genres related to technology: visual poetry, video essay, graphic essay, blog, film script. The course was embedded in Chinese culture, reflecting its commitment to tradition, as the creation of historical forms is covered: sonnet, cinquain, iambic pentameter, ode, elegy, epithalamium, as well as philological issues: perspective in narrative, autobiography, suspense. References to *creative writing*, Hollywood, Valentine's Day, on the other hand, illustrated the reactive nature of Chinese culture (Mikułowski-Pomorski, 2003, p. 122), i.e., referring to Western models, instead of taking their own initiative.

Also, the JMOOC on its cover page, in the mode characteristic of the collectivist culture, declares „to expand individual values to the whole of society's shared values through learning for Japan and Asia based on business-academia collaboration” (JMOOC, nd.).

Thus, it can be said that in terms of designing individual and social learning MOOCs reflected the cultures of their creators and administrators. Even FutureLearn, seemingly diverging from the individualistic nature of Western culture, referred to the Western paradigm first-ever MOOC course, created in Canada by Stephen Downes and George Siemens *Connectivism and connective knowledge* (2008). Moreover, subsequent research revealed that forum participants were mainly Western young adults i.e. high-performing students, who formed crowds, not communities of learners (Gillani et al., 2014).

### **Teacher – partner or leader?**

Substituting teacher lectures by discussion forums is common in the MOOCs connectionist model. In the analyzed courses, lectures were often supplemented with discussion forums and peer assessment. Such courses were classified as interactive. It turned out that Coursera (98%) and all Eastern platforms relied on such interactivity. On the FutureLearn platform, on the other hand, courses were based most often on lectures (70%) and quizzes, which follow the European and British tradition of academic training. Discussion forums were attached to lectures here and did not constitute separate modules as in collectivist courses.

The use of discussion forums on the Coursera platform emerged from Western connectionist tradition, i.e. the technical need to provide users with interactivity along the lines of social media, and a reliance on procedures based on an unambiguous written word that requires no context. It also reflected the decline of teacher's authority. On the Eastern and FutureLearn platforms, on the other hand, the discussion forums with the high quality of most user contributions reflected the collectivist nature of Oriental culture, the importance placed on context and dialogue, and the teacher's authority as a master due to the high rate of power distance. In Oriental platforms, this was due to the pedagogical tradition, while in FutureLearn it was the result of selecting a teaching strategy and presenting high technology.

### **Learning outcomes – fast or deferred?**

On the Coursera platform, courses (99%) are geared toward quick success for the user who may write a novel during 127 hours of instruction (*Write Your First Novel*), for example, or develop the ability to use narrative in order to build leadership, brand and competitive advantage through course completion. Similarly, on the Indonesian Skill Academy platform for employees, training is 100% geared toward quick career success, e.g. *Make Interesting Writing with Storytelling & Creative Writing, Storytelling for Interesting Content Writing*.

In contrast, on the other platforms, soft skills were developed in most courses, bringing deferred profits. On JMOOC, this was true for all the courses. The authors took care of promoting traditional Japanese culture, such as: *A Pictogram that Conveys Meaning in Shape, Practical Communication Course to Deepen Trusting Relationships, Manga, Anime and Game Theory*. In addition, the user was forced to learn about the full range of offerings, choosing courses carefully and in the context of similar MOOCs, because of abandoning the internal search engine and dividing courses into thematic categories. Similarly, on the XuetangX platform, where the goal of *creative writing* was considered as characteristic of a collectivist culture to connect to ourselves and to connect with others (Wang et al., 2023). The term *connect* refers to the reactive culture's characteristic feature of maintaining contact with the West for far-flung educational and business purposes, in courses such as: *Academic English and Literacy, Business Letters and Emails in International Trade*.

Created in Western culture with a short-term orientation, Coursera reproduces this characteristic feature, but short-term goals have also been set for Skill Academy users, despite the fact that commercial administrators and most course authors are connected with a long-orientation culture. The focus on quick or deferred learning outcomes depends on the type of administrating the platform – commercial (Skill Academy), government (XuetangX) or academic (FutureLearn by 2022 administered by the Open University), not on the cultural orientation of authors or administrators toward short- or long-term goals.

## Lectures – recorded or live?

On Western platforms Coursera and FutureLearn, the lectures were recorded, hence participants lacked a direct contact with the teacher who could answer their questions in real-time as it was in remote teaching during a pandemic. On the other hand, lectures were broadcast in real-time on Oriental platforms. This was most common in Skill Academy (63% of courses) and JMOOC (29%). In this way, Western platforms reflected the culturally characteristic strict adherence to procedures, linear order of monochronic culture and suppression of feelings, while Oriental ones reflected spontaneity, polychronic time perception and lack of structuring, as well as vivid displays of emotion (Mikułowski-Pomorski, 2003, p. 143).

XuetangX's main page offered a live streaming of the *Global MOOC and online Education Conference* (2021) available later in the registered version. Also, on other Oriental platforms, the main pages announced upcoming lectures in a live version, with the opportunity to chat with the lecturers. Users registered for the course were informed by e-mail about similar courses with live lectures.

Advanced search on the JMOOC homepage provides for Search by face-to-face learning course option, and live lectures are announced on the homepage of the plugged-in Gacco platform. Additionally, Ritsumeikan University offers live lectures. All of this is indicative of the distinctive attention paid to live words and dialogue in Eastern cultures, i.e. to context rather than to transcript.

English is compulsory at most universities in Japan, but „creative writing has not been widely used” (Honda, 2011). Japanese students tend to be afraid of making mistakes in class, especially in front of other students, and hesitate to be active (Honda, 2011, p. 45). In contrast, remote learning of *creative writing* emboldens students to communicate despite making mistakes, involves invention and the use of imagination, and thus it is more satisfying and intrinsically pleasurable (Honda, 2011, p. 48–49). For teachers, it provides an opportunity to promote national culture. For example, Professor Tsukasa Yamanaka in the course *Theory of Linguistics as Education: Language Deceives Us and Makes Life Difficult* (Yamanaka, 2018) highlighted an important role of non-verbal expression in high context cultures and “(Unfair) Privileges for Written Language” (Yamanaka, 2018). Thus, the course reflects the features and problems of high-context cultures resulting from the dominance of written language on the Internet. JMOOC includes 29% of courses with live lectures, confirming the local demand for this form of instruction. The incorporation of *creative writing* into English language instruction has reflected the reactive nature of the Japanese culture (Mikułowski-Pomorski, 2003, p. 122), i.e., relating to Western models instead of exclusively promoting one's own. However, Japan has an original literary tradition: classic waka, haiku, tanka, renga, and manga. Waseda University (n.d.) presents Japanese literary culture in the electronic and print media. Professor Kunihiko Nakajima of this

university associated the term *creative writing* with drawing letters in a pictogram form that make up English words (Boggio, 2019). Also, the students' work on Japanese poetry – a project for *creative writing* combined haiku and tanka poetry with Oriental music, Japanese landscapes, graphics and costumes, cherry blossoms, a bonsai tree, etc. (Brokenmemories7, 2009). The course *A Pictogram that Conveys Meaning in Shape* is also rooted in the Japanese culture. Participants learn to communicate using pictograms that verbalize actions or depict animals. They study the design principles of non-verbal visual communication, inquiring into what people understand from numbers and how they shape their consciousness through the creation of pictograms (Shirao, 2014).

After registration, emails were received from FutureLearn and Gacco (a subplatform of JMOOC). The administrators of the first one contacted us only three times within three days, informing us about the work plan for the first week and about two reviews of our poem. On the other hand, the Gacco office sent us 26 e-mails, at intervals of 1–7 days, from August to November 2023 (when the article goes to press), inviting us to participate in field trips and off-line seminars, in workshops and stationary classes, in live broadcasts and public lectures. They informed us about broadcasts of discussion meetings and invited to participate in projects sponsored by universities. They recommended new courses, the national Nikkei TEST business intelligence exam, and offered career counseling and support in changing jobs. It can, therefore, be concluded that social learning on the Gacco platform takes place in real contacts with lecturers and other participants of MOOC courses, while FutureLearn is limited to virtual contacts.

Thus, Western platforms, as representing a low-context culture, are dominated by the written word requiring no explanation. In contrast, real-time face-to-face contact and a variety of contexts are relatively common on Eastern platforms. The difference, therefore, is due to cultural learning practices rather than the commercial or governmental/academic nature of the platform.

## Discussion

On each of the surveyed platforms, MOOCs were presented in a specific design, enforcing content layout, ways of applying social learning and technology. This means that platform administrators influence MOOCs design. In this way, MOOC courses turn out to be not so much a mirror of cultures as a reflection of the business (Coursera, Skill Academy) or a political-economic (XuetangX) strategy of the administrators.

Platform administrators' strategies are reflected more clearly in the proposed applications of *creative writing* than in the accessible learning practices, which

are more culturally and organizationally determined by the learning systems in each country.

Coursera reflects the features of modern Western culture created by the expansion of technology and globalization: *creative writing* has become popular in Western culture and has multiple applications in business, education, popular culture, and even personal development. The pandemic, meanwhile, has accelerated the trend of targeting MOOCs to employees and future employees, rather than the most ambitious students who want to develop their specialized interests. Skill Academy resources confirm that this is a global trend.

*Creative writing* courses serve different purposes, depending on the platform owner's strategy, including a business strategy. According to Dhaval Shah (2022), the takeover of MOOC platforms as edX and FutureLearn from academic entities by commercial administrators means feeding learners into different entities belonging to new owners, thereby reducing the acquisition costs of platforms.

In Asia, however, *creative writing* has also been linked to the national literary tradition, especially in poetry. This is because the English language is seen as a manifestation of the expansion of Western culture. Therefore, on JMOOC and Xuetangx platforms Oriental MOOC authors combine *creative writing* with learning English and use literary education to deepen users' relationships with their native culture.

The results of our analysis of teaching strategies correlate with the cultural dimensions identified by Hofstede et al., and confirm the validity of the digital neocolonialism model of learning outcomes (Portmess 2013, Altbach 2014; Adam 2019), which, as it turned out, is implemented not only on Western platforms, but on commercial ones (Coursera, FutureLearn, Skill Academy et al.).

This means that the increasing commercialization of Western and Oriental platforms with MOOCs will probably replace their social learning in the real world by individualism and will limit the role of the e-teacher as a leader.

## Conclusions

The idea of spreading quality education to improve quality of life, which accompanied the creation of the first MOOCs, is becoming a thing of the past. More and more courses are being made available for a fee and without free versions. In-depth humanities courses are proving unprofitable, so commercial and governmental administrators tend to choose a few-hour courses to improve practical skills, especially business, and marketing. Contemporary MOOCs, therefore, do not tend to reflect the characteristics of the culture in which they were created, but the concentration and commercialization of the market for educational services.

Today, it is not culture, but the creative economy that often regulates education and exacerbates the reluctance of many academic entities to MOOCs.

In order for MOOCs to meet the educational needs of a different culture representative, not only translations into other languages are needed, but also modifications to learning objectives, content design, and layout. However, on commercial platforms, these are subordinated to business goals, not educational ones.

Adapting MOOCs to audiences from different cultures could help deepen mutual respect and understanding, and reduce or creatively resolve cultural, economic, and social conflicts internationally. This is possible because education, especially humanistic courses, strengthen cultural identity, deepen awareness of cultural differences, and develop cultural intelligence for their creative use. Therefore, financial and organizational support is needed for universities that still offer non-commercial, academic MOOC courses.

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Anna Ślórsarz

## MOOC: Globalne Cele Biznesowe i Lokalne Strategie Edukacyjne

### Streszczenie

MOOCs to kursy e-learningowe tworzone przez uniwersytety, instytucje badawcze, podmioty biznesowe i rządowe. Uniwersytety upowszechniają w nich najnowszą wiedzę, a podmioty biznesowe ułatwiają rozwijanie kompetencji, szczególnie z zakresu biznesu, ekonomii i informatyki. Paradoks polega na tym, że choć MOOCs są otwarte dla globalnych użytkowników, to jednak prezentują cechy charakterystyczne dla kultur swych twórców i administratorów, ponieważ są tworzone lokalnie.

Aby zidentyfikować cechy kultur widoczne w strukturze i treści wybranych kursów MOOC, przeanalizowano 267 kursów na temat *creative writing* zamieszczonych na 5 platformach: Coursera (USA), FutureLearn (Wielka Brytania), XuetangX (Chiny), JMOOC (Japonia) i Skill Academy (Indonezja). Okazało się, że Skill Academy i Coursera są najbardziej ukierunkowane na cele biznesowo-marketingowe, choć reprezentują odmienne kultury. Natomiast kursy chińskie, japońskie i indonezyjskie konsekwentnie odzwierciedlają reaktywność tych kultur i są zorientowane na ludzi oraz afiliację. Prezentują holistyczne podejście do uczenia (nacisk na kontekst), czyli wykorzystują wykłady na żywo, co nie zdarza się na obu platformach zachodnich.

Dlatego za mit należy uznać stwierdzenie, że MOOC jest lustrem kultury, w której powstał. Platforma MOOC prezentuje interesy administratorów i właścicieli. Platforma odzwierciedla jednak tylko niektóre kulturowe cechy głęboko zakorzenionych praktyk edukacyjnych. Właściciele platform diametralnie różnią cele ich działalności: akademickie (przekazywanie wiedzy ogólnej odchodzące do przeszłości po komercjalizacji Coursera i edX), marketingowe (nastawione na zdobycie klientów i pracowników) lub gospodarczo-polityczne (XuetangX).

Aby MOOC był użyteczny dla reprezentantów innej kultury, potrzebne jest nie tylko tłumaczenie na inny język, lecz także modyfikacja celów i metod nauczania, treści i szaty graficznej.

Słowa kluczowe: MOOC, reaktywność, indywidualizm, kolektywizm, rozwój osobisty, kontekst

Anna Ślósarz

## MOOC: Objetivos Comerciales Globales y Estrategias Educativas Locales

### Resumen

Los MOOC (cursos masivos abiertos en línea) son cursos de aprendizaje electrónico preparados por universidades, centros de investigación, empresas y organismos gubernamentales. Se trata de un dispositivo con el que los centros académicos difunden conocimientos de última generación, mientras que las entidades empresariales facilitan el desarrollo de competencias, particularmente en negocios, economía y TI. La paradoja es que, aunque los cursos MOOC están abiertos a usuarios globales, contienen y difunden características distintivas de la cultura original de sus inventores y administradores porque han sido creados localmente.

Para identificar las características culturales evidentes en el contenido de algunos cursos MOOC seleccionados, se analizaron 267 cursos de escritura creativa publicados en cinco plataformas: Coursera (EE.UU.), FutureLearn (Reino Unido), XuetangX (China), JMOOC (Japón) y Skill. Academia (Indonesia). Resultó que Skill Academy y Coursera eran las que más se centraban en objetivos de marketing empresarial, aunque representaban culturas diferentes. En cambio, los cursos de chino, japonés e indonesio reflejaban sistemáticamente la capacidad de respuesta de esas culturas y estaban orientados a las personas y a las afiliaciones. Emplearon un enfoque holístico de la enseñanza (énfasis en el contexto), es decir, operaron con conferencias en vivo, lo que no había sucedido en ninguna de las plataformas occidentales.

Por tanto, la convicción de que los MOOC son un espejo de la cultura en la que fueron creados debe considerarse un mito. Es la plataforma MOOC que presenta los intereses de los administradores y propietarios. Sin embargo, la plataforma refleja sólo algunas de las diferencias culturales de prácticas educativas profundamente arraigadas. Los propietarios de plataformas difieren dramáticamente en sus objetivos: académicos (la transferencia general de conocimientos pasa a ser cosa del pasado después de la comercialización de Coursera y edX), marketing (centrado en ganar clientes y empleados) o económico-político (XuetangX).

Para que un curso MOOC sea útil para los representantes de otra cultura, no sólo se necesita una traducción a otro idioma, sino también una modificación adecuada de los objetivos y métodos de aprendizaje, un contenido modificado y un diseño adecuado.

Palabras clave: MOOC, reactividad, individualismo, colectivismo, desarrollo personal, contexto

## **МООК: глобальные бизнес-цели и местные образовательные стратегии**

### А н н о т а ц и я

МООК (массовые открытые онлайн-курсы) — это курсы электронного обучения, подготовленные университетами, исследовательскими центрами, деловыми и государственными органами. Это инструмент, с помощью которого академические центры распространяют самые современные знания, а субъекты предпринимательства способствуют развитию компетенций, особенно в сфере бизнеса, экономики и информационных технологий. Парадокс заключается в том, что, хотя курсы МООК открыты для пользователей со всего мира, они содержат и распространяют отличительные особенности оригинальной культуры своих изобретателей и администраторов, поскольку были созданы локально.

Чтобы выявить культурные особенности, очевидные в содержании некоторых избранных курсов МООС, было проанализировано 267 курсов по творческому письму, размещенных на пяти платформах: Coursera (США), FutureLearn (Великобритания), XuetangX (Китай), JMOOC (Япония) и Skill. Академия (Индонезия). Оказалось, что Skill Academy и Coursera больше всего ориентированы на цели бизнес-маркетинга, хотя и представляют разные культуры. Напротив, курсы китайского, японского и индонезийского языков неизменно отражали отзывчивость этих культур и были ориентированы на людей и их принадлежность. Они использовали целостный подход к преподаванию (акцент на контекст), то есть оперировали живыми лекциями, чего не было на обеих западных платформах.

Поэтому убеждение в том, что МООК является зеркалом культуры, в которой он создан, следует считать мифом. Именно МООК-платформа представляет интересы администраторов и владельцев. Однако платформа отражает лишь некоторые культурные различия глубоко укоренившихся образовательных практик. Владельцы платформ кардинально различаются по своим целям: академические (общая передача знаний уходит в прошлое после коммерциализации Coursera и edX), маркетинговые (ориентированные на привлечение клиентов и сотрудников) или экономико-политические (XuetangX).

Чтобы курс МООК был полезен представителям другой культуры, необходим не только перевод на другой язык, но и правильная модификация целей и методов обучения, измененное содержание и соответствующая верстка.

**К л ю ч е в ы е с л о в а:** МООК, реактивность, индивидуализм, коллективизм, развитие личности, контекст





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# **Evaluating the Impact of Gamification on Learning Effectiveness in Technical Vocabulary Instruction**

## **Abstract**

With the rise of digital education, the integration of gamified elements has emerged as a potential strategy to enhance student engagement and comprehension in various academic disciplines. This study seeks to evaluate the impact of gamification on learning effectiveness in the domain of technical vocabulary instruction during an online course. A mixed-methods approach was employed, involving data collection from students enrolled on an online technical vocabulary programme offered by the Language Centre at Gdansk University of Technology. A quantitative analysis of placement test scores, the frequency of using course material and final grades was conducted to understand their impact on learning outcomes, and data from surveys provided insights into students' perceptions and experiences with gamified activities. The findings indicate that the incorporation of gamification positively influenced learning effectiveness during the online course. The participants demonstrated higher levels of motivation, active participation, and a deeper understanding of technical terminology achieved through gamified interactions. The study's outcomes contribute to the growing body of research on gamification's potential benefits in online learning environments, especially in the context of technical vocabulary instruction, and offer valuable implications for educators and course designers seeking innovative approaches to optimize learning experiences in virtual settings.

**Key words:** gamification, ESP, technical English, assessment, effectiveness, learning outcomes

## Introduction

The landscape of higher education is undergoing a transformative shift driven by student-centred pedagogical paradigms and the integration of technology into the educational environment. As universities strive to meet the diverse needs of today's digitally native student population, traditional teaching methods, once considered the cornerstone of academia, are now being supplemented and, in some cases, replaced by innovative approaches structured around Internet technologies. Among them, gamification has emerged as a strategy aiming to enhance student engagement, motivation, and overall learning outcomes.

Gamification refers to the application of game elements and principles in non-gaming contexts, such as education. By harnessing the appeal of games, including rewards, challenges, interactive experiences and story-based content, educators try to create dynamic and immersive learning environments that captivate and inspire students (Rincon-Flores & Santos-Guevara, 2021; Connolly et al., 2012; Kotuła, 2022; Mokwa-Tarnowska, Tarnowska, & Roszak, 2023). They believe that digital natives accustomed to instant gratification through online interactions, the razzmatazz of web applications and easily accessible technologies often find themselves disengaged in conventional lecture-based classrooms, bored with instructivist methods that have been domineering the teacher-controlled educational setting.

This research paper explores the multifaceted realm of gamification in technical language learning and teaching within higher education. It explores practical implementations and considers the implications it holds for the future of university education. The nature of the benefits derived from gamification is not yet fully understood, as only a limited number of longitudinal studies have been conducted, and their results are mixed as they primarily focus on the general usefulness of broadly understood gamification in education.

Lester et al. (2023) emphasize attitudinal, design-related and administrative barriers that can be overcome by educating technical staff and university administrators to support educators. Moreover, they note that gamification is likely to enter the educational process if perceived as useful, easy to use and not overly challenging for both teachers and students.

According to Mokwa-Tarnowska, Tarnowska, and Roszak (2023), a gamified language course is seen as attractive and engaging by technically-minded students partly due to its gamified format, but mainly due to its resources utilizing authentic

materials focusing on modern technological advances, interesting and provocative ideas, future trends and developments. However, their study only tested one gamified environment, leaving it unclear what impact more interactive courses with various embedded game-like elements could have on student engagement.

Saxena and Mishra (2021) add that most studies focus on using multiple game elements without separating and analysing their association with specific variables and effects in students. That is also confirmed by Dehghanzadeh et al., (2021), who state that research has yet to identify which game elements can effectively improve certain learning outcomes. Additionally, they note that the majority of findings are solely based on the perceptions of language learners and not actual learning outcomes.

Jayalath and Esichaikul (2022) hypothesise that integrating game thinking into the educational process, structured around the competency-based approach, can help improve learner motivation and foster competency achievement, an aspect they are currently investigating. Kalogiannakis, Papadakis, and Zourmpakis (2021) stress the necessity of clarifying the actual effects of gamification on motivation, learning-related behaviours, outcomes and teacher strategies, particularly in science education, as there is limited research in this area. According to Zainuddin, Chu, Shujahat, and Perera (2020), to fully understand the impact of gamification, we should investigate the pedagogical approaches used to create a gamified environment, including the competency-based approach, and the pedagogical models involved in game-based instructional design.

The certain ambiguity related to understanding the true nature of gamification can be partially attributed to the diverse interpretations of the concept of a 'game,' as explained by cognitive linguists. According to their insights, a game can be seen as a natural category with no necessary and sufficient features (Lakoff, 1987:16, 18, 21, 42, 62, 65; Kalisz & Kubiński, 1996). Thus, a wide array of games and their attributes can be harnessed to create gamified experiences, which in turn presents a unique challenge in researching the use of game elements in non-game contexts. Literature review shows that there is no rationale for choosing certain game elements over others (Khaldi, Bouzidi, & Nader, 2023).

Through empirical research, this paper aims to provide a further understanding of gamification's role in reshaping the landscape of higher education. It seeks to shed light on its potential effectiveness to improve technical English competence in students whose language skills range from B1 plus to C1 according to the Common European Framework of Reference (CEFR). This is done by evaluating students' learning outcomes and their overall performance based on the degree of engagement in learning on a gamified online course.

The impact of game-based instructional design on an improvement in knowledge and skills will be presented through the analysis of a course that was offered by the Language Centre at Gdansk University of Technology (GUT) in the summer semester of the academic year 2022/2023. The ideas shared in the

paper will be supported by quantitative research findings. The following research questions were addressed:

- How does gamification impact student motivation and performance?
- What are students' attitudes towards a gamified Moodle course in technical English structured around authentic resources?
- How effective can a gamified Moodle environment be to increase technical vocabulary in master's students?
- How do initial language skills and the frequency of using course material impact the final grade showing the ability to use contextualised vocabulary?

## **Gamified Environments and Gamification Methodology**

The experience of enjoyment and fun in gamified contexts is a fundamental aspect of gamification that appears to contribute to its effectiveness in engaging learners (Othman et al., 2023). Incorporating a compelling narrative or storytelling element can help participants immerse in the storyline, making their interactions feel like a part of an adventure.

Educational programmes with game-like elements are designed to present challenges that are neither too easy nor too difficult in an engaging and appealing story-based environment (Alrashed et al., 2023: 1226; Krishnamurthy, 2022). Overcoming them, that is achieving good scores in quizzes and high marks for additional activities is understood to provide a sense of achievement. Additionally, receiving rewards, whether in the form of points, badges and trophies, triggers positive emotions and enhances the fun factor.

Gamification alone may not effectively motivate students to participate in learning activities unless it is rooted in a cognitivist framework, which focuses on activities that involve active participation, problem-solving, decision-making strategies and critical thinking (Lyons, Fox, & Stephens, 2023). This could result in various learning outcomes, including cognitive, emotional, and behavioural development (Alt, 2023).

When gamified experiences align with a person's interests, goals and personality (Sanchez, Langer, & Kaur, 2020), they become intrinsically motivated to participate. This intrinsic motivation is a powerful driver of engagement (Qiao et al., 2023: 15–16). In the case of technical vocabulary instruction, contextualised vocabulary exemplified by authentic discourse, resources about state-of-the-art technologies and relevance to contemporary and future challenges aim to help students to self-direct their learning and keep them engaged throughout the whole online course (Mokwa-Tarnowska, 2017: 18–29).

Gamified experiences with quizzes provide immediate feedback on actions or progress. This keeps participants engaged and provides a sense of achievement, contributing to the overall enjoyment and satisfaction. It is noteworthy that not only summative feedback but also formative feedback, such as advice, encouraging comments and emoticons, helps students feel less isolated in an online environment and guides them throughout the whole experience.

When students are offered a choice, when they can decide which activity to choose to progress to the next stage, they feel in control over the learning process. As a result, they are more likely to have a positive experience. Moreover, making choices encourages students to take responsibility for their education. It fosters a sense of accountability. Additionally, allowing them to choose activities that align with their individual needs, learning preferences, strengths, and interests can lead to more effective and enjoyable learning. Finally, the process of making choices in learning is an opportunity for students to develop soft skills such as critical thinking and decision-making (Mokwa-Tarnowska, Roszak, & Kołodziejczak, 2018).

The visual and auditory elements on a gamified course, including graphics and sound effects, can contribute to the overall positive perception of the learning experience. Well-designed and aesthetically pleasing gamified environments enhance the user experience.

All of the above-mentioned factors involved in gamification methodology were used to develop the Moodle course 'My Interstellar Colony Mission (MyICM)', which is offered by the Language Centre at Gdansk University of Technology to master's students. Moodle was not designed for gamification, but it can be adapted to utilise game-like elements in English for Specific Purposes (ESP) courses. Moreover, it is the university's primary Learning Management System and is well protected against data security breaches.

The course mimics a traditional 14-week workload with 14 stages over 5 levels. Each stage offers three paths: two for self-paced study and one for extra activities, some involving face-to-face meetings. To progress, participants must score 60% in one of two "Test Yourself" quizzes and can try two "Challenge Yourself" quizzes for more points. The course structure resembles a board game, with horizontal moves within stages and vertical ones between stages. The colour scheme denotes seniority, with darker colours for higher positions obtained as the story develops and stages are successfully passed through. Participants collect trophies (badges) as they advance in a narrative of building a distant colony, learning contextualized professional and formal English. Quizzes encourage engagement with materials, while additional activities boost scores through critical thinking and writing. Default icons are hidden for visual appeal, using clickable images to guide participants to subpages. Feedback is provided through percentage points, written comments, recorded stimuli and emoticons.

Contextualised technical vocabulary is introduced using authentic papers, videos and animations linked to the course and highlighted by means of other

Moodle-based resources in the form of bulleted lists, tables, comments with examples, explanations and suggestions, followed by various activities developed with Moodle tools. The subsequent topic areas divided into stages include: job application procedures, habitation, food production, energy production, communication and transportation systems as well as regulations. The storyline guides students through coursework and also exemplifies appropriate, context-specific technical language.

## **Research Methodology**

Data for this study were gathered through an online questionnaire accessible via the Moodle course website upon the completion of the game. The questionnaire comprised 17 questions, including one open-ended, two about the placement test score and overall score presented on interval scales, as well as inquiries about the faculty in which the respondent is enrolled, the least and most interesting stages, and the most challenging stages, along with workload. These questions were represented using a nominal scale, where categorical variables do not possess inherent order. The remaining questions were structured using a five-point Likert-style scale, where respondents were instructed to rate their responses, facilitating a nuanced understanding of their opinions. Each question on the ordinal scale concluded with a request for participants to provide comments, offering deeper insights into the rationale behind their quantitative ratings, thus enriching the data collection process qualitatively.

The questionnaire's reliability and validity are confirmed through administering the same set of questions three times over three semesters to a group of students from the same university and a comprehensive statistical analysis of their responses. The questionnaire included standardised questions commonly used to assess online education and language courses. To maintain the integrity of the study, all participants received the same set of questions and underwent testing under identical conditions. This approach ensures that the findings remain unaffected by variations in question content or testing circumstances. Lastly, it is crucial to note that participation in the questionnaire was restricted to those who had successfully completed the gamified course, reaching the final stage. This selection criterion was applied to maintain methodological consistency. In total, 94 students enrolled on the course in January 2023; 84 passed it, and 72 completed the questionnaire.

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

The study yielded outcomes that exhibited a high degree of generalizability. This trend was consistently observed across the entire sample of participants, reinforcing the reliability of the results.

Quantitative data are presented as percentages. Ordinal data are expressed also as median, interquartile range and minimum and maximum values, and are represented in box plots. Data were analysed with correlation matrices and a linear regression model. Although the results presented in this paper were considered statistically insignificant with  $p > .05$ , they provided valuable insights into the educational value of a gamified environment. The statistical analyses were performed with RStudio.

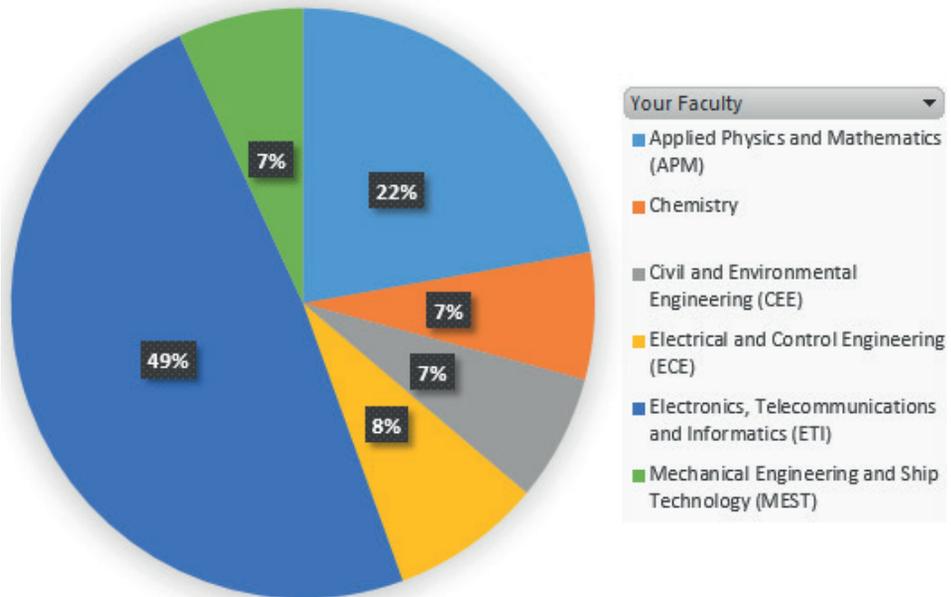
## Results and Discussion

The survey participants consisted of students from six different faculties, which is visible in Figure 1: 16 of the Faculty of Applied Physics and Mathematics (APM), 5 of the Faculty of Chemistry, 5 of the Faculty of Civil and Environmental Engineering (CEE), 6 of the Faculty of Electrical and Control Engineering (ECE), 35 of the Faculty of Electronics, Telecommunications and Informatics (ETI) and 5 of the Faculty of Mechanical Engineering and Ship Technology (MEST). In total, 72 participants completed the questionnaire out of the 84 who completed the course.

The sample size, divided by faculty, is insufficient for analysing whether students' perceptions of their educational experiences differ based on their respective faculties. However, as all the participants are science and engineering students, they form a relatively homogeneous group. Additionally, being master's students, they possess a significant amount of educational experience and specialised knowledge acquired prior to the commencement of the gamified course in technical English. Therefore, despite the variation in faculties, it is possible to observe similarities in their attitudes and understanding of the added value of the course environment across the entire sample. This makes it a sufficient basis for analysis.

The data presented in Figures 1–11 and in Table 1 were collected and analysed by us with no support from other parties. The graphs for statistical analyses were generated using RStudio.

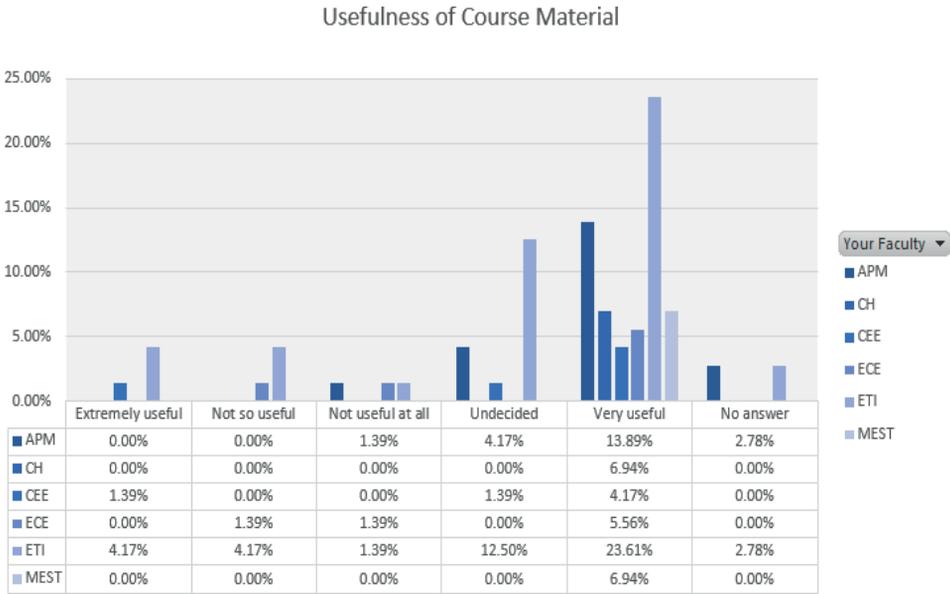
## Faculties



*Figure 1.* Survey participants by faculty

Note. Survey participants were divided by faculty to assess diverse academic perspectives.

The students were asked to evaluate the usefulness of the course materials, both resources and activities, to improve their language skills (Figure 2). More than half of the respondents, that is 66.67%, rated them as either ‘very useful’ or ‘extremely useful.’ The percentage distribution reveals an intriguing trend: students from the Faculty of Electronics, Telecommunications and Informatics, as well as those from the Faculty of Applied Physics and Mathematics, found these materials the most valuable. This finding is noteworthy, given that the former group exhibits less enthusiasm for topics unrelated to their specialisation in a traditional classroom setting. It seems that the storyline was engaging enough to encourage them to pursue other areas as well, such as for example architecture and building constructions. However, a notable portion, 18.06% of the students, expressed no opinion. This may have resulted from them participating in a course structured around various technical topics for the first time, some of which were highly specialized and not immediately applicable to their main field of study. Around one tenth of the respondents (9.73%) did not recognise the educational value of the materials related to language skills improvement.

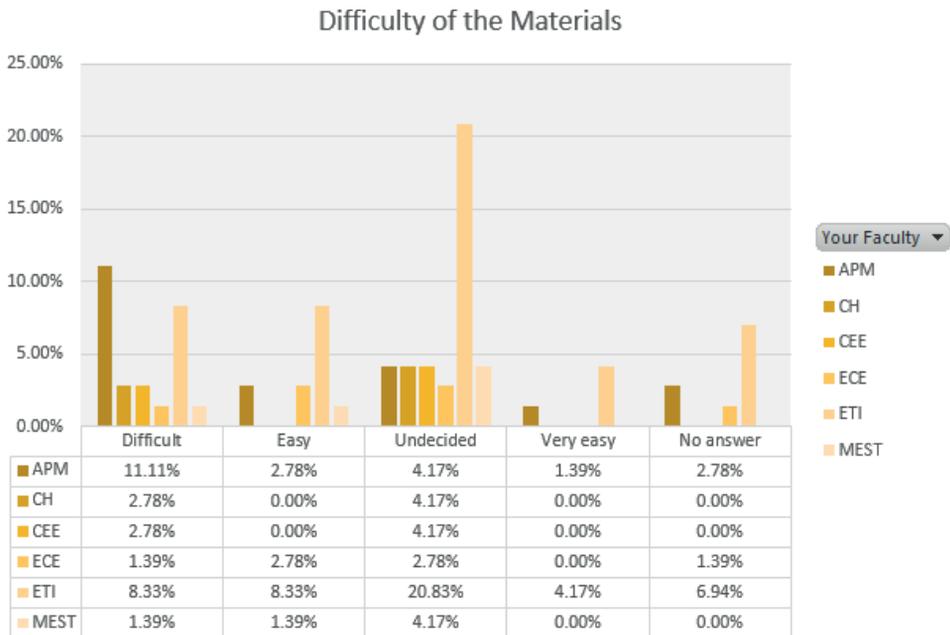


**Figure 2.** Usefulness of the course materials to improve language skills

Note. The usefulness of the course materials in improving language skills was highly rated by the students.

The resources were based on authentic materials so in many videos and articles the language was more difficult than in a typical coursebook for advanced students. Particularly, it was visible in the case of some of the jargon and prepositional phrases used. Nevertheless, for foreigners whose command of the English language is relatively strong and whose-subject specific knowledge is substantial, grasping the fundamental meaning did not present significant difficulties. That was evidenced by the responses to the question about the difficulty of the materials (Figure 3) and comments explaining the choice.

It is worth noting that no student marked the answer ‘very difficult’, only 27.78% found the content difficult, and as many as 40.28% were undecided. Additionally, 11.11% opted not to provide a response.

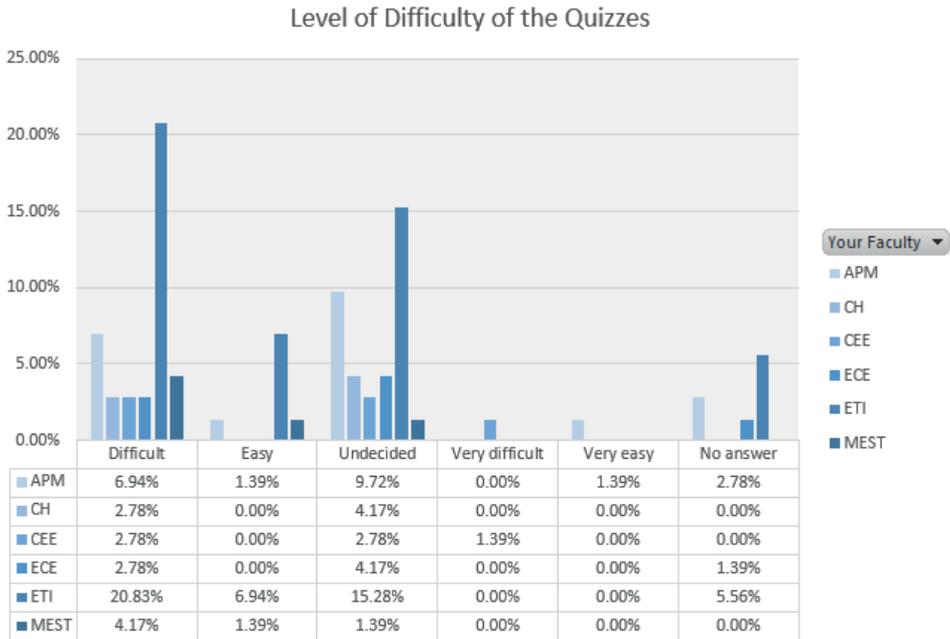


**Figure 3.** Perception of the difficulty of the materials

Note. Students' perception of the difficulty of the materials did not vary significantly across the faculties, with some exceptions.

Compared to the perception of the difficulty of the course materials, the resource-based quizzes were deemed significantly more challenging (Figure 4). Just over two fifths of the respondents (41.67%) rated them as difficult, with 1.39% finding them very difficult. Similarly, an equivalent number of respondents considered them very easy, and for 9.72% they were easy. Much like the perceived difficulty of the course materials, students from the Faculty of Electronics, Telecommunications, and Informatics tended to view these quizzes as demanding.

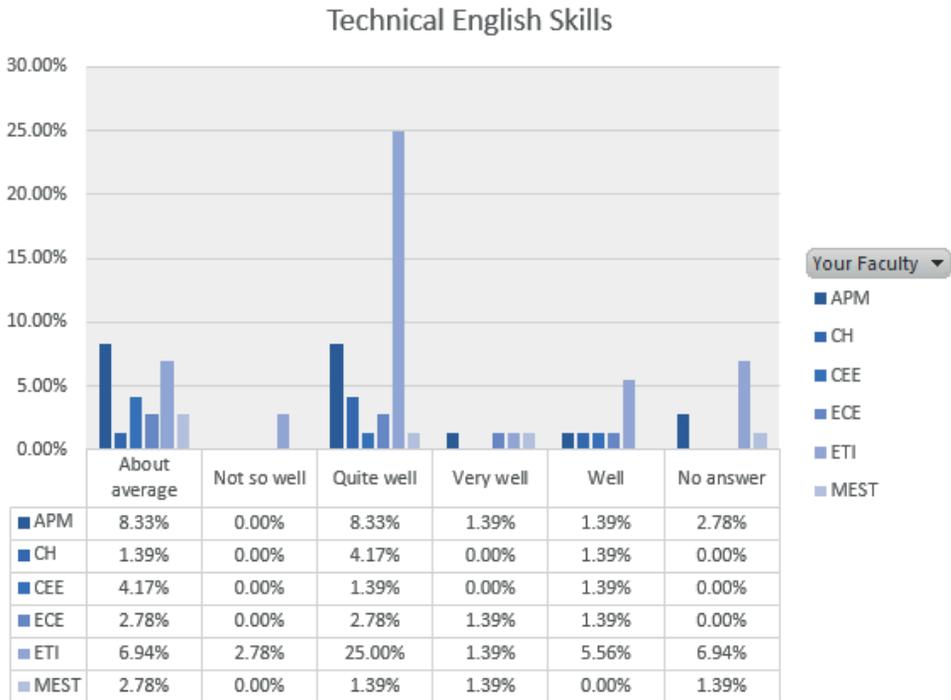
These quizzes assessed the use of context-specific prepositions and collocations, making them potentially more intricate for students more accustomed to reading mathematical notations and physics formulas. The comments explaining the choices indicate that students are not accustomed to closely analysing the language of the text but rather tend to focus on the meaning itself. Furthermore, some students did not recognise the educational value of the quizzes, which often aimed at teaching them less obvious or not directly translatable collocations.



**Figure 4.** Perception of the difficulty of the quizzes

Note. The students’ perception of the difficulty of the quizzes was generally consistent, though a few found them challenging.

The students were asked to objectively evaluate their ability to use technical English based on their performance and comments they had received on their work (Figure 5). The majority, which constitutes 86.12%, were satisfied with the outcome, with 5.56% who rated it as very good, 11.11% as good, 43.06% as quite good and 26.39% as about average. Only 2.78% expressed their dissatisfaction and 11.11% did not opt for any answer. No students chose the ‘rather badly’ or ‘badly’ responses. The distribution of answers can be explained by the students achieving the 60% threshold pass in the vast majority of the quizzes. However, the top performance, which in a traditional context exceeds 90% score, was rarely recorded. Some of the students lost points by attempting the quizzes without reading and watching the resources, which they confirmed in the questionnaire.



**Figure 5.** Assessment of technical English proficiency based on performance and comments received

*Note.* The assessment of technical English proficiency was based on performance and comments received, revealing a range of skill levels among participants.

Generally, the students were satisfied with the gamified format of the course (Figure 6). This assumption is based on the fact that they had not previously engaged in a similar educational experience, which they confirmed in various additional comments. A positive response came from 34 (47.22%) participants who gave it grade 4, and 14 (19.44%) who chose the highest rating. Only two students expressed strong disapproval, and four evaluated it low by choosing grade 2. Four of the low scores came from participants with final grades in the 55%–64% range, one from an individual who scored above 70%, and one from a student who just passed the course (40%–49%). While participants were familiar with the general concepts behind this gamified Moodle-based course, they did not consider the format a significant factor in providing added value.

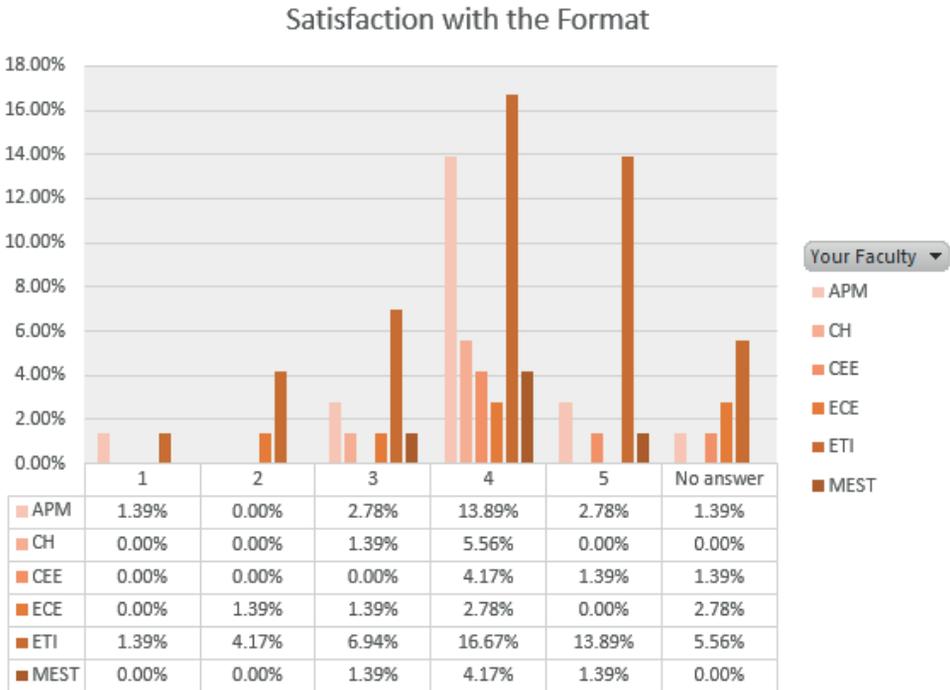


Figure 6. Satisfaction with the course format on a scale of 1 to 5, with 5 symbolizing the highest level of contentment

Note. Satisfaction with the course format was measured on a scale of 1 to 5, with 5 symbolizing the highest level of contentment, and the above average score indicated a generally positive response from participants.

Altogether seven respondents stated that they were not satisfied with the gamified experience (Figure 7), which is consistent with the answers provided for the question about the satisfaction with the course format. A similar number – 55 students, which accounts for 62.5%, expressed their positive attitude. It can be inferred from these results that the gamified format employed in the course was, for the majority, not only well-received but also sufficiently engaging. The positive responses suggest that it effectively motivated and inspired the participants, encouraging them to work at their own pace and ultimately yielding satisfactory results. This trend supports the understanding that the gamified structure of a course manages to foster a sense of engagement among the participants. Moreover, thus constructed gamification appears to stimulate a self-directed learning pace, enabling participants to progress in a manner that suits their individual preferences and capabilities.

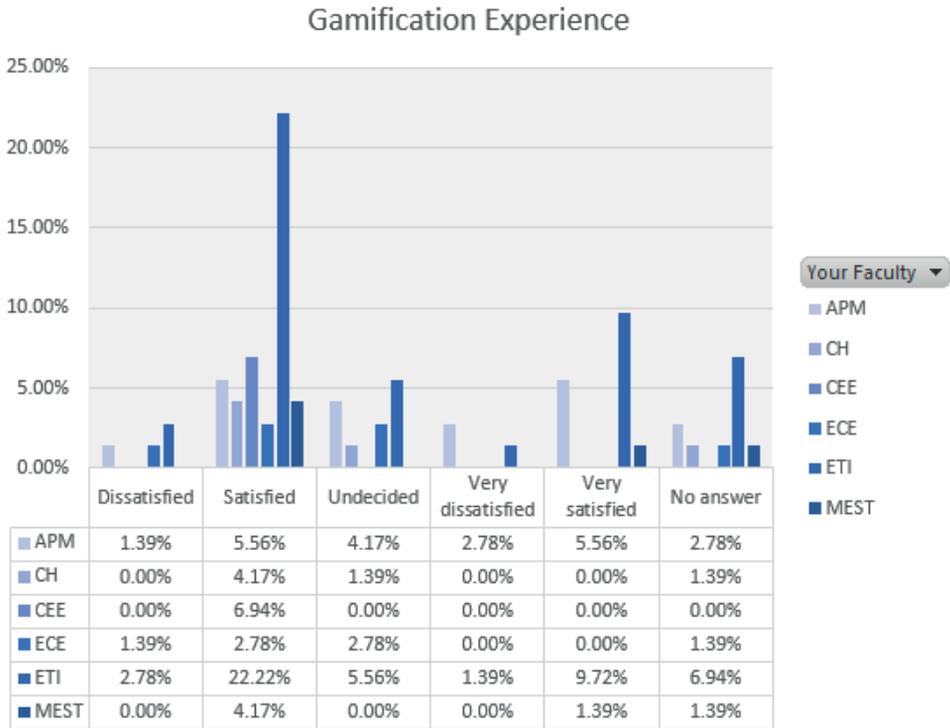


Figure 7. Participant ratings of gamification experience

Note. Participant ratings of the gamification experience reflected a high level of engagement and satisfaction.

Interestingly, as Figure 8 shows, the majority of the students stated that the gamified course met their expectations in terms of quality learning (20.83% of the ‘strongly agree’ answers and 51.39% of the ‘agree’ ones). The percentage of positive responses is even higher, that is 80%, if they are calculated against the total number of participants who decided to mark one of the options provided – seven students did not give any answer. It can be assumed that if the students considered their learning experiences in such a positive way, they treated the environment as effective for technical vocabulary instruction and improvement in technical English language skills.

The five students who did not treat this gamification experience as an example of quality learning scored in the range of 55%–64% and only one above 70%. This shows that either the course content and structure were not sufficiently engaging or the students did not have time for learning or it was difficult for them to self-direct their learning, as four of them stated that they had worked irregularly. Their perception of quality learning may be rather related to teacher-led instruction in a traditional classroom setting.

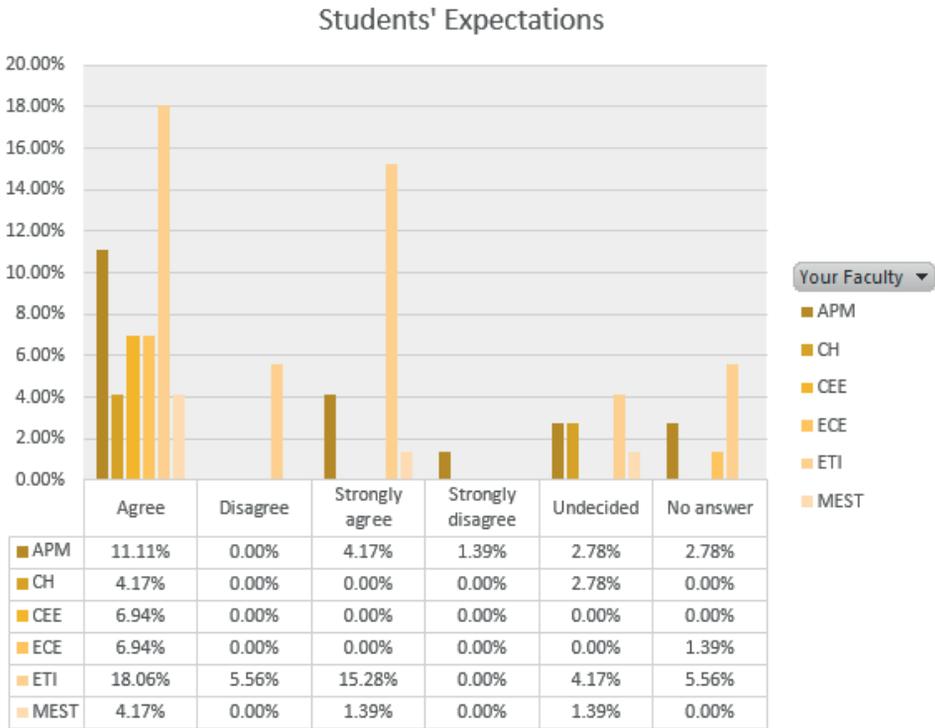


Figure 8. Expectations in terms of quality learning

Note. Expectations in terms of quality learning were met or exceeded for the majority of participants in the online gamified program.

Figure 9 demonstrates the absence of correlations between the placement test scores, measured on an interval scale ranging from 30 to 120, and the final grades, assessed on a scale ranging from 40 to above 70. The Pearson correlation coefficient ( $r = 0.12$ ) indicates no significant linear relationship between higher placement scores and higher final grades. This finding is reinforced by a calculated p-value of 0.3, which exceeds the threshold of 0.05, indicating that the result is not statistically significant. Therefore, based on this statistical analysis, it can be inferred that higher scores in the placement test did not necessarily translate into higher grades in the course.

The course content was designed to engage students in learning, with an emphasis on ensuring that the language used in the instructional materials was not overly challenging for technically-minded students, especially master's students who often need to use English to enhance their specialized knowledge. Furthermore, the content varied in terms of language difficulty and complexity, and course participants had the flexibility to choose which tests and challenges they wanted to attempt. As a result, students with lower-level skills were able to achieve learning outcomes similar to those of advanced students.

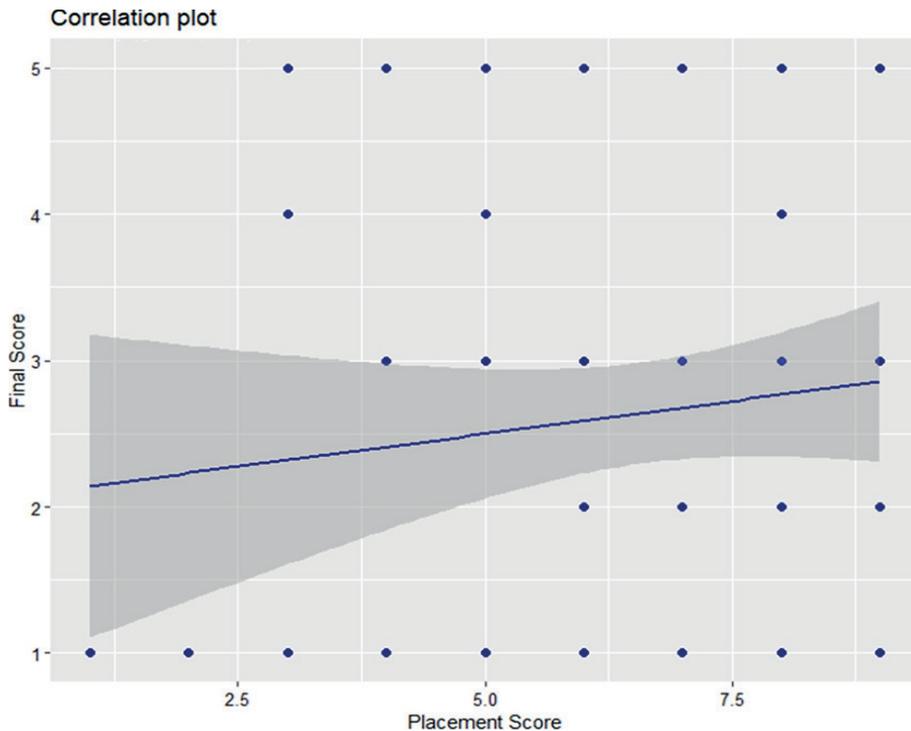


Figure 9. Correlation between placement test scores and final grades

Note. Placement Test Score Bands:

Band 1 – 31–40 marks; Band 2 – 41–50 marks; Band 3 – 51–60 marks; Band 4 – 61–70 marks; Band 5 – 71–80 marks; Band 6 – 81–90 marks; Band 7 – 91–100 marks; Band 8 – 101–110 marks; Band 9 – 111–120 marks

Final Grade Bands:

Band 1: 40%–49% (equivalent to grade 3); Band 2: 50%–54% (grade 3.5); Band 3: 55%–64% (grade 4); 65%–69% (grade 4.5); Band 5: 70% and above (grade 5).

Figure 10 further confirms the absence of a correlation between the frequency of using course materials and final grades ( $r = -.02$ ,  $p\text{-value} = .08$ ). Students were surveyed to rate their usage frequency on a scale ranging from 1 to 7, where 1 indicated minimal usage (i.e., the least frequent course website access), and 7 represented intense usage of more than three hours per week. Notably, 27.78% of students reported an average of 2 to 3 hours, aligning with the assumed workload. Conversely, an equal proportion of students worked irregularly, accessing the course website at intervals of every other week or less frequently, without specifying session durations. The statistical analysis reveals no discernible linear relationship between these two variables; students who accessed the course website more frequently did not achieve higher scores.

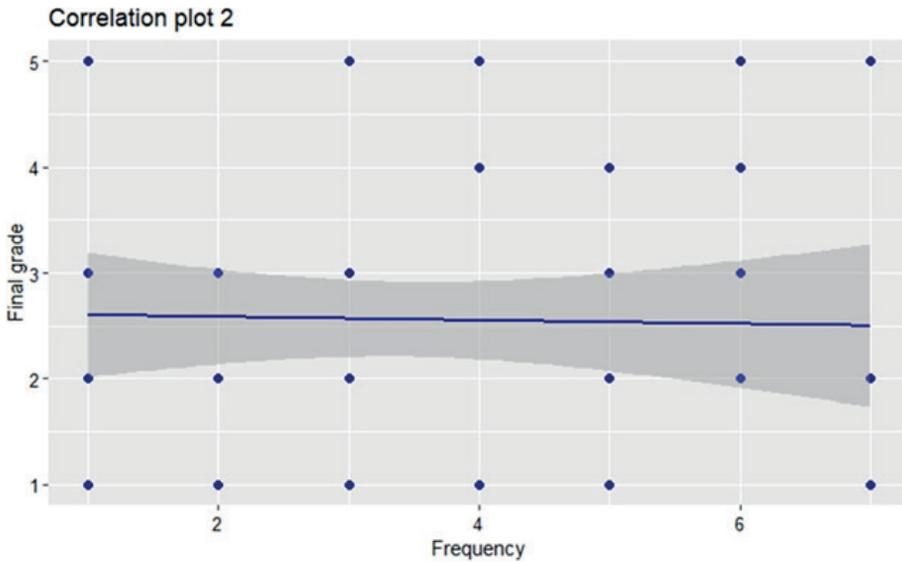
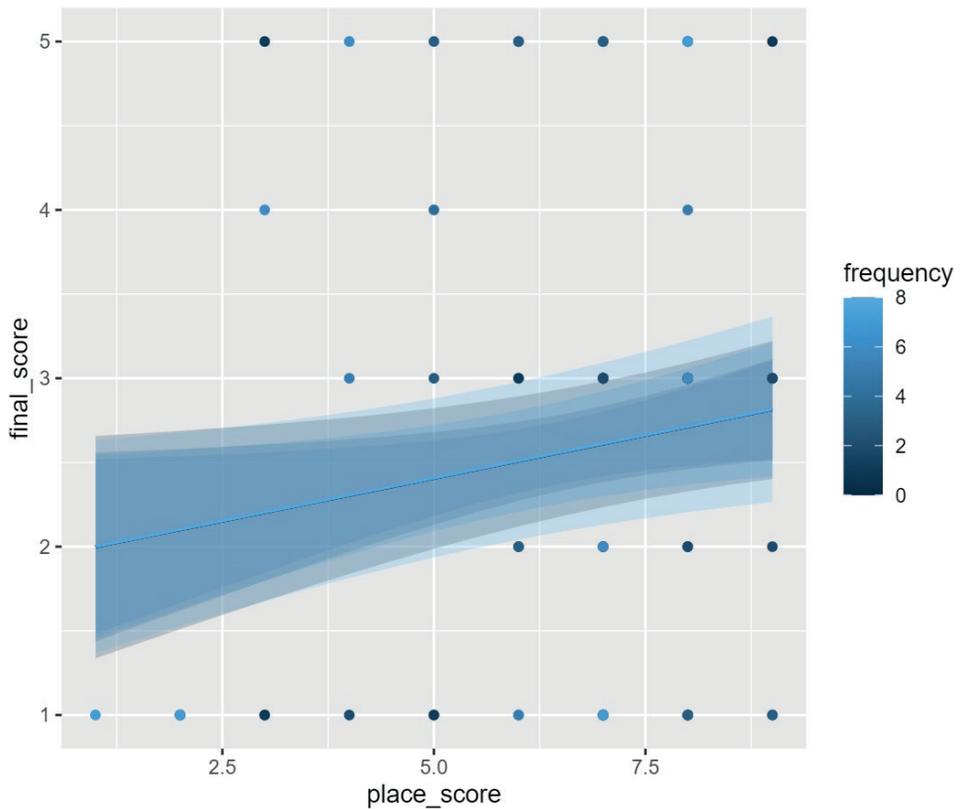


Figure 10. Correlation between frequency of using course material and final grade

Note. Frequency intervals: 7 – More than 3 hours a week, 6 – 2–3 hours a week, 5 – 1–2 hours a week; 4 – less than an hour a week; 3 – every other week; 2 – once a month; 1 – other.

The data analyses indicate that there is no significant predictive relationship between the final grade and the examined independent variables, specifically the placement score and the frequency of using course material (Figure 11). To assess this, a multiple linear regression model was employed, and the regression yielded statistically non-significant results. This conclusion aligns with the model results. According to F-statistics ( $F(2, 63) = .67$ ) none of the independent variables are useful in predicting the outcome, R-Squared coefficient ( $R^2 = .02$ ) indicates that the outcome cannot be predicted by any of the independent variables. The overall p-value = .5166, which exceeds the threshold of .05, indicates that there is a non-significant relationship. The individual predictors were examined further and indicated that placement score ( $t = 1.14, p > .05$ ) and the self-reported frequency of studying ( $t = .01, p > .05$ ) were non-significant predictors.



*Figure 11.* Correlation between placement test scores, frequency of using course material and final grades

Note. The analysis revealed a correlation between placement test scores, frequency of using course material, and final grades, indicating that higher engagement with the material often led to better outcomes.

As seen in Table 1, the mode – the most frequent number – in the placement score category is band 101–110 (19 students out of 72). The median band stands at 91–100. This indicates that, overall, the students had fairly advanced general English language skills before the course began. Moving to the final grade category, the mode is 40%–49%. Considering the passing threshold at 30%, this grade, achieved by a significant proportion of students (23 out of 72), is relatively low. The median for the final grade falls within band 3, specifically 55%–64%, which proves that a sufficient number of students were able to meet the requirements set for this online course at a fairly satisfactory level. Regarding the frequency of using course materials, the median falls within interval 3, meaning the students worked every other week. Interestingly, the mode for this category mirrors the median, which may have resulted from the students not being able to efficiently self-direct their learning, but it shows consistency in the obtained results.

Table 1

*Comparison of medians, modes, minimum, and maximum values of placement test scores, final grades, and frequency of course material use across course participants*

	<i>Median</i>	<i>Mode</i>	<i>Min</i>	<i>Max</i>
<b>Placement Score</b>	7	8	1	9
<b>Final Score</b>	3	1	1	5
<b>Frequency</b>	3	3	1	7

Note. The comparison of medians, modes, minimum, and maximum values of placement test scores, final grades, and frequency of course material use across course participants provided a comprehensive overview of the performance and engagement levels within the cohort.

The statistical model's validity and reliability is supported by the fulfilment of crucial assumptions. Both linearity, which ensures that the relationship between independent and dependent variables can be effectively represented by a linear model, and homoscedasticity, which indicates consistent residual variance across all levels of the independent variables, are met. Consequently, the sample is representative of the population.

In summary, based on the statistical analyses and the fulfilment of model assumptions, it should be emphasised that neither the placement score nor the frequency of using course material can reliably predict the final grade in the dataset. These results emphasize the need to explore other factors or variables that may influence academic performance. It appears that learning styles, cognitive factors, intrinsic and extrinsic motivation, self-regulation, and personal interests and goals have a more significant impact on learning outcomes in a gamified learning environment than initial language skills and the frequency of using course materials.

## Conclusions

The analysis of the survey results has shown that gamification can have a positive impact on the effectiveness of technical vocabulary instruction. The novelty of the created environment enhances student engagement and motivation. Game-like elements appear to make learning more enjoyable and encourage students to actively participate in the learning process. The element of surprise, resulting from the course's structure that reveals itself when participants successfully complete subsequent stages, serves as an additional stimulus to continue their coursework.

Furthermore, gamified learning experiences can be adapted to individual learners. This personalization can help students progress at their own pace and

address their unique learning needs. Although some students worked irregularly and accessed the course website at different intervals, they managed to meet the requirements and pass the course. The vast majority exceeded the 70-percent threshold, enabling them to finish with the highest grade. However, they had to do some extra tutor-marked assignments, not obligatory but adding additional percentage points granted by the tutor at the end of the course.

The effectiveness of gamification depends on the context in which it is used. It may be more effective for certain subjects or age groups and less so for others. This was partly supported by the students' comments, which indicated that they enjoyed the storyline about building a colony on another planet. They understood the reasons behind incorporating different topics and they did not object to studying context-specific vocabulary unrelated to their specialisation. Additionally, the workload and passing threshold requirements set for each stage were not overly burdensome, allowing students to allocate less effort, though not entirely avoiding it, to the sections that demanded more specialized knowledge, which they might have lacked as students pursuing an unrelated master's degree. It is worth emphasizing that many of the specific language structures and vocabulary identified and targeted in the quizzes can be applied when speaking and writing professional texts across various disciplines. In a traditional setting, master's students doing an English course at Gdansk University of Technology would not be exposed to contextualised technical language in context unrelated to their specialism. Thus, it can be concluded that the building-colony-based online course with a board game-like structure and various rewards engaged them in learning a variety of technical vocabulary.

While gamification can make learning fun or lighter when compared to a traditional classroom setting, it is crucial to strike a balance between entertainment and educational goals. Games should align with learning objectives and not become distractions. In this case, the colony building scenario did not infantilise the participants. It managed to introduce them to a variety of technical subjects. The course was built based on authentic materials, i.e., scientific articles, documentary programs, podcasts, and lectures. The resources discussed new technologies currently in use and showcased innovative solutions that are still in the testing phase, which encouraged the students to immerse in topics not necessarily related to their specialisation but building general education competence in technical subjects.

The long-term impact of gamification on learning is still a subject of research as shown in the referenced literature. While gamified activities can result in short-term increases in engagement and motivation, as supported by the data collected in this study, their long-term effectiveness may vary. Furthermore, the gamified course was promoted to approximately 250 master's students, but only 94 chose to enrol, and 10 dropped out at various stages. A significant majority, well over 50%, preferred attending teacher-led traditional classes. The reasons can vary, but

definitely one of them was the feeling of isolation the students suffered from during the COVID-19 pandemic, which they feared would again negatively influence their learning. Moreover, in-person contact hours with the teacher remain a much more preferred method for learning a foreign language for the students of Gdansk University of Technology.

Finally, it seems to be difficult for university students to self-direct self-paced learning required on an online course. However, the gamified experience, the element of innovation in teaching in particular, supposedly resulted in the students enjoying their learning experience and increasing the knowledge of technical vocabulary in focus to a satisfactory level.

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## Ocena wpływu gamifikacji na skuteczność uczenia się słownictwa technicznego

### Streszczenie

Wraz z rozwojem edukacji cyfrowej, gamifikacja stała się potencjalną strategią zwiększającą zaangażowanie i przyrost kompetencji studentów w różnych dziedzinach akademickich. Niniejsze badanie ma na celu ocenę wpływu gamifikacji na skuteczność uczenia się angielskiego słownictwa

technicznego. Wykorzystano dane zebrane od studentów studiów magisterskich Politechniki Gdańskiej, zapisanych na semestralny kurs języka technicznego, oferowany przez Centrum Języków Obcych. Przeprowadzono analizę porównawczą wyników testów diagnostycznych, ocen końcowych oraz częstotliwości korzystania z materiałów kursowych przez studentów. Dane z ankiet dostarczyły wglądu w postrzeganie przez studentów zgamifikowanych aktywności. Wyniki wskazują, że wprowadzenie gamifikacji miało pozytywny wpływ na skuteczność uczenia się w trakcie kursu online. Dzięki interakcjom wynikłym z wprowadzenia elementów gamifikacji, uczestnicy wykazali wyższy poziom motywacji, chęć aktywnego uczestnictwa oraz głębsze zrozumienie terminologii technicznej. Wyniki badania stanowią przyczynek do dyskusji na temat korzyści z gamifikacji w nauczaniu online, zwłaszcza w kontekście nauczania słownictwa technicznego, i oferują cenne wskazówki dla edukatorów i projektantów kursów, którzy poszukują innowacyjnych podejść zmierzających do optymalizacji doświadczeń edukacyjnych w wirtualnych środowiskach.

**Słowa kluczowe:** gamifikacja, techniczny angielski, ocenianie, efektywność, efekty uczenia się

Iwona Mokwa-Tarnowska, Viviana Tarnowska

## **Evaluar el Impacto de la Gamificación en la Efectividad del Aprendizaje en la Instrucción de Vocabulario Técnico**

### **R e s u m e n**

Con el auge de la educación digital, la integración de elementos gamificados ha surgido como una estrategia potencial para mejorar la participación y comprensión de los estudiantes en diversas disciplinas académicas. Este estudio busca evaluar el impacto de la gamificación en la efectividad del aprendizaje en el ámbito de la instrucción de vocabulario técnico durante un curso en línea. Se empleó un enfoque de métodos mixtos que implicó la recopilación de datos de estudiantes inscritos en un programa de vocabulario técnico en línea ofrecido por el Centro de Idiomas de la Universidad de Tecnología de Gdansk. Se realizó un análisis cuantitativo de las puntuaciones de las pruebas de ubicación, la frecuencia de uso del material del curso y las calificaciones finales para comprender su impacto en los resultados del aprendizaje, y los datos de las encuestas proporcionaron información sobre las percepciones y experiencias de los estudiantes con las actividades gamificadas. Los hallazgos indican que la incorporación de la gamificación influyó positivamente en la efectividad del aprendizaje durante el curso en línea. Los participantes demostraron niveles más altos de motivación, participación activa y una comprensión más profunda de la terminología técnica lograda a través de interacciones gamificadas. Los resultados del estudio contribuyen al creciente cuerpo de investigación sobre los posibles beneficios de la gamificación en entornos de aprendizaje en línea, especialmente en el contexto de la instrucción de vocabulario técnico, y ofrecen valiosas implicaciones para educadores y diseñadores de cursos que buscan enfoques innovadores para optimizar las experiencias de aprendizaje en entornos virtuales.

**Palabras clave:** gamificación, ESP (inglés con fines específicos), inglés técnico, evaluación, eficacia, resultados de aprendizaje

Ивона Моква-Тарновска, Вивиана Тарновска

## **Оценка влияния геймификации на эффективность обучения технической лексике**

### **Аннотация**

С ростом цифрового образования интеграция игровых элементов выходит на передний план как потенциальная стратегия повышения заинтересованности и понимания студентов в различных академических дисциплинах. Это исследование направлено на оценку влияния геймификации на эффективность обучения в области обучения технической лексике во время онлайн-курса. Был использован комбинированный подход, включающий сбор данных от студентов, обучающихся на онлайн-курсе технической лексики, предлагаемый Языковым центром Гданьского технологического университета. Проведен количественный анализ результатов вступительных тестов, частоты использования учебного материала и конечных оценок для понимания их влияния на результаты обучения, и данные из опросов предоставили представление о восприятии и опыте студентов с игровыми активностями. Выводы свидетельствуют о том, что внедрение геймификации положительно повлияло на эффективность обучения во время онлайн-курса. Участники проявили более высокий уровень мотивации, активного участия и более глубокого понимания технической терминологии благодаря игровым взаимодействиям. Выводы исследования способствуют росту объема научных исследований возможных преимуществ геймификации в онлайн-учебных средах, особенно в контексте обучения технической лексике, и предоставляют ценные рекомендации для преподавателей и разработчиков курсов, которые ищут инновационные подходы для оптимизации учебного опыта в виртуальных средах.

**Ключевые слова:** геймификация, английский для специальных целей (ESP), технический английский, оценка, эффективность, результаты обучения



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## **Formation of Socially Successful Personality of Adolescent Pupils by Means of Gamification (Kyiv City, Ukraine)**

### **Abstract**

The research highlights the essence of gamification and the results of teenagers' participation in the educational program with the elements of gamification called "Social successfulness" in the educational process of educational institutions. Theoretical methods are applied – analysis, synthesis, comparison, systematization, generalization of materials from psychological and pedagogical sources regarding the problem of social successfulness and the possibilities of its formation in adolescents in the conditions of out-of-school and general secondary education institutions, specification for harmonizing the content of the curriculum devoted

to “Social successfulness”; empirical methods – observation, questionnaires for collecting empirical information, blitz surveys concerning the awareness of the characteristics of a successful personality.

The authors consider gamification as a set of various tools and mechanics that contribute to the significant enrichment of the educational process with entertaining, educational, motivational, and social-communicative components. The researchers characterized the educational program “Social successfulness”, in particular, determined its target orientations and key competencies of teenagers, highlighted the gamification tools necessary for the implementation of the program, found out that the mixed format is the optimal format for its implementation, as it combines the advantages of offline and online learning and can be effective in conditions of increased danger associated with martial law.

The article carried out a pedagogical reflection and found out that, according to the results of the blitz survey, teenagers verbalize the two most common portraits of a socially successful personality (based on external indicators of success and personal qualities). According to the results of the questionnaire, it was found out that the participation of teenagers in the “Social Successfulness” program contributes to their positive and optimistic attitude towards themselves and their life prospects; growing interest in socially significant team activities; enhances pleasant experiences of success from achieving set tasks.

The issue of using gamification tools for children of different ages, including those with special educational needs, and the creation of an algorithm for using gamification elements in various educational institutions require further research.

**K e y w o r d s:** success, social successfulness, game elements, gamification tools, adolescent competencies, mixed learning

## **Research Problem**

Globalization and civilizational changes in the modern world are accompanied by increasing demands for the intensity of life, the speed of information dissemination and its accuracy. Changing traditional behavior patterns and algorithms requires a person to adapt to changing social reality, as well as the ability to use the latest information technologies. The dynamics of the development of social life imposes strict requirements for the formation of a teenager’s personality. It is them, on the threshold of adulthood, who must possess those social and personal qualities that will allow them to navigate in the field of uncertainty and construct social reality (being competitive, creative with a variable way of thinking, socially active and socially competent, flexible and at the same time responsible for their own life

trajectory). In this case, a growing individual will be able to reveal their potential, realize themselves, gain social recognition, and become socially successful.

Social success is one of the most important values of an individual. In this regard, researcher A. Yarema notes that “we can speak with confidence about the formation of the ideology of social success in modern society and the establishment of the doctrine of social success in the public consciousness. Orientation to achieve success in various spheres of life, the desire to meet social standards of success, demonstration of symbols of social success become factors that determine the behavior of social agents and significantly influence the structuring of social space” (Yarema, 2010, p. 92). Agreeing with this scientific position, we note that the aspiration of a growing individual to such external aspects of social successfulness as a high status in society and material well-being must necessarily be complemented by the development of important components of socialization – moral responsibility, ethical attitude towards others, readiness for productive interaction with representatives of different age and social groups. According to the American scientist B. Cantwell, the pupil’s success should not only be their personal responsibility, but should become the responsibility of the entire educational system (Cantwell, 2018, p. 10).

Note that today’s teenagers, as children of the digital age, are focused on the constant use of gadgets and related information and communication technologies. That is why Ukrainian researchers consider a teenager as an active participant in such activities that would “influence the development of his interests, encourage them to construct social relationships, the material and spiritual world on the basis of his own ideal of the future. This is possible only if such activity is creative, shared with peers and approved by adolescent groups” (Bedlinskyi & Bedlinskyi, 2011, p. 23–24).

The integration of a teenager into the system of modern social relations, them obtaining a positive experience of social success and the adaptation of the educational process to their needs are facilitated by modern means of education and upbringing, in particular, information and communication technologies. The content analysis of modern scientific sources (Antonov, 2022; Dichev & Dicheva, 2017; Lam & Tse, 2022; Oliveira et al., 2023; Pathak et al., 2021; Sahan, 2022; Smiderle et al., 2020; Taspinar et al., 2016) testified that the effectiveness of forming a socially successful adolescent personality is ensured by gamification, that is, the application of game principles and game elements in the practice of general secondary and out-of-school education institutions.

The focus of the research is to highlight the essence of gamification in the context of the formation of a socially successful personality of a teenager and the results of the approbation of the educational program with elements of gamification called “Social successfulness” in the educational process of educational institutions.

## Research Methodology

### General prerequisites of the research

Throughout human history, games have always been used not only for entertainment purposes, but also for educational purposes. This is due to the motivational content and the simultaneous educational and therapeutic impact of the game: “aiming at self-affirmation, humorous coloring, the desire to play” (Voitsiakh, 2015, p. 54) are combined in it with the performance of important tasks of personality upbringing. The game contributes to the formation of the ability to self-knowledge (awareness of one’s own impressions, reactions, prejudices, stereotypes), the development of the ability to analyze both the motives of other people’s behavior and one’s own, to constructively resolve conflict situations. The game opens up opportunities to overcome psychological barriers much easier on the way to building harmonious relationships with others.

The very term “gamification” “originated in the digital media industry and was first used in 2002 by the developer of popular video games, N. Peling, who opened a consulting company to create game interfaces for electronic devices” (Sahan, 2022, p. 100). Gamification has been widely recognized since 2010, when it began to be implemented in various spheres of life. Foreign scientists emphasize that today there is no single generally accepted approach to understanding gamification: “gamification” is a heavily contested term, especially within the game industry and the game studies community. Discontent with current implementations, oversimplifications, and interpretations have led some to coin different terms for their own arguably highly related practice. For instance, designer and researcher Jane McGonigal redefined “Alternate Reality Games” as “a game you play in your real life”... “to describe her work, and game scholar and designer Ian Bogost recommended replacing the term “gamification” with “exploitationware” as an act of linguistic politics that would more truthfully portray the “villainous reign of abuse” that “gamification” presumably entails” (Deterding et al., 2011).

Such a loose interpretation of this term is connected, first, with the significant expansion of the field of gamification in recent years, the introduction of gamified tools both in the field of recreation and education for children and adults, and in the development of various services. As American and Bulgarian researchers emphasize: “In recent years gamification has seen rapid adoption in many initiatives. This is driven by its potential to shape users’ behavior in a desirable direction” (Dicheva et al., 2015).

We agree with the scientific position of the scientist L. Serhiieva regarding the effectiveness of gamification in various fields of human activity: “gameplay (the game process of a computer game from the player’s point of view) cannot contribute to the country’s gross domestic product, but (...) games affect the quality

of our life, creating positive emotions (optimism and curiosity) and strong social relationships (...) Gamers who prefer hard, complex games learn quick decision-making and stress resistance, as well as awareness of the consequences of the player's actions – mistakes are not repeated, successful strategies are applied again” (Serhieieva, 2014). We consider it worth noting that with the help of gamification, a certain process or object becomes so attractive that a person retains interest in it for a long time.

The trend of gamification in education is closely related to the concept of interactivity, which promotes dialogue, motivation for self-development and, above all, the active involvement of the pupil in the educational process. For example, the educational game based on poker “Minecraft” in schools in Sweden helps education seekers master the basics of engineering and construction art, the game “Lumosity” acts as a virtual “trainer” that activates the mental activity of pupils. Infographics (a combination of text and graphics) are also becoming more widespread, which helps to understand the educational material more deeply, strengthen its visual perception, and empathically involve the pupil in solving the problem under research.

That is why American scientists consider gamification a new educational theory and emphasize that “gamification is a product of an overlooked history of pedagogic refinement, a history of training that is effective, but largely ignored, namely the process of games teaching players how to play” (Dichev & Dicheva, 2017). The scientific conclusions of Ukrainian scientists are unanimous, who consider the gamification of education “a natural consequence of development associated with the use of technology in everyday life and the encouragement of the activity of the younger generation, which adequately understands the game and responds positively to its mechanisms. The main goal of gamified learning is the acquisition and application of knowledge, not the usual passing of a stage or getting a good grade” (Mykhaylova et al., 2023). At the same time, using gamification for educational purposes, according to Algerian researchers, “is essential to choose the right combination of game elements that perfectly matches the desired behavior change” (Khaldi et al., 2023).

In our opinion, in the educational process, gamification is a set of various tools and mechanics that contribute to its significant enrichment with entertaining, educational, motivational, and social-communicative components.

### **Research questions**

1. Should a special educational program with elements of gamification be aimed at forming competencies of a teenager's personality, and in what organizational format will its implementation be optimal?

2. Does the educational program “Social successfulness” with elements of gamification contribute to the effectiveness of forming a socially successful personality of a teenager and in what way?

### **Research hypothesis**

The hypothesis of the research is the assumption of the necessity to introduce special programs for teenagers with elements of gamification as an innovative and effective means of forming their socially successful personality.

### **The methodological basis of the research**

The research is based on the principles of personally oriented, competence-based and activity-based approaches to education, upbringing, development and socialization of teenagers. The use of these approaches has a positive effect on the optimization of teenagers' education, their readiness for professional self-determination, and intellectual, emotional and spiritual maturity, openness to self-development in crisis conditions. The identified approaches contribute to the implementation of the leading principles of humanistic education (child-centeredness, social hardening, cooperation, reliance on the subjective experience of pupils) as guiding principles for the formation of a socially successful adolescent personality.

The main components of forming the social success of a teenager's personality are defined as cognitive, emotional-motivational, and activity-practical. At the same time, the level of formation of the emotional and motivational component is of key importance in adolescence. In the context of the research topic, the main indicators of the formation of such a component will be a positive-optimistic attitude towards oneself and one's life prospects; interest in team socially significant activities; a pleasant experience of success from the achievement of set tasks. The level of formation of the indicator is determined using the following distribution: level A – 1–4 points – low; level B – 5–6 points – reduced; level C – 7–8 points – average; level D – 9–10 points – advanced.

### **Research instrument and procedure**

The following methods were used in the research process: theoretical – analysis, synthesis, comparison, systematization, generalization of materials from psychological and pedagogical sources regarding the problem of social successfulness and the possibilities of its formation among teenagers in the conditions of

out-of-school and general secondary education institutions; concretization – to agree the content of the educational program “Social successfulness” and the process of its approval; empirical – observation of teenagers during classes in the “Social successfulness” educational program, surveys (questionnaires) to collect empirical information, blitz surveys concerning awareness of the characteristics of a successful personality.

The research took place during the 2022/2023 academic year based on the Center for out-of-school work “Northern Lights” in the Svyatoshyn district of Kyiv. 214 teenagers from the number of pupils of grades 7–9 were involved in the research. The diagnostic tool of the survey was the questionnaire for teenagers called “My participation in the program Social successfulness”. Among the interviewed teenagers, 59.1% are boys, 40.9% are girls. 15.2% of teenagers live in a village, 22.2% in an urban-type settlement, 25.3% in a small town, and 37.4% in a big city.

The questionnaire for teenagers called “My participation in the program Social successfulness” was a diagnostic tool for surveying teenagers to assess the effectiveness of the “Social successfulness” training program for the formation of social success of an individual. Assessment according to such a questionnaire was carried out before and after the implementation of the specified educational program. This article presents the results of a survey of teenagers on only one part of the questionnaire – “Emotional and motivational component of social successfulness”. Such a section contains five questions: 1. Rate your own positive and optimistic attitude towards yourself and your life prospects on a 10-point scale. 2. Which elements of gamification cause you the most positive and optimistic emotions? 3. Rate on a 10-point scale your own interest in team socially significant activities. 4. Rate on a 10-point scale the presence of your own pleasant experiences of success from achieving the set tasks. 5. Why do gamification elements promote successfulness?

### **Analysis of research data**

*The advantages of gamification as an innovative means of forming a socially successful personality of a teenager.*

The formation of a socially successful personality of a teenager is a long and complex creative process aimed at their active life position, productive social activity, the desire for knowledge and the desire to influence social processes, the development of qualities necessary for social success – purposefulness, assertiveness, initiative, tolerance, attentiveness, diligence, cleverness, mobility, etc. Gamification helps to modernize this process and involve a teenager in it.

In this regard, Chinese scientists note that “attractive game aesthetic or badges and points are welcomed, though not necessary, features of an engaging gamified

lesson. Rather, with some good planning and design on teachers' part, effective gamification can be applied to everyday teaching with remarkable results" (Lam & Tse, 2022). Researchers in India share the same opinion: "Game based learning has gained importance recently. Because of its playful nature, it is able to motivate and attract students. Explaining the concept through games is a technique to make students learn better. Students have wide experience with respect to master, understanding, enjoyment and motivation" (Pathak et al., 2021, p. 2154).

Ukrainian scientists dwell in more detail on the potential of gamification: "The gamification tool provides an opportunity to learn in an active way, which, unlike the traditional, passive study of material, creates an emotionally comfortable environment for acquiring new knowledge and skills and facilitates the assimilation of new material. Its toolkit is a kind of technology for manipulating the pupil's behavior, an attempt to encourage them to study without coercion, through interest (...). A wide range of game gameplay provides an opportunity to choose the appropriate tools for each pupil, with a different psychotype, with a different level of motivation and goals, to interest in the educational process and to teach teamwork" (Zholubak & Mechus, 2020, p. 218–219).

The elements of gamification make it possible to make fun (feeling of satisfaction) synonymous of the learning. For example, Hard Fun: accept a challenge, overcome difficulties, solve problems; Easy Fun: explore new worlds with interesting characters, participate in the discussion; Serious Fun: to combine the pleasant with the useful, creating new educational content; People Fun: cooperation, collaboration, communication, etc. Thus, a teenager can acquire knowledge and competences while playing.

The implementation of gamification creates conditions for achieving high results in education and self-realization of teenagers, in particular, by using the following techniques in the educational process:

- focus attention on the key idea of the material;
- to structure information, presenting it "in portions" according to the principle of "small content block – rest" for better mastery of new educational material;
- use constant repetition to strengthen knowledge, encourage innate curiosity and desire for knowledge;
- draw attention to the discussed problem with emotionally meaningful visual stimuli (interesting, graphically presented facts, telling examples, jokes related to the topic);
- use the possibilities of a multi-sensory environment (animation, videos, scribing, various devices), etc.

Therefore, gamification significantly contributes to the formation of various competencies of pupils. With its assistance, teenagers learn to: plan their work; argue their own judgments; make a decision; assign roles, interact; analyze and present the results; evaluate your actions and the actions of your game partners, put yourself in another person's place. That is why one of the signs of a successful

environment in a modern educational institution is the presence of a cloud-oriented educational environment that takes into account the needs of teenagers and the peculiarities of their use of various gamified mechanisms.

*Characteristics of the educational program with elements of gamification called "Social successfulness".*

The purpose of the educational program with elements of gamification called "Social successfulness" (hereinafter – the Program) (the author – a Ukrainian researcher, K. Bezruk) is a comprehensive program and methodical support for the formation of a socially successful personality of a teenager in an out-of-school education institution. Its target orientations are defined as the formation and development of soft skills in education seekers, which allow them to be successful regardless of the specifics of the activity or the direction that the education seeker of education chooses; formation of the mindset of a successful personality in teenagers, motivation to achieve success.

The program is based on the principles of close interaction between the educational institution and stakeholders in the formation of a socially successful adolescent personality and promotes the formation of the following competencies in pupils:

- *cognitive* – provides awareness of the value basis of one's own life activity and becomes a system-forming focus for the development of social cohesion, initiative, responsibility and other components of social success;
- *social* – promotes the development of ideas about oneself as a bearer of certain social roles, skills of effective cooperation, responsibility for the results of joint activities, the ability to be an active member of society;
- *information* – stimulates the development of skills to effectively operate with information (search, collection, analysis, evaluation and use of information, obtaining new knowledge), the ability to navigate in the flow of diverse, contradictory information (distinguish between reliable and unreliable information);
- *life-creating* – promotes the development of self-analysis skills, self-control, self-upbringing, self-education, self-learning, life planning, the ability to identify, search for, acquire and apply resources necessary for the realization of life goals;
- *practical* – promotes the development of self-management skills, goal setting, planning teamwork for results, constructive behavior in conflict situations, increasing self-esteem and self-confidence, critical thinking and creative problem solving;
- *communicative leadership* – provides knowledge exchange, dialogue development, understanding of goals and objectives, involvement in decision-making, performance evaluation and feedback;
- *legal* – promotes the development of the ability to protect and realize one's rights and freedoms, the fulfillment of universal and civic duties;

- *competences to longlife learning* – forms the ability to reason, compare, generalize, observe, independently search for information from various sources, acquire individual experience of self-organization, educational reflection, and self-study skills.

The scope of the Program is calculated for 1 year of study at the basic level, i.e. 144 hours per year. A feature of the Program is that, depending on how quickly and qualitatively pupils acquire practical skills, the head of the group can change the number of theoretical and practical classes within the specified hours (Bezruk, 2022).

The program is addressed to a wide range of users: teachers of out-of-school and general secondary education institutions, social pedagogues and psychologists.

## Research Results

Approbation of the Program took place during the 2022/2023 academic year based on the Center for Out-of-School Work “Northern Lights” in the Svyatoshyn district of Kyiv. The classes were held twice a week for two study hours in each group. Spatially, each group was allocated a separate room for classes, where it was possible to store the developed artifacts and products of the participants’ creativity until the very end of the training. The room was equipped with the tools necessary for training: interactive whiteboards, flip charts, markers, colored and white paper, etc. According to the agreement, the participants had to bring their own devices to the class, because according to the Program, it was supposed to actively use the “Bring your own devices” (BYOD) method and gamification tools.

The reinterpretation of previous scientific research and the reflection of observations of the educational process proved that in modern conditions the program “Social successfulness” can be implemented in three organizational formats. Their comparative analysis made it possible to choose a mixed format for approval (figure 1).

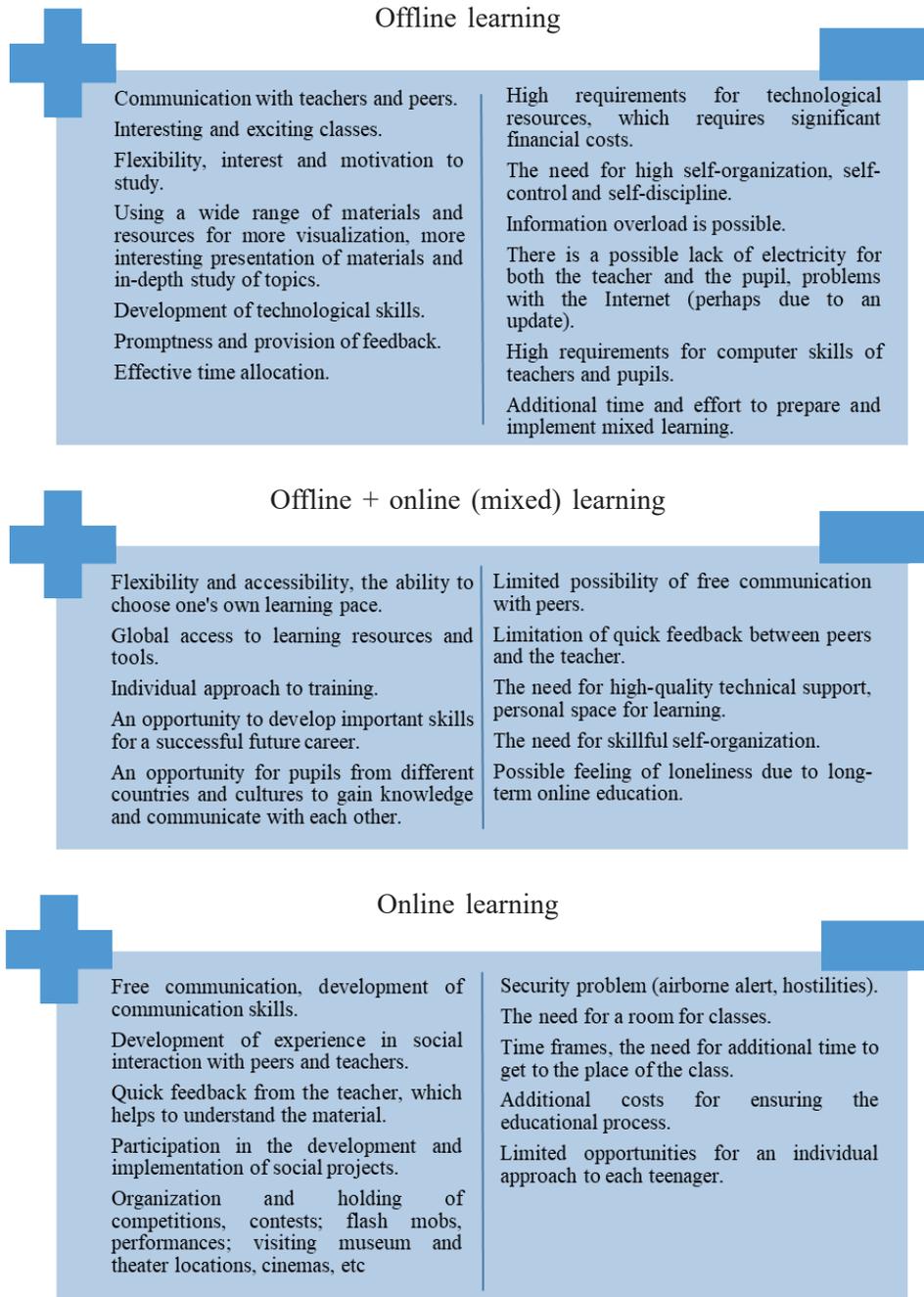


Figure 1. Possible transmitting formats of the “Social successfulness” program: comparative characteristics

Source: Own work

During the approbation and implementation of the Program, various gamification tools were used:

1. *Creation of a thematic promotional video.* Promotional video with a motivational mini-video “To success on your own wings!” presented the target orientations and features of the “Social Successfulness” program, emphasized its strengths for adolescent development, invited participation and outlined potential benefits from mastering the Program. The advertisement clip was distributed among pupils, parents, teachers or other interested persons, was placed on platforms or channels that are available for viewing by the target audience of the Program (YouTube; Facebook; Instagram; Telegram, Viber, WhatsApp; Microsoft Teams). As an option, the teacher-trainer could post a thematic stream on the above-mentioned platforms or channels. The widest possible coverage was welcomed.
2. *Visualization of interaction rules.* The Canva online resource was chosen for use, which allows you to create designs and animations for social networks, presentations and websites; provides opportunities to select animation templates and customize them to your needs; has a simple and clear interface. It is also recommended to use such a tool as a “word cloud” (a visual representation of key words in the text – the frequency of use of the word is displayed using the font size or its weight). This tool can be created in several ways. The first is involving pupils using Google Forms or the Mentimeter resource. The second is the creation of a “word cloud” without pupils’ suggestions, only to visualize the previously worked out results. Interactive tools such as WordArt or TagCrowd were used to create a “word cloud”.
3. *Visualization of successful narratives.* An example can be the creation of a digital museum called “Pantheon of successful personalities” (success stories of famous personalities). To implement this task, the participants were offered to use such ideas as: a virtual exhibition hall; multimedia presentation (in PowerPoint or Google Slides); a didactic game in them teenagers answer questions, solve puzzles and explore the life stories of celebrities (Kahoot!, Genially, LearningApps.org, Scratch, Flippity platforms); a comic or animation about stories of successfully overcoming personal or social problems (Pixton, ToonDoo, Powtoon, Scratch, Animaker resources); video stories – pupils create short videos about the achievements of famous successful personalities (online tools: Clipchamp, WeVideo, Animoto).
4. *Using mind maps* as part of a narrative or as a way of visualizing stories. Working with mind maps does not require complex resources or programs (Coggle, MindMup, Canva, Lucidchart, Draw.io platforms), which allows you to add elements – nodes, links and text blocks, edit text and colors.
5. *Chat or forum discussions of the progress and results of joint activities.* It is important to create a friendly and open environment for discussions, where teenagers can communicate, process and analyze acquired knowledge,

exchange information, ideas and news. For this, you should choose a common platform: Telegram, Viber, WhatsApp, Facebook Groups, Slack, Microsoft Teams, etc. During the creation and operation of the group, it is important to observe privacy, confidentiality and take care of the protection of personal data. To maintain the activity of the group, it is necessary to: ask interesting questions, raise relevant topics for discussion, share useful information and resources, and add photos, videos, links and other multimedia elements for more interesting and meaningful discussions.

6. *Use of means of stimulation and competitiveness* (obtaining premium points, badges, statuses, certificates). An effective element of motivation for active and interested participation is receiving bonus points for completing tasks. It is important that teenagers understand exactly what they are doing: speed, clarity, creativity, meaningful actions, etc. The Kahoot! platform was used to stimulate teenagers' activity and increase their sense of competitiveness, which provides an opportunity to view and analyze the result after completing a mug or quiz.

To carry out a pedagogical reflection of the educational results of the participants, a blitz survey was conducted (teenagers answered the question: "What does it mean for me to be socially successful?"). For example: "This is a person who knows how to work on their own development", "(...) has the flexibility to fulfill social roles", "(...) is aware of the importance of leadership for successful life activities", "(...) is ready to make decisions and bear responsibility for them", "(...) strives to self-organization, self-movement, self-development", "(...) demonstrates creativity, constructive activity, reflexivity", "... is able to achieve planned results", "(...) is able to win well-deserved recognition", "(...) is able to achieve personal and social well-being", "(...) ignites others with their example for victories". According to the data obtained, teenagers verbalize the two most common portraits of a socially successful person: the first is built based on external, socially recognized indicators of success; the second – personal qualities that reflect people's views on successful activities.

Analysis of respondents' answers to the statement "Rate on a 10-point scale your own positive and optimistic attitude towards yourself and your life prospects?" given in table 1.

Table 1.

Attitude level	Before participation in the Program	After participation in the Program	Dynamics (+/-)	p
<i>Low</i>	31 (14,5%)	18 (8,5%)	- 6%	p<0,05
<i>Reduced</i>	94 (43,9%)	58 (27,1%)	- 16,8%	
<i>Average</i>	68 (31,8%)	106 (49,5%)	+ 17,7%	
<i>Increased</i>	21 (9,8%)	32 (14,9%)	+ 5,1%	

According to the Pearson  $\chi^2$  test, the distribution of responses in general has a probable difference  $\chi^2=22.56$ , the critical value  $\chi^2=7.82$ .

According to the results of teenagers' answers to the question "Which elements of gamification bring about the most positive and optimistic emotions?" it was found that more than three quarters of the respondents had a positive perception of game tools.

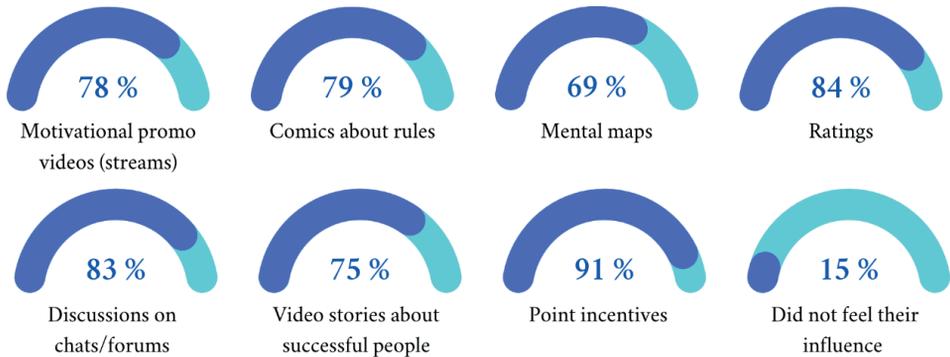


Figure 2. Which elements of gamification bring about the most positive and optimistic emotions?

Source: Own work

Most of all, teenagers liked "score incentives" (91%), "ratings" (84%) and "discussions on chats/forums" (83%), which can be explained by the correspondence to the leading types of age-related activities of teenagers – communication and competition.

The results of respondents' answers to the statement "Estimate on a 10-point scale your own interest in team socially significant activities" are presented in table 2.

Table 2.

Attitude level	Before participation in the Program	After participation in the Program	Dynamics (+/-)	p
Low	24 (4,2%)	12 (5,6%)	- 1,4%	p<0,05
Reduced	61 (28,5%)	34 (15,9%)	- 12,6%	
Average	81 (37,9%)	121 (56,5%)	+ 18,6%	
Increased	39 (18,2%)	47 (21,9%)	+ 3,7%	

According to Pearson's  $\chi^2$  test, the distribution of responses in general has a probable difference of  $\chi^2=20.16$ , a critical value of  $\chi^2=7.82$ .

The answers to the statement “Estimate on a 10-point scale the presence of your own pleasant experiences of success from achieving the tasks” are presented in table 3.

Table 3.

Attitude level	Before participation in the Program	After participation in the Program	Dynamics (+/-)	p
<i>Low</i>	13 (6,1%)	7 (3,3%)	- 2,8%	p<0,05
<i>Reduced</i>	41 (19,2%)	11 (5,1%)	- 14,1%	
<i>Average</i>	108 (50,5%)	131 (61,2%)	+ 10,7%	
<i>Increased</i>	52 (24,2%)	65 (30,4%)	+ 6,2%	

According to Pearson’s  $\chi^2$  test, the distribution of responses in general has a probable difference of  $\chi^2=22.77$ , a critical value of  $\chi^2=7.82$ .

Answers to the question “What do game elements of learning work for?” were distributed as follows (figure 3):

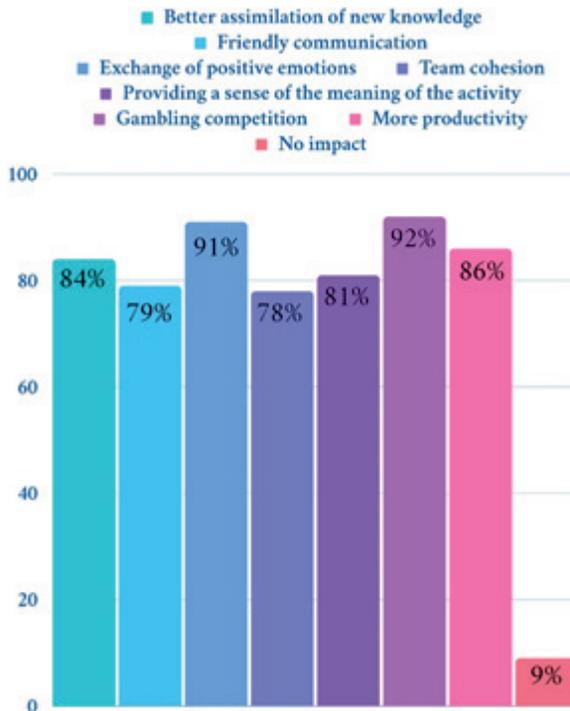


Figure 3. What do game elements of learning work for?

Source: Own work

It is noteworthy that after the implementation of the Program, the first two positions were occupied by “gambling competitiveness” (92%) and “exchange of positive emotions” (91%), and the third place was “better assimilation of new knowledge” (89%).

## **Discussions**

We share the scientific position of American and Bulgarian researchers (Dicheva et al., 2015) that the effective implementation of gamification requires the presence of a certain type of environment that supports the inclusion of selected game mechanics and has the necessary technological resources. Thus, we agree with scientists that gamification has a powerful potential for solving various educational tasks, “if it is well designed and used correctly. Therefore, more substantial empirical research is needed to investigate, in particular, the motivating effects of using single game elements in specific educational contexts and for particular types of learners. This would inform instructors who are interested in gamifying their courses and help them in deciding what game elements to use in their specific context” (Dicheva et al., 2015).

According to the research by Brazilian scientists who used game elements in teaching programming, a gamified environment is more conducive to positive changes in the behavior of participants and improving their educational results, compared to a non-gamified environment: “The results showed a change in the behavior of the gamified group showing a significant improvement in the accuracy of students with personality traits with low agreeableness, low openness, and introverts who used the gamified version” (Smiderle et al., 2020). We reached similar scientific conclusions during the approbation of the “Social Successfulness” training program: gamification helps teenagers gain responsibility and self-confidence, feel their importance to others, adequately perceive others, realize their own advantages and disadvantages, and promotes a constructive attitude to reality.

## **Conclusions**

Thus, gamification expands the possibilities of working with information and increases motivation for social success; creates favorable conditions for discussing various difficult life situations; encourages independent choice of life position

and ways of achieving social success; helps the adaptation of the teenager in the environment of peers, their successful socialization.

The educational program with elements of gamification called “Social successfulness” contributes to the formation of a socially successful personality of a teenager. A mixed format has been identified as the optimal format for implementing this program, as it combines the advantages of offline and online learning and can be effective in the heightened threat associated with martial law. It has been experimentally determined that the participation of teenagers in the “Social Successfulness” program contributes to their positive and optimistic attitude towards themselves and their life prospects; growing interest in socially significant team activities; enhances the pleasant experience of success from achieving set tasks (probability is verified using the Pearson  $\chi^2$  test). Teenagers believe that the elements of gamification of learning contribute to friendly communication, exchange of positive emotions, better assimilation of new knowledge, team cohesion, greater work productivity, gambling competitiveness, ensuring a sense of the meaning of activity.

The introduction of gamification tools into the practice of forming a socially successful personality of a teenager allows to make the educational process modern, interesting and useful for pupils.

The issue of using gamification tools for children of different ages, including those with special educational needs, and the creation of an algorithm for using gamification elements in various educational institutions require further research.

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## **Kształtowanie społecznie skutecznej osobowości dorastającego ucznia za pomocą grywalizacji (Kijów, Ukraina)**

### Streszczenie

Badanie podkreśla istotę grywalizacji i testowania programu nauczania z elementami grywalizacji pt. «Sukces społeczny» w instytucjonalnym procesie edukacyjnym. Zastosowane metody teoretyczne to analiza, synteza, porównanie, systematyzacja, uogólnienie źródeł psychologicznych i pedagogicznych dotyczących problemu sukcesu społecznego i możliwości jego kształtowania u młodzieży w pozaszkolnym i ogólnokształcącym szkolnictwie średnim, specyfikacja w celu koordynacji treści programu nauczania pt. «Sukces społeczny» i procesu jego testowania; metody empiryczne – obserwacja, kwestionariusze w celu zebrania informacji empirycznych, ankiety błyskawiczne dotyczące świadomości cech osobowości odnoszącej sukcesy, testowanie programu i ocena wyników.

Badacze opisują program nauczania «Sukces społeczny», w szczególności określają jego docelowe kierunki i kluczowe kompetencje nastolatków, podkreślają narzędzia grywalizacji niezbędne do wdrożenia programu i dowiadują się, że format mieszany jest optymalnym formatem do jego wdrożenia, ponieważ łączy w sobie zalety uczenia się offline i online i może być skuteczny w warunkach zwiększonego zagrożenia związanego ze stanem wojennym.

W artykule przeprowadzono refleksję pedagogiczną i stwierdzono, że zgodnie z wynikami ankiety błyskawicznej młodzież werbalizuje dwa najczęstsze portrety osobowości odnoszącej sukcesy społeczne (w oparciu o zewnętrzne wskaźniki sukcesu i cechy osobiste); zgodnie z wynikami ankiety zdecydowana większość respondentów pozytywnie postrzegала narzędzia do gier i uznawała własne działania za produktywne podczas nauki opartej na grywalizacji. Potrzebne są dalsze badania nad wykorzystaniem narzędzi grywalizacyjnych dla dzieci w różnym wieku, w tym ze specjalnymi potrzebami edukacyjnymi, oraz nad stworzeniem algorytmu wykorzystania elementów grywalizacji w różnych instytucjach edukacyjnych.

**S ł o w a k l u c z o w e:** sukces, sukces społeczny, elementy gier, narzędzia grywalizacji, kompetencje nastolatków, blended learning

## **Formación de la Personalidad Socialmente Exitosa del Estudiante Adolescente a través de la Gamificación (Ciudad de Kiev, Ucrania)**

### Resumen

Este estudio destaca la esencia de la gamificación y la implementación de un programa educativo con elementos de gamificación llamado «Éxito Social» en el proceso educativo de las instituciones educativas. Se utilizaron métodos teóricos como el análisis, síntesis, comparación, sistematización y generalización de materiales de fuentes psicopedagógicas en relación al problema del éxito social y las posibilidades de su formación en adolescentes en escuelas secundarias y extraescolares, así como la especificación para coordinar el contenido del programa educativo «Éxito Social» y su proceso de

prueba; los métodos empíricos incluyen observación, encuestas para recopilar información empírica, encuestas rápidas sobre la comprensión de las características de la persona exitosa, la prueba del programa y la evaluación de los resultados por los encuestados.

Las autoras consideran la gamificación como un conjunto de diversas herramientas y mecánicas que enriquecen significativamente el proceso educativo con componentes de entretenimiento, educación, educación en valores, motivación y comunicación social. Las investigadoras describen el programa educativo «Éxito Social», en particular, identifican sus objetivos y competencias clave para los adolescentes, destacan las herramientas de gamificación necesarias para implementar el programa, determinan que el formato mixto es el formato óptimo para su implementación, ya que combina las ventajas del aprendizaje presencial y en línea y puede ser efectivo en condiciones de riesgo elevado, como una situación de guerra.

En el artículo se realiza una reflexión pedagógica y se aclara que, según los resultados de la encuesta rápida, los adolescentes verbalizan dos retratos más comunes de una persona socialmente exitosa (basados en indicadores externos de éxito y cualidades personales), y de acuerdo con los resultados de las encuestas, la mayoría de los encuestados perciben positivamente las herramientas de juego y consideran su propia actividad durante el aprendizaje con gamificación como productiva. Las cuestiones relacionadas con el uso de herramientas de gamificación para niños de diferentes edades, incluidos aquellos con necesidades educativas especiales, y la creación de un algoritmo para utilizar elementos de gamificación en diferentes instituciones educativas, requieren una investigación adicional.

**Palabras clave:** éxito, éxito social, elementos de juego, herramientas de gamificación, competencias de los adolescentes, aprendizaje mixto

Валерія Нечерда, Катерина Безрук, Жанна Петрочко, Валентина Кириченко, Елена Денісюк

## **Формирование Социально Успешной Личности Учащегося Подросткового Возраста Средствами Геймификации (г. Киев, Украина)**

### **Аннотация**

В исследовании отражена сущность геймификации и апробация учебной программы с элементами геймификации «Социальная успешность» в образовательном процессе учебных заведений. Применены теоретические методы – анализ, синтез, сравнение, систематизация, обобщение материалов психолого-педагогических источников относительно проблемы социальной успешности и возможностей её формирования у подростков в условиях заведений внешкольного и общего среднего образования, конкретизация для согласования содержания учебной программы «Социальная успешность» и процесса её апробации; эмпирические методы – наблюдение, анкетирование для сбора эмпирической информации, блиц-опросы для осознания характеристик успешной личности, апробация программы и оценивание результатов её влияния респондентами.

Авторы рассматривают геймификацию как совокупность разнообразных инструментов и механик, которые способствуют существенному обогащению образовательного процесса развлекательной, учебной, воспитательной, мотивационной и социально-коммуникативной составляющими. Исследовательницами охарактеризована учебная программа «Социальная успешность», в частности, определены её целевые ориентиры и ключевые компетентности подростков, освещены необходимые для внедрения программы инструменты геймификации,

выяснено, что смешанный формат является оптимальным форматом её реализации, поскольку он сочетает преимущества офлайн и онлайн обучения и может быть эффективным в условиях повышенной опасности, связанной с военным положением.

В статье осуществлена педагогическая рефлексия и выяснено, что, согласно результатам блиц-опроса, подростки вербализуют два наиболее распространённых портрета социально успешной личности (на основе внешних показателей успеха и личностных качеств), по результатам анкетирования, подавляющее количество респондентов положительно восприняло игровые инструменты и признало продуктивной свою деятельность во время обучения с применением геймификации. Дальнейшего изучения требуют вопросы использования инструментов геймификации для детей всех возрастов, в том числе, с особыми образовательными потребностями и создания алгоритма использования элементов геймификации в различных учебных заведениях.

**К л ю ч е в ы е с л о в а:** успех, социальная успешность, игровые элементы, инструменты геймификации, компетентности подростков, смешанное обучение





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# **Interactive RShiny Reports – Independence and Autonomy in Medical Data Visualization**

## **Abstract**

The article discusses the use of the R language, especially the RShiny tool, to create interactive reports in the field of medical data analysis. The authors emphasize the need for an interdisciplinary approach to teaching statistics among medical students. An alternative to traditional static reports was presented, proposing the creation of interactive web applications that enable exploration, analysis and visualization of medical data changing in real time. The use of the R language as an open source tool allows for the development of medical students' competences in the field of data analysis and the adaptation of research tools to individual needs. A draft lesson plan using sample medical data on cervical cancer was also presented, along with a proposal for specific analyzes of these data and their visualization using interactive RShiny reports. The article ends with a discussion on the role of learning the R language in the education of students of Polish medical universities and the need to expand the educational offer for them with courses in data analysis in an open source environment.

**Key words:** RShiny, R, data visualization, interactive report, statistics, medical teaching

## **The Motivation for Creating an Interactive Teaching Project**

Teaching data analysis to medical students requires an interdisciplinary approach. Understanding how complex mathematical formulas and data analysis techniques impact topics in biology and chemistry (fields central to our students' interests) is crucial. Typically, biostatistics courses illustrate data analysis examples using commercial programs available at a given university. Of course, every instructor aims to minimize the time spent on specific software during classes, choosing packages with an intuitive interface and sufficient capabilities for implementing the teaching material. This is the right approach: students who comprehend the discussed issues and learn how to calculate them using the software used in classes will likely adapt to using another statistical package in the future and perform similar calculations.

However, it is important to recognize the abundance of available software with varying capabilities. Learning how to use each new package consumes valuable time, particularly for students or clinicians. Furthermore, as we advance in the scientific field, it becomes apparent that even mastering and acquiring the latest software may still be insufficient to perform all the analyses related to our study. So, what alternatives do we have, and in what direction should education progress in order to become a true guide on the path of development for future scientists?

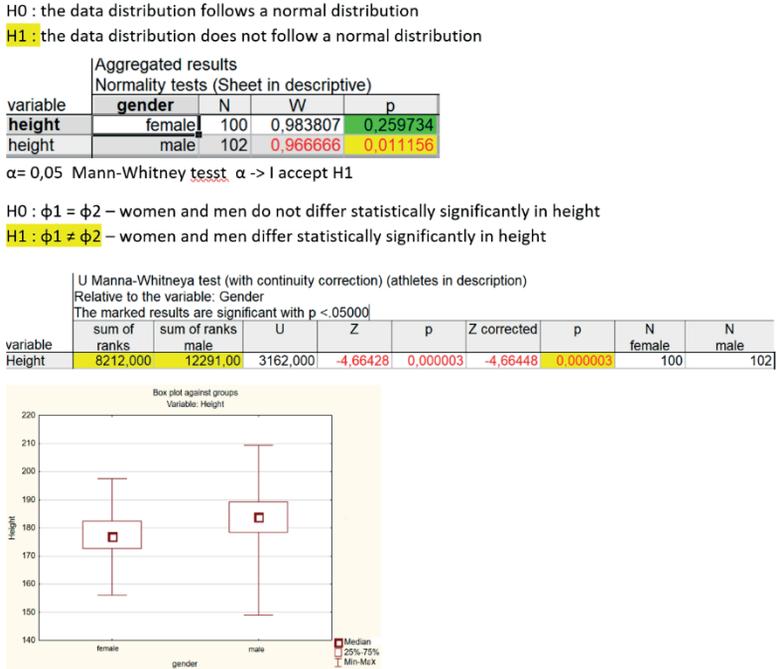
### **The present state of biostatistics instruction**

The current approach to teaching biostatistics at the Poznan University of Medical Sciences is tailored to the allocated hours for this subject within a specific field. Some classes also incorporate elements of online teaching. Whether conducted remotely or in-person, the focal point remains practical application (Roszak et al., 2020). For medical majors, the emphasis is on the hands-on aspect of performing analyses frequently employed in scientific research within the medical domain.

This involves delving into the fundamental principles governing individual statistical tests, allowing students to interpret results obtained through dedicated software. Historically, this methodology has sufficed for most students, involving executing specific commands according to discussed frameworks and in alignment with the capabilities of the software in use. The prevalent form of presenting results has been static reports, essential for conveying findings in scientific publications. Naturally, during the initial phases of learning basic analyses, students document and describe each result covered in classes.

Currently, at Poznan University of Medical Sciences, four commercial software licenses are available for teaching biostatistics: Statistica, PQStat, MedCalc,

and JMP. Illustrated in Figure 1 is a typical report of a task calculated using the Statistica program during biostatistics classes:



Women and men differ statistically significantly in height.

Figure 1. An example static report from biostatistics classes generated in the Statistica program

Source: Authors' own work.

However, real data mining requires calculating many simple analyzes and deciding whether and what more advanced models we will need in our study. Efficient analysis of basic results is crucial here. This is noticed by young researchers who analyze their data within scientific clubs, or when analyzing their own or team research work. We think about them with the greatest care, because they are the future of science. Providing them with optimal data analysis tools is the goal that every teaching and research team should set.

### Choosing R as an option

This article aims to emphasize the existence of a tool that can serve as a robust foundation for the development of students or doctoral candidates in the field of data analysis and scientific research. Just as proficiency in English serves as

a crucial communication tool in the realm of science, similarly, in the domain of data analysis, mastery of the R language is indispensable. As open-source software, available for free to everyone, R offers numerous benefits and advantages. Designed with statistics in mind, the R language excels as a tool for performing calculations and processing data. It is an excellent choice for students outside the IT field who primarily want to use programming skills for data analysis and processing. Moreover, learning R prepares students to acquire future competencies valued in the world of science. The R language boasts a vast community of users and package developers (*CRAN: Manuals*, n.d.), providing numerous built-in statistical functions and eliminating the need to search for them in additional libraries. The availability of free educational materials, online courses, support forums, and extension packs facilitates students' learning journey, enabling them to expand their skills. University classes can be organized both on-site and on e-learning platforms, offering a synchronous or asynchronous teaching. It is crucial to note that the R language allows the creation of non-standard solutions and tools tailored to specific research needs (Biecek, 2017), making it more flexible than commercial programs with limitations in adapting to unusual tasks.

Researchers using R are not constrained by the capabilities of specific software, allowing exploration of the latest data mining and statistical analysis techniques, consultation, and discovery of better, more tailored solutions in their research area. Programming in R enables the creation of custom tools that empower medical scientists to explore data and test hypotheses, expediting discoveries in clinical medicine. Proficiency in programming basics automates routine tasks related to data analysis and clinical trials, enhancing the efficiency of scientists' work and saving valuable time. When sharing test results with other specialists and patients, interactive applications and reports offer virtually unlimited possibilities for visualizing test results.

### **Interactive resources**

Facilitating interactivity and visualization is the heart of good pedagogy (SL Wang et al., 2021). Simulations, in turn, are a very effective teaching method because computer software offers them the opportunity to review concepts multiple times (Jamie, 2002). All this means that today's educational materials, especially e-learning (Grześkowiak et al., 2020), have so many interactive elements (Kumar et al., 2017). Graphical representations of data, such as interactive charts, allow you to quickly communicate key information. The human brain is more likely to process visual information quickly than text. The ability to manipulate data allows users to experiment with different perspectives and scenarios. This, in turn, helps you understand the context of your data, eliminating the need to analyze large (and boring) results tables.

Among many tools that enable the creation of such materials, the most popular are those that create web applications. They only require a browser, which makes them more accessible. Hence, these technologies can replace the capabilities of applications created on traditional platforms that are no longer fully supported, such as Java or Flash.

Perhaps the best-known collection of online applications for teaching statistics is the Rossman-Chance applet collection, available to educators at [www.rossmanchance.com/applets/](http://www.rossmanchance.com/applets/). It is a software written mainly in JavaScript and is considered as an example of a well-designed educational application.

One of many tools related to the R language, giving unlimited possibilities for creatively presenting the results of your own research, are interactive dashboards and web applications. Since RShiny is an R package, researchers can leverage their R coding knowledge and experience to create RShiny applications without additionally learning another programming language. Of course, advanced interactive RShiny reports can be expanded with additional CSS themes, HTML elements, JavaScript scripts, etc. But this is not necessary, and they can successfully be used only at the basic stage.

## RShiny

Since the creation of RShiny interactive reports, they have become a popular tool for creating web applications. Thanks to them, you can replace hundreds of pages of traditional static reports with interactive applications that provide self-service data analysis and easy sharing of analysis results. And all of this without advanced programming skills. A chart with „independence and autonomy” characteristics is one that is self-contained and entirely understandable to the audience. It does not require additional explanations. Individual elements of the chart (such as axes, legends) are clear enough for the chart to operate autonomously. Through interactive reports, we have a greater chance of choosing a medical data illustration that is fully comprehensive, allowing, for example, to shorten the time associated with selecting the direction for further data exploration by the research team.

Many useful and easy-to-use applications of RShiny web application have been implemented so far in the field of medicine and health sciences. These include:

- HPVTIMER: A shiny web application for tumor immune estimation in human papillomavirus-associated cancers (Liu et al., 2023), created at the University of Houston
- RIMeta – an RShiny application for estimating the reference interval from a meta-analysis (Jiang et al., 2023), University of Minnesota, USA.

- ShinyBioHEAT – an RShiny application enabling the identification of the gene driving the phenotype in two commonly used model bacteria, *E. coli* and *Bacillus subtilis* (C. Wang et al., 2023), Baylor College of Medicine, Houston.
- RNA-Seq Ontology Graphic User Environment – an RShiny application for RNA sequencing analysis and biomarker discovery (Farel et al., 2023), written by scientists from the USA, National Institutes of Health, Bethesda

The number of such applications is increasing rapidly. Thanks to RShiny, specialists can visualize and share the results of their work with a wide audience. This tool is also used by startups and their commercial implementations. Noteworthy, for example, is the Polish application Mbaza AI, which supports the protection of endangered animal species. It was recognized in 2023 as one of the 10 best applications in the world by the International Center for Research on Artificial Intelligence (IRCAI) under the auspices of UNESCO (,Polish application Mbaza AI one of the best in the world according to UNESCO', 2023).

RShiny's interactive reports can also be used to support teaching during data analysis classes for medical university students. They can constitute a reliable teaching base that facilitates creative exploration and analysis of data. The purpose of such statistical education applications is to enrich the teaching of both introductory and upper-level statistics courses. To date, many RShiny applications have been developed around the world, and the collection is constantly growing. As an example goes the collection of RShiny applications created for preliminary statistics at Grand Valle State University (*Daniel Adrian | IntroStat Shiny Apps*, n.d). Another example is University Park, Pennsylvania, which recognized the benefits of RShiny's interactive reports and used them to try to incorporate research-based learning into a senior-year undergraduate statistics course (SL Wang et al., 2021). Interactive graphics and dynamic visualizations built in the RShiny environment used for working with analyzed data were also appreciated by veterinary sciences from the University of Veterinary Medicine Hannover (Liebig et al., 2022).

At the Poznan University of Medical Sciences, there are plans to introduce classes using the RShiny application, enabling future scientists to integrate medical competences with data analysis skills. As a proposal to use the possibilities of R in biostatistics classes, the authors present the project whose aim is to create a web application allowing the exploration, analysis and visualization of medical data. It will generate interactive RShiny reports. Web applications during classes will be built using the RShiny package, while on the server side interactive data processing will be made using R script (version 4.0.2, <https://www.r-project.org/>).

The classwork should revolve around examples closely related to the students' field of interest (Pfannkuch, 2011). Ideally, this involves using real datasets from specific clinical trials or medical scenarios. In this project, a publicly available database containing information like age, sex, diagnoses, and laboratory test results was utilized. Through RShiny, we developed an interactive user interface that facilitated data viewing and analysis. These classes provide a valuable opportunity

for students to independently explore data, adjusting variables and parameters to observe their impact on diagnoses. Importantly, advanced programming skills are not required, as only a basic knowledge of the R language is sufficient to design tables, interactive charts, and dashboards. The added advantage of RShiny lies in its ability to visualize and share results online without the need for extensive web coding.

The three basic parts needed to create an RShiny application (Wickham, 2021), then:

- **ui**: nested R functions that assemble an HTML user interface for your application
- **server**: a function with instructions on how to build and rebuild the R objects displayed in the UI
- **shinyApp**: combines ui and server into an application. Wrap with `runApp()`.

Below (Figure 2) is an example code of the simplest application that generates a histogram based on random data with a normal distribution generated using the `rnorm()` function (Wickham, 2023).

```
# This is a Shiny web application

library(shiny)
# Define UI for application that draws a plot histogram
ui <- fluidPage(

  numericInput(inputId = "size",
               "Sample size",
               value=25),
  plotOutput(outputId="our_histogram")
)

# Define server logic required to draw a histogram
server <- function(input, output) {

  output$our_histogram <- renderPlot({
    hist(rnorm(input$size))
  })
}
# Run the application
shinyApp(ui = ui, server = server)
```

add input to the UI with functions – `numericInput()`  
add R object/output to the UI with functions – `plotOutput()`

tell how to build the output from the input in functions `renderPlot()`  
assign `renderPlot()` to the output

Figure 2. Sample R code for an application that generates a histogram based on random normally distributed data generated using the `rnorm()` function

Source: Authors' own work.

The RShiny application interface may contain tabs or panels that allow you to select specific views and analyzes (Wickham, 2021). In the prepared tool, using the `ggplot2` package or other graphic packages related to R, we will show how individual variables are related to each other and what relationships can be noticed in the analyzed medical data. For example, you can simulate the impact of variable X on outcome Y depending on various scenarios and parameters. Providing students with the opportunity to explore various statistical models, manipulate

the assumptions and parameters of these models, and even generate data from the model can improve understanding of the medical problem being analyzed as well as the statistical issues being discussed (Garfield & Ben-Zvi, 2007).

### **Data used in the project**

The project in question used the so-called open medical data. Students participating in classes should be made aware of the legal aspects of data use. Users must be sure that we meet all conditions for using data found online, provided by research institutions or organizations, and respect the principles of privacy and ethics. The most popular data sources that can be used to work with students are: Kaggle, UCI Machine Learning Repository and GitHub. These platforms offer access to a truly diverse range of medical data.

The project presented in the article used a data set collected at the „Hospital Universitario de Caracas” in Caracas, Venezuela, and made available in 2017 under the CC BY 4.0 license (Fernandes & Fernandes, 2017). This dataset was created to analyze indicators related to cervical cancer diagnosis and includes, among others: demographic information, patient habits and medical records (858 records). Some patients did not decide to answer all the questions, so we also have missing values in the analyzed database.

Cervical cancer is closely associated with human papillomavirus (HPV) infection, which is transmitted sexually. Infection with this virus can lead to chronic infections, increasing the risk of genital and anal cancer. HPV is a common sexually transmitted infection, especially among young people. In addition to HPV infection, there are several risk factors associated with cervical cancer, such as age, early sexual initiation, number of sexual partners, long-term smoking, low socioeconomic status, and history of cervical intraepithelial neoplasia (CIN). It is also worth taking into account other risk factors, such as long-term use of hormonal contraceptives, a diet low in antioxidants and untreated vaginal inflammation caused by *Chlamydia trachomatis*, *Neisseria gonorrhoea* and HSV-2.

The biopsy is the so-called the gold standard in the diagnosis of cervical cancer, therefore it was taken as a dependent variable in the analyzes performed.



this case, a *boxplot* and a *histogram*. Class participants can independently explore subsequent variables to learn the specifics of the analyzed database.

### Comparison of two groups

The next image (Figure 4) shows a screenshot of the application that presents interactive results of comparing a selected variable in two independent groups that received a positive and negative biopsy result. Then, depending on the results of the test checking the compliance of the selected variable with the normal distribution (Guzik & Więckowska, 2023), a comparison is made using the parametric or non-parametric method (Milewski & Roszak, 2023).

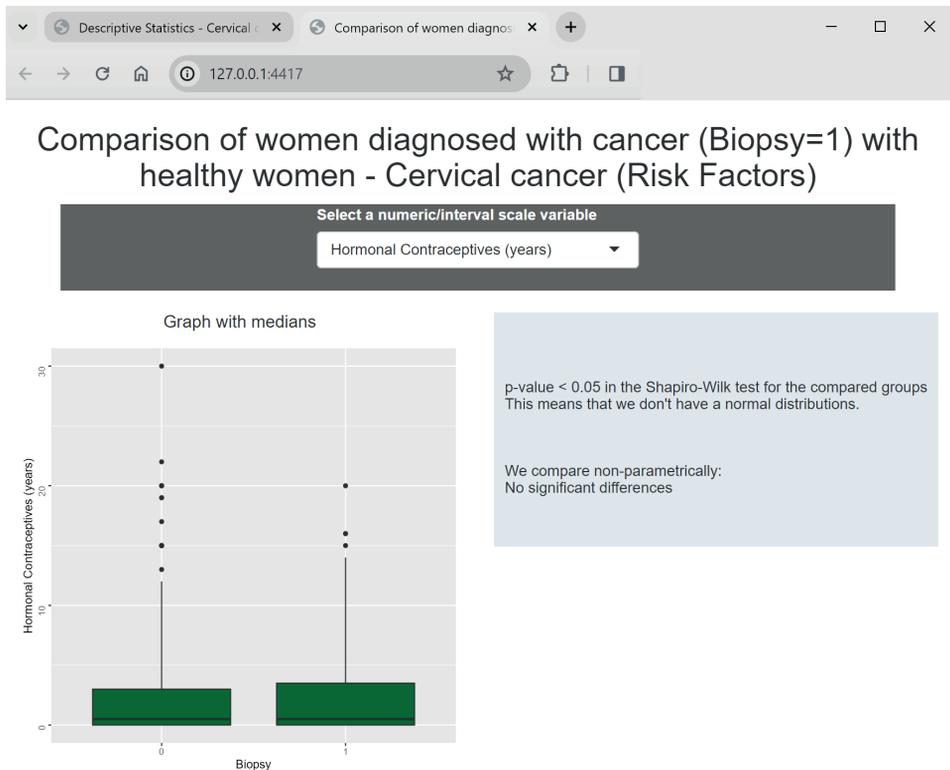


Figure 4. Sample screenshot of the RShiny application with the results of comparing two variables

Source: Authors' own work.

## ROC curve

One example of statistical analysis very often used for medical data is ROC (Receiver Operating Characteristic) curve analysis. It is a tool used in medical diagnostics to evaluate the performance of a diagnostic test based on the chosen cut-off point set for a specific variable. The ROC curve shows the relationship between sensitivity (true positive rate) and specificity (1 – false positive rate) depending on the different thresholds used in the diagnostic test. In practice, the higher the ROC curve, the better the diagnostic test, and the Area Under the Curve (AUC) measures the overall effectiveness of the test (Biecek, 2013). This method is widely used in fields such as oncology, cardiology, and neurology to evaluate diagnostic tests such as imaging tests, laboratory tests, and diagnostic questionnaires.

Below (Figure 5) an example of an application drawing a ROC curve for selected variables. By analyzing the displayed results one by one, you can try to answer the question: Will a given variable be useful in detecting cancer?

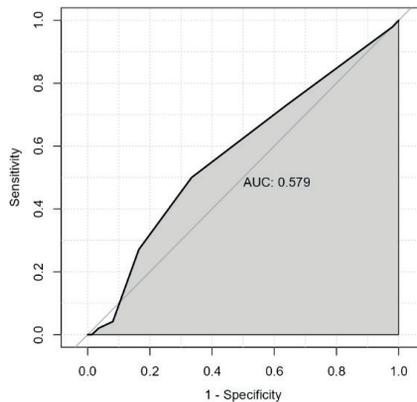
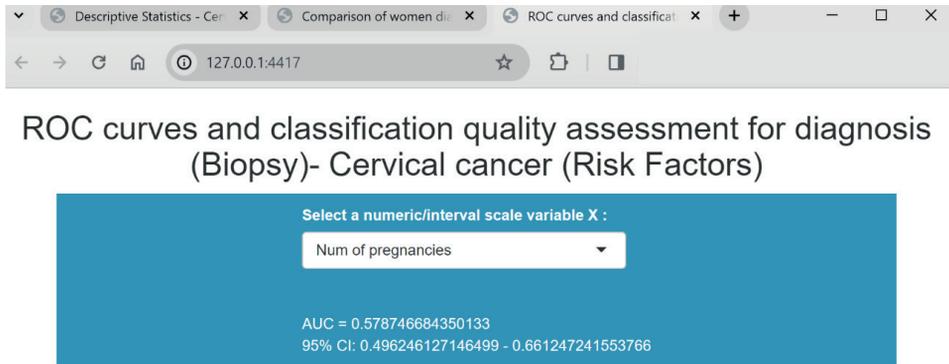
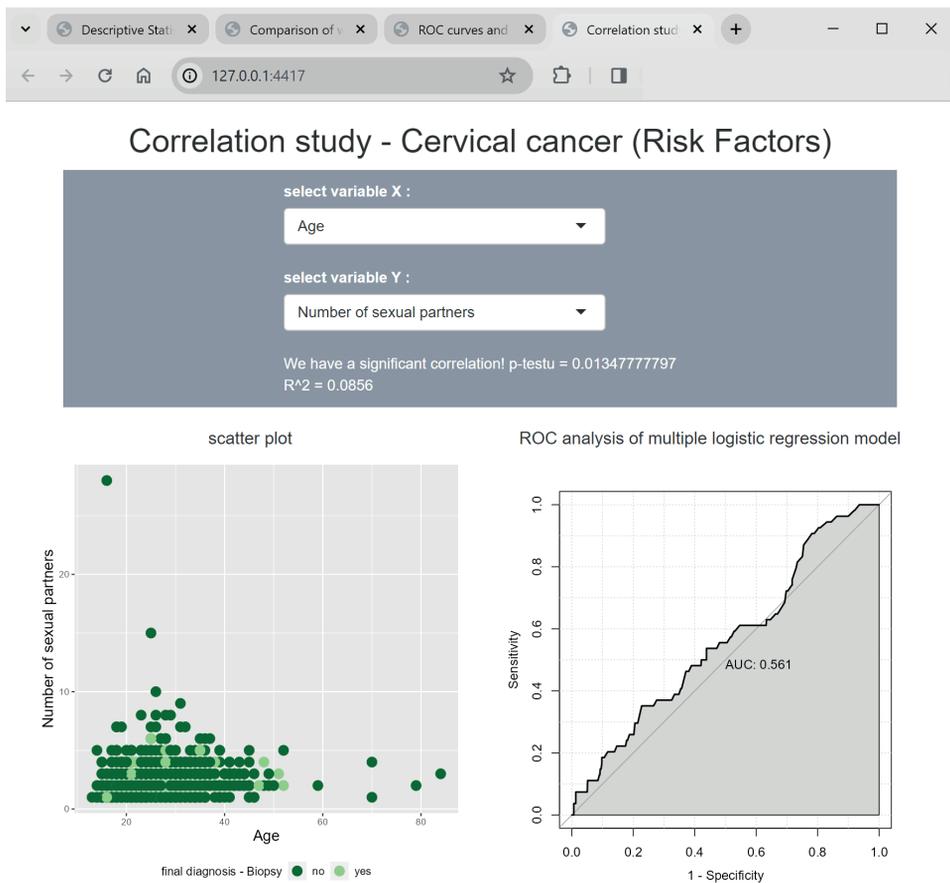


Figure 5. Sample screenshot of the RShiny application with ROC curve analysis results

Source: Authors' own work.

## Correlation study

Another way to look at the data analyzed in the project is to analyze their interconnections. Studying the correlation between selected variables can shed new light on the interactions between them. (Hegarty, 2004) Below (Figure 6) an example operation of the application is presented, in which the user selects two variables and interactively observes the changing calculations and a scatterplot regarding the analyzed relationship.



**Figure 6.** Sample screenshot of the RShiny application with correlation analysis results

Source: Authors' own work.

In the above example (Figure 6), patients with positive and negative biopsy results are additionally marked in color. Such an overview of the relationships between various variables may provoke further exploration of the data.

## Advanced Models

An additional advantage of using RShiny's interactive reports may also be the designed simulation of single- and multi-dimensional models, the changing parameters of which will suggest the advantage of a specific research concept. You can encourage class participants to discuss the specificity of the analyzed measurements and explore various possibilities for designing a model to support cancer diagnosis. Figure 6 additionally shows the ROC plot related to the evaluation of the logistic model (using the *glm()* function) for two selected independent variables. This is, of course, a version for students learning more advanced methods during compulsory or optional classes. A logistic model is a statistical tool used to model the relationship between one or more independent variables and a dependent variable (Fawcett, 2018). In this case, the dependent variable is the biopsy, which takes binary values (yes/no). This model is based on a logistic function that has the shape of a sigmoidal curve. In practice, the logistic model is used when we predict the probability of belonging to one of two categories (biopsy). This model is often used in the analysis of medical data, disease risk prediction or subgroup classification.

In the case of an extended timeframe for working with an advanced group of students, it is also possible to introduce visualization for multidimensional logistic models. However, it is crucial to ensure that the assumptions of each analysis are met. Students are expected to determine which parameters of the resulting model are essential and should be presented in the research report.

## Implementation of the project in classes

This section introduces two distinct proposals for implementing the lesson plan outlined in the preceding part, contingent on the allocated number of class hours for a specific subject.

### A Suggestion for Classes with Limited Hours

When dealing with classes of shorter duration, a viable approach is to provide students with templates. These templates could be files containing a pre-prepared operational R code structure, ready for completion during class. This way, students are not required to code the entire RShiny application from scratch; instead, they focus on the specific sections related to direct data analysis. Furnishing

students with code snippets for independent work can be an effective means of teaching, offering them exposure to programming basics, even if they have no prior experience. Suggested code additions for students may include invoking relevant statistical tests or modifying visualizations.

For instance:

- Modifying the chart type,
- Introducing additional geometries to an existing plot in the `ggplot()` function, like points, lines, bars, etc.
- Altering the scale of the x or y-axis,
- Adjusting parameters related to the chart background, font color, and including titles and labels.

In the R environment, we can craft charts that are precisely tailored to the specific requirements of the data analysis author.

### **Recommended Classes for Advanced Students**

For more advanced students, this example can be used to delve into the fundamentals of programming. In the presented R code example below (Figure 7), BMI coefficients are calculated. Subsequently, they are described within individual groups using an appropriate measure of descriptive statistics, depending on whether their distribution adheres to the normal distribution (Guzik & Więckowska, 2023). The decision is made using the logical function `if()` or `ifelse()`. This function is a fundamental tool in many programming languages, including R, for creating conditions in code (Biecek, 2017). It allows the execution of a specific instruction or block of instructions only when a specific condition is met. Another very useful instruction is `for`, which enables performing specific analyses for the entire list of variables – in the code below (Figure 7), for each of the many subgroups of patients treated with different methods.

For students interested in coding, there is the opportunity to create personalized functions or packages, which are sets of functions. One of the significant advantages of advanced coding in R is the capability to perform multiple analyses simultaneously within a written script. This script, essentially a set of instructions or commands compiled in a single file, serves a specific task. Another undeniable advantage is the independence to generate reports and visualize data according to the specific guidelines set by the code author (researcher) and easily modify them.

```
# Function to calculate BMI
calculate_BMI <- function(weight, height) {
  bmi <- weight / (height^2)
  return(bmi)
}

# A for loop to calculate BMI for different subgroups
unique_groups <- unique(data$patient_group)

# Initialization of empty lists into results
description_BMI <- list()

# A for loop to calculate average BMI for different subgroups
for (group in unique_groups) {
  subgroup <- data[data$patient_group == group, ]
  BMI_column_name <- paste("BMI", group, sep = "_")
  subgroup[[BMI_column_name]] <- calculate_BMI(subgroup$weight, subgroup$height)

  # Checking the normality of distribution using the Shapiro-Wilk test
  p_value <- shapiro.test(subgroup[[BMI_column_name]])$p.value

  # If p-value less than 0.05, calculate the median instead of the mean
  if (p_value < 0.05) {
    description_BMI[[group]] <- median(subgroup[[BMI_column_name]])
  } else {
    # Calculation of the average BMI for a given subgroup
    description_BMI[[group]] <- mean(subgroup[[BMI_column_name]])
  }

  # Display the results
  print(paste("Mean BMI (or median if irregularly distributed) for the group", group, ":",
             description_BMI[[group]]))
}
```

Figure 7. Sample R code for an application that calculates BMI in patient subgroups

Source: Authors' own work.

## Discussion

Contemporary medicine and clinical research heavily depend on data analysis. Evidence-Based Medicine (EBM) represents an approach to medical practice where clinical decisions hinge on the best available scientific evidence. It has become the standard in medical research, striving to guarantee that healthcare is evidence-based and personalized to meet patients' needs. Currently, 18 Regional Digital Medicine Centers are being established in Poland, aiming to aggregate comprehensive clinical data from local hospitals within a span of 5 years. (Creation and development of Regional Digital Medicine Centers–2023–Medical Research Agency, 2023). This nationwide initiative is modeled on European practices. The establishment of these centers necessitates individuals with competencies in both medicine and a broad range of data analysis skills. Graduates from medical universities equipped with enhanced proficiency in working with data across various tools, including open

source platforms, will be well-positioned to contribute to research teams, including those associated with these centers.

Students undergoing education at medical universities should not limit their learning experience solely to the use of commercial software, as has been the case until now. While paid statistical programs offer advantages, such as a user-friendly interface, they should not be entirely excluded from educational practices. However, acquiring knowledge in biostatistics and working with data in an open-source environment (e.g., R) can serve as a valuable complement to students' skills, providing them with opportunities to engage with entities like University Clinical Research Support Centers or the aforementioned Regional Digital Medicine Centers. The amalgamation of scientific knowledge enables future doctors to approach medical issues more precisely and effectively. Therefore, if there is a discernible interest among medical students in scientific pursuits, it is crucial to support and facilitate their usage and development of these skills. The willingness of medical university students to enhance their expertise in areas such as biostatistics, bioinformatics, or medical physics is an invaluable phenomenon. This allows them to participate in interdisciplinary research teams, contributing to scientific discoveries and innovations in the realms of medicine and health sciences.

Numerous medical universities in Poland not only provide courses that cultivate skills related to fundamental data processing, the utilization of statistical tools, and the interpretation of scientific research findings but also offer classes aimed at extending this knowledge for independent data exploration using open-source tools. A noteworthy example is the bachelor's studies program in Clinical Biostatistics at the Medical University of Białystok, which stands out for its uniqueness and deserves significant recognition (Laureaci\_szp\_2023\_2. Pdf, n.d). The field of Clinical Biostatistics at the Medical University of Białystok serves as an alternative to both theoretical sciences like mathematics or computer science and practical fields associated with medical, pharmaceutical, or health sciences. Researchers from this university emphasize that engaging in biostatistics would be unattainable without operating in an open-source environment. As they assert, „In R, you can find libraries with all the methods we are looking for,” a level of convenience unmatched by commercial software.

Medical universities in Poland are progressively broadening their curriculum at the intersection of exact sciences. The preeminent Polish institution, the Jagiellonian University Medical College, presently provides elective classes in the R environment within the Department of Bioinformatics and Telemedicine (the JU MC Syllabus, n.d.). Tailored for medical and dietetics students, these classes cover the assessment of tools for handling and analyzing data in scientific projects. Additionally, the university extends biostatistics classes, augmented with fundamental programming skills in R, to participants in the doctoral school.

The Poznan University of Medical Sciences also provides optional classes in data analysis using R and Python, serving as a valuable resource for aspiring

scientists. Beyond the primary audience of medical students, these classes also attract participants from pharmacy, physiotherapy, and medical analytics. While recognizing the need for straightforward statistics classes with a user-friendly interface for all medical majors, there is a call to expand educational offerings. This expansion also enhances the competencies of medical university students, allowing them to integrate knowledge from diverse fields. Ideally, students should be introduced to both R and Python. However, due to constraints in time and budget, the decision on the language of instruction for biostatistics classes for medical students should be made judiciously.

The feedback from medical students who have participated in optional R language classes is overwhelmingly positive. They highlight the ‘practical side’ of these classes and express the belief that the skills acquired ‘may prove useful when writing scientific papers in the future.’ Among the aspects that garnered the most satisfaction is the independent design of graphic concepts for visualizing analyzed data. We concur with the notion that ‘clear and communicative data visualization strengthens the results, while ill-considered or illegible data visualization undermines the reliability of the analyses performed’ (Discover! Reveal! Explain! A collection of essays on the art of presenting data – PDF, 2014). Below is an illustrative chart (Figure 8) created by a student from optional classes during the ‘Data Analysis in R’ class in the academic year 2023/24:

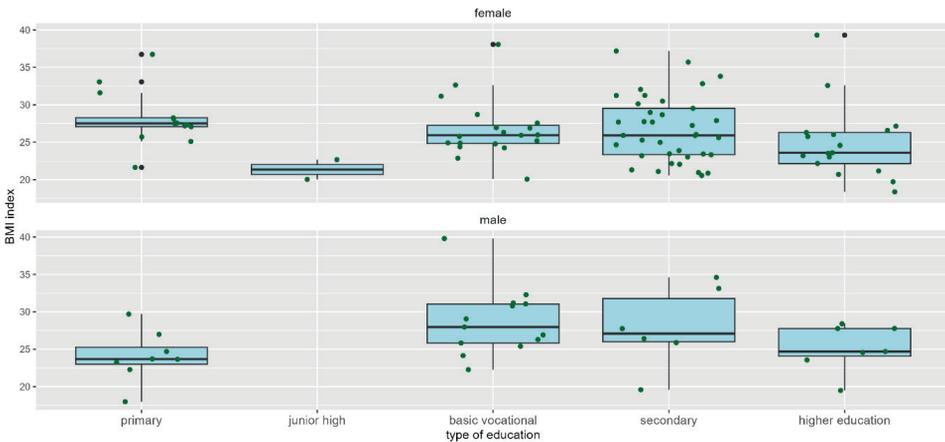


Figure 8. Graph generated during the optional class „Data analysis in R”

Source: Authors’ own work.

At Poznan University of Medical Sciences, a distinctive, unique teaching initiative has been established, centered on interacting with dynamic RShiny reports in an open-source environment. In the information society, cultivating critical thinking skills and the proficiency to manipulate data through visual representations are paramount for fostering research competencies, facilitating

decision-making, and ensuring effective communication (Murray, 2014). Today, information is available at our fingertips, so the ability to approach it critically becomes a key tool in developing knowledge (Central Statistical Office / Thematic Areas / Health, n.d.) (How to Gain Access to SRP – Ministry of Digitization – Gov.Pl Portal, n.d.) (Creation and Development of Regional Digital Medicine Centers–2023–Medical Research Agency (2023).

Visualizations play a crucial role in identifying trends, relationships, and patterns, thereby prompting the formulation of new research questions. Simultaneously, the capacity to generate or interpret visual representations enhances the effectiveness of conveying information to others and engaging in evidence-based discussions.

The meticulously crafted scenario is poised for execution, with due consideration for the intended recipients within medical universities, whether they be students or doctoral candidates. This culmination is the product of several years of research and pedagogical observations, pointing to a growing demand for interdisciplinary scientists. In the future, these individuals will integrate into research teams in academic units, both within universities (public sector) and the private sector operating in the medical domain. Suggesting classes where future scientists actively participate in programming and autonomously create data mining solutions within a web application embodies an innovative approach. It can be implemented in various formats, depending on the allocated class hours and the proficiency level of the participant group. Polish medical universities currently lack implementations in this didactic domain. Developing such a class concept requires high statistical and IT competencies, including programming, experience in teamwork on medical projects, and extensive teaching experience with medical students. Future publications will present the results of evaluating such classes to validate the aforementioned assumptions. The ultimate decision between R and Python hinges on the specific project needs and user experience, encompassing IT competencies. In practice, both platforms are frequently employed depending on the context of the task. It is crucial to tailor the tools to the educational objectives and understand the unique nature of the student group. For medical school students aiming to concentrate on medical data analysis, R may be a more immediate choice. Consequently, R was deliberately selected as the tool for this project.

## Conclusions

The presented project, designed for medical university students, outlines a curriculum illustrating the utilization of the RShiny tool to develop interactive web applications, eliminating the necessity for advanced programming skills,

particularly in JavaScript. Students will learn to construct RShiny applications, engaging in data visualization, statistical analysis, and model simulation, offering valuable skills for their future research and scientific endeavors. Unlike static reports limited to predefined parameters, these applications will produce dynamic visualizations and reports based on selected parameters. The results will be accessible through interactive charts and tables in the web browser. RShiny facilitates the creation of applications where users can dynamically choose variables and parameter settings through buttons, sliders, and other interactive elements. This approach fosters a more flexible and interactive exploration of data. The resulting series of visualizations allows for the selection of a graphical interpretation of the discussed research problem that is self-contained, requiring no additional explanations for the audience's full understanding.

Given the limited time available for medical students, this project offers a means to autonomously create dynamically evolving visuals that captivate attention, stimulate creative thought, and facilitate pattern recognition. Visual representations, including charts, graphics, and infographics, prove to be highly effective tools in analyzing and interpreting medical data. The innovative character of the presented research project (Table 1) sets it apart as a unique concept ready for integration into medical education, especially for the facilitation of engaging interactive sessions.

The proficiency in utilizing diverse tools, beyond just commercial solutions, can enhance students' adaptability and preparedness for the varied challenges they may encounter in their future scientific endeavors within the realm of medicine. The gradual incorporation of programming elements into classes and courses focused on data analysis within medical university curricula becomes imperative. This evolution is a natural response to the dynamic advancements in technology and the progress within biomedical sciences, where data analysis plays an increasingly pivotal role in enhancing healthcare and driving innovative medical research. Clinician scientists equipped with fundamental programming skills will be better equipped to tackle the future challenges in medicine.

The faculty engaged in the convergence of mathematical and biological domains should inspire medical students to broaden their perspectives within the realm of exact sciences. This presents an enticing opportunity, offering not only intellectual fascination but also a chance to enhance one's medical practice. Proficiency in areas such as mathematics, statistics, or computer science can serve as a meaningful contribution to advancements in diagnostics, therapy, and clinical research. Embracing this approach brings notable advantages, including the potential for more efficient utilization of modern technologies, precise analysis of medical data, and active involvement in innovative research initiatives. Developing competencies in interactive data visualization within this context will undoubtedly provide students with the gratification of expanding their knowledge while unlocking new vistas and challenges in the dynamic realm of evidence-based medicine.

Table 1.  
*Identified Needs and Challenges at Medical Universities in Poland with Innovative Solutions Proposals*

Identified Needs and Challenges at Medical Universities in Poland	Innovative Solutions Proposals
1. Pioneering the development of research competencies in the contemporary information society.	• Crafting graphics that capture attention, inspire creative thinking, and encourage pattern recognition, thus extending memory traces through associations.
2. Enhancing the efficiency of interdisciplinary teamwork within the medical domain.	• Providing data manipulation capabilities, allowing users to experiment with various perspectives, scenarios, and the formulation of new research questions.
3. Equipping future medical researchers for evidence-based discussions (EBM) skills.	• Proficiency in real-time visualization creation using the RShiny package, without the need for in-depth programming understanding.
4. Initiating a discourse on the significance of introducing programming fundamentals into the curriculum of Polish medical university students.	• Teaching fundamental programming skills in the R environment within the education of medical university students.
5. Broadening the educational spectrum by offering courses in data analysis within an open-source environment, catering to the needs of exceptionally talented students.	• Developing a missing implementation concept in the discussed educational area for medical university students by a qualified team with statistical and IT competencies, including programming skills.
6. Fostering interdisciplinary collaboration by combining expertise across scientific and medical disciplines among all medical university students.	• Utilizing experience in collaborative work with medical projects and extensive teaching experience with students in medical disciplines.
7. Cultivating high competencies and interdisciplinary skills among teaching and research staff.	• Implementing classes in various formats, depending on the number of instructional hours and the proficiency level of the participant group.

Source: Own work.

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Justyna Marcinkowska, Magdalena Roszak

## **Interaktywne raporty RShiny – czyli niezależność i samodzielność wizualizacji danych medycznych**

### **Streszczenie**

W artykule omówiono wykorzystanie języka R, a szczególnie narzędzia RShiny, do tworzenia interaktywnych raportów w dziedzinie analizy danych medycznych. Autorzy podkreślają potrzebę interdyscyplinarnego podejścia do nauczania statystyki wśród studentów medycyny. Przedstawiono alternatywę dla tradycyjnych statycznych raportów, proponując tworzenie interaktywnych aplikacji webowych, które umożliwiają eksplorację, analizę i wizualizację danych medycznych zmieniającą się w czasie rzeczywistym. Wykorzystanie języka R, jako narzędzia open source, pozwala na rozwijanie kompetencji studentów kierunków medycznych w dziedzinie analizy danych oraz dostosowywanie narzędzi badawczych do indywidualnych potrzeb. Przedstawiono także projekt scenariusza zajęć wykorzystujących przykładowe dane medyczne dotyczące raka szyjki macicy wraz z propozycją konkretnych analiz tych danych i ich wizualizacji przy pomocy interaktywnych raportów RShiny.

Artykuł kończy się dyskusją na temat roli nauki języka R w edukacji studentów polskich uczelni medycznych i potrzeby rozbudowy oferty edukacyjnej dla nich o kursy z zakresu analizy danych w środowisku open source.

**Słowa kluczowe:** RShiny, R, wizualizacja danych, interaktywne raporty, statystyka, nauczanie studentów medycyny

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## **Informes interactivos de RShina – independencia y autosuficiencia de la visualización de datos médicos**

### **R e s u m e n**

El artículo analiza el uso del lenguaje R, especialmente la herramienta RShiny, para crear informes interactivos en el campo del análisis de datos médicos. Los autores enfatizan la necesidad de un enfoque interdisciplinario para la enseñanza de la estadística entre los estudiantes de medicina. Se presentó una alternativa a los informes estáticos tradicionales, proponiendo la creación de aplicaciones web interactivas que permitan la exploración, análisis y visualización de datos médicos cambiantes en tiempo real. El uso del lenguaje R como herramienta de código abierto permite el desarrollo de competencias de los estudiantes de medicina en el campo del análisis de datos y la adaptación de herramientas de investigación a las necesidades individuales. También se presentó un borrador de plan de lección utilizando datos médicos de muestra sobre el cáncer de cuello uterino, junto con una propuesta para análisis específicos de estos datos y su visualización mediante informes interactivos RShiny. El artículo finaliza con una discusión sobre el papel del aprendizaje del lenguaje R en la educación de los estudiantes de las universidades médicas polacas y la necesidad de ampliar la oferta educativa para ellos con cursos de análisis de datos en un entorno de código abierto.

**Palabras clave:** RShiny, R, visualización de datos, informes interactivos, estadística, enseñanza a estudiantes de medicina

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## **Интерактивные отчеты RShina – независимость и самодостаточность визуализации медицинских данных**

### **А н н о т а ц и я**

В статье рассматривается использование языка R, в частности инструмента RShiny, для создания интерактивных отчетов в области анализа медицинских данных. Авторы подчеркивают необходимость междисциплинарного подхода к преподаванию статистики студентам-медикам. Была представлена альтернатива традиционным статическим отчетам, предлагающая создание интерактивных веб-приложений, позволяющих исследовать, анализировать и визуализировать изменяющиеся медицинские данные в режиме реального времени. Использование языка R в качестве инструмента с открытым исходным кодом позволяет развивать

компетенции студентов-медиков в области анализа данных и адаптации исследовательских инструментов к индивидуальным потребностям. Также был представлен проект плана урока с использованием выборочных медицинских данных о раке шейки матки, а также предложение по конкретному анализу этих данных и их визуализации с использованием интерактивных отчетов RShiny. Статья завершается обсуждением роли изучения языка R в образовании студентов польских медицинских вузов и необходимости расширения образовательного предложения для них курсами по анализу данных в среде с открытым исходным кодом.

**К л ю ч е в ы е с л о в а:** RShiny, R, визуализация данных, интерактивные отчеты, статистика, обучение студентов-медиков



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# **Application of AI Technologies in STEAM School Education**

## **Abstract**

Artificial intelligence is increasingly entering all spheres of our lives, including the sphere of education. These technologies offer numerous advantages and opportunities to perform various activities and tasks throughout the educational process. This article discusses some aspects of the application of AI technologies to improve personalization, accessibility, and interactivity in school education, and especially in learning STEAM subjects. The authors aim to propose approaches to successfully integrate AI into the work of teachers and facilitators during the pre-planning phase of lessons, the preparation of personalized tasks for students, the process of testing and assessing knowledge, as well as in group and project-based learning. The article shares the experience of teaching a compulsory computer science course as well as working in an interest club related to artificial intelligence and robotics with 6th grade students in secondary school, highlighting the potential of certain chatbots to support and enrich the process of programming.

**Key words:** Artificial Intelligence in Education (AIED), Chatbots, STEAM education

The development of AI technologies in the digital age has the potential to fundamentally change and modify traditional approaches, methods and technologies for teaching and learning. In school education, some of the opportunities that these technologies provide are increasingly used in various aspects such as: establishing and analyzing learning outcomes, personalizing educational resources and the learning process, providing immediate feedback and increasing the activity and motivation of the students, etc.

The implementation and use of intelligent learning platforms that include personalized learning and assessment systems offer great potential for increasing students' knowledge, building essential key competencies, and assisting teachers in organizing personalized education (Glushkova, 2015). This way, teachers can focus their attention on more critical activities such as lesson planning and supporting students, while using automated assessment and feedback systems. It is a fact that providing a learning environment tailored to the personal expectations, characteristics, goals and interests of each individual student leads to increased interest and motivation of students and increases the effectiveness of the learning process (Noskova et al., 2021).

Despite these advantages, the use of AI in education (AIEd) also raises important ethical questions. These issues are largely related to the exacerbation of existing inequalities in the educational system because AI algorithms often tend to perpetuate biases and distort information embedded in machine learning algorithms. Another significant problem is the fact that most professors have not studied AI at all during their university education. Therefore, for teachers to use AI effectively in their teaching practices, they need appropriate additional and ongoing training and support.

The article discusses some aspects of the application of AI technologies to improve personalization, accessibility and interactivity in school education and, in particular, STEAM learning.

## Related Works

Artificial intelligence has the potential to change many aspects of our lives – commerce, business, tourism, agriculture, healthcare and, of course, education (Alawi, 2023). Artificial intelligence, as defined by John McCarthy as far back as 1955, refers to machines being able to perform tasks that normally require human intelligence (McCarthy, 1987). Indeed, AI is not itself intelligent, but rather can perform tasks that are considered intelligent with a certain degree of success (Chiu et al., 2022). Based on these concepts, we can consider any theory, methodology or technique that facilitates the analysis, simulation and study of human thought

processes and behavior by machines such as AI. Intelligent systems cover a wide range of technologies such as robotics, natural language processing, semantic knowledge modeling with common sense, expert systems, neural networks, machine learning, etc., (Sarker, 2022).

AI is considered a powerful tool for creating new paradigms in the organization of the learning process, the assessment of technological progress and the conduct of educational research. Three main AIEd paradigms are defined (Ouyang & Jiao, 2021):

- *AI-directed learning* – AI is used to introduce cognitive learning tools, with learners in the role of recipients of AI services.
- *AI-supported learning* – AI supports learning through the application of various cognitive and social constructivist theoretical foundations. Students collaborate with AI to obtain desired knowledge, skills, and competencies.
- *AI-empowered learning* – this paradigm is based on collaboration, with AI empowering learners to take initiative in their own learning, and collaboration between students, facilitators, teachers, information, and technology increasing the added value of learning.

In AIEd, two aspects are clearly distinguished: the development of AI-based learning tools and the use of AI to manage, evaluate and improve learning. AIEd includes the integration of different social, cultural, economic and pedagogical approaches in the use of AI technologies such as intelligent learning cyber-physical systems (Stoyanov et al., 2022), chatbots, learning robots, learning tracking and analysis tools, adaptive learning systems and automated assessment and analysis, etc.

One of the most commonly used AI technologies to support teaching and learning activities is the utilization of Chatbot technology (Deng et al., 2023). By nature, a Chatbot is an intelligent agent that engages in meaningful conversations with users, thanks to a well-structured knowledge base. Creating a Chatbot is based on Natural Language Processing (NLP) technologies. The first Chatbot, “Eliza,” was developed to act as a psychotherapist as early as 1966. As technology advanced, numerous Chatbots were created, including SmarterChild, Apple Siri, Amazon Alexa, IBM Watson, Microsoft Cortana, Google Assistant, and more (Reis et al., 2018). We will look at some chatbots and their functionalities through the prism of school education.

*ChatGPT* was created by OpenAI and launched in November 2022. ChatGPT is described as a powerful machine learning software that uses the Generative Pre-Trained Transformer (GPT) algorithm to generate answers to text questions. ChatGPT is trained on a huge set of diverse data such as articles, websites, books, and written conversations. However, through a fine-tuning process that includes dialog optimization, ChatGPT is capable of having a conversation with users (Rahman, 2023). Generative pre-trained transformers (GPTs) are a class of advanced language models that use deep learning to improve their output.

By identifying patterns and regularities in the data, GPTs generate relevant phrases and words or produce relevant images in response to user queries. ChatGPT can perform a very wide range of tasks such as: language translation, conversation and answering questions, generating long or short text, explaining complex concepts or topics, generating or debugging program code, etc. ChatGPT's ability to understand natural language queries and generate responses has made it a popular tool for getting quick answers to a wide variety of questions in the classroom. For example, it can quickly summarize a long and difficult topic in a few sentences. It not only discovers what the problem is, but also provides descriptive solutions to mathematical and physical problems; can help detect program errors; comment and explain program fragments and modules.

*Microsoft 365 Copilot* is another chatbot that aims to improve collaboration between participants in the educational process and facilitate team and project work. It provides personalized advice and suggestions to help teams perform their tasks more effectively. It is integrated into Microsoft 365 applications such as Word, Excel, PowerPoint, Outlook and Teams and offers collaboration to all participants in the learning process. To implement these features, Copilot provides personalized access to user profiles and manages personal calendars, emails, chats, documents, meetings, contacts, etc. (Quibeldey-Cirkel, 2023). In addition, this chatbot can also be embedded in programming environments such as Visual Studio Code and support the teaching of programming in various programming languages in the middle school (Puryear & Sprint, 2022).

All this explains the significant potential of AI to improve the process of learning and teaching, as well as to implement pedagogical innovations in the field of monitoring the development, assessment, and management of education.

## **Methodology of Research**

The potential of AI to transform education is undeniable, but achieving good educational outcomes requires extensive scientific research and pedagogical experimentation to ensure the necessary reliability, validity and security of the learning process. The use of AIED technologies, learning content and pedagogical approaches must be integrated and adapted to the characteristics of the learning environment in the modern school. Therefore, when designing learning activities supported by AI, teachers should consider six key elements to achieve the expected learning goals: learners, context, tasks, pedagogical approaches, methods of interaction and application of AI technologies.

When we talk about the application of AI in school education, we usually mean different aspects aimed at improving learning, teaching and administration

processes. We base our research on the understanding that AI can provide significant benefits to education, but that it can only complement and enhance teacher teaching, rather than replace it entirely.

The peculiarities of different educational systems and schools determine the need to conduct research on the effectiveness of the application of AIED technologies. Given the stated realities and processes in modern education, it is necessary to conduct research on various aspects of the application of AI in school education. This motivates the authors, who have set themselves the task of studying the possibilities of applying some AI technologies in STEAM education in the conditions of Bulgarian schools.

In Bulgaria, school education is mainly conducted in a classroom-lesson format with predetermined curricula for each subject. This does not allow for formal training in artificial intelligence, but enables the use of AI technologies in separate activities in the training of various academic subjects. New opportunities for experimentation in this direction are provided by the creation of STEAM centers in all schools in the country, and the organization of interest clubs as an optional form of education. The methodological toolkit, in addition to the development of educational materials, also includes a test measurement of knowledge, as well as the results of the project work of an experimental group of 6th and 7th grade students on the subject „Computer Modeling and IT“ related to Python programming. In addition, the results of project work in a STEAM club on interests in the field of AI and robotics with students of the same age group are also measured.

The research methodology includes the development of teaching materials on „Computer Modeling and IT“ (as a coauthor of textbooks for compulsory training (Garov, Glushkova et al., 2022),); the development of a curriculum for the STEAM interest club in AI and robotics (Stoyanov, Glushkova et al., 2019); the creation of Learning and Creativity Plans for the application of AI technologies in individual school subjects (FACILITATE-AI, 2023); preparation of tests to check students' knowledge; preparation of a survey among students, teachers, and parents. The study was conducted during the 2022–2023 school year at „Hristo Smirnenski“ secondary school in the town of Brezovo and partially in several other secondary schools in the Plovdiv region. 76 students, 7 teachers, and 32 parents participated in the research.

The participation of the authors in several national and European projects related to the development of educational content on AI and the application of AI technologies in the classroom helped to use both personal and shared collective experiences that allowed us to make some of the summaries and analyses shared in the article.

## **Our Experience in the Application of AI Technologies in STEAM Training**

In the last few years, a team of scientists and pedagogical specialists from Plovdiv University „Paisii Hilendarski“ in Bulgaria, together with teachers in secondary schools of the Plovdiv region, have developed different approaches for the application of AI in school education in almost all aspects discussed above. A prototype of an intelligent educational platform Virtual Educational Space (VES) was developed as a cyber-physical and social system that provides adapted learning resources and services to students of various specialties in the Faculty of Mathematics and Informatics (Valkanov, 2016) (Rahnev, 2014). VES is realized as a multi-agent platform, with the personalization of learning realized through the interaction between the personal assistants of all users – students, teachers, and university administration (Todorov, 2019 a).

As an adaptation of VES for school education, a prototype cyber-physical space called BLISS was developed (Todorov et al., 2019 b). This platform is multi-agent and enables personalized learning for self-studied students, as well as personalized access to learning resources and services for regular students. By using blockchain technologies in BLISS, an electronic diary related to the administrative process of issuing documents with factory numbering is modeled and is in the process of prototyping (Krasteva, 2022). The system for checking and evaluating knowledge is connected to the electronic diary, which monitors the progress of students and, in the presence of educational problems, informs the parents and teachers of the student.

In parallel with the development of BLISS, the team also turned its attention to the integration of AI chatbots, which, on the one hand, can interact with the personal assistants and other intelligent agents in the space, and on the other hand, help to solve various tasks in the present classroom training. Over the past two years, with the rapid development of LLM and chatbots, we have been experimentally using the capabilities of AI in STEAM education in the school in the following aspects: for planning the learning process and lessons by the teachers; for personalization of the learning process; for supporting the programming process; for evaluation and testing of students.

## Organization of training in STEAM education

Working in interest clubs in the established STEAM centers in schools provides an opportunity to develop students' creativity, analytical and critical thinking. Teamwork, when working on common projects, unites students and builds the skills of understanding, tolerance, empathy, and inclusion so necessary for modern development. In order to achieve these goals, the teacher must plan his/her activity well, create an appropriate curriculum, think about interesting projects and think about organizing team activities. For example, let us organize a robotics interest club activity with 6th and 7th grade students with the help of ChatGPT.

First, let us create the curriculum. The request to ChatGPT is: “*Create a curriculum of 30 lessons on the topic “Robotics” for a STEAM interest club in the 6th grade*”. The part of chatbot answer is presented in Figure 1.

Curriculum: Robotics for 6th Grade STEAM Interest Club

**Lesson 1: Introduction to Robotics**

- Learning Objectives:**
  - Understand the concept of robotics and its applications in real-world scenarios.
  - Identify the main components of a robot and their roles.
- Key Digital Competences:**
  - Digital Literacy: Understanding basic technological terms related to robotics.
  - Computational Thinking: Introducing the logic behind robot actions and decisions.
- Assessment:**
  - Quiz on robotics concepts and terminology.
  - Participation in a group discussion about potential robot applications.

**Lesson 2: Robot Design and Construction**

- Learning Objectives:**
  - Learn about the engineering design process and its application in robotics.
  - Create a simple robot design using 3D modeling software.
- Key Digital Competences:**
  - Digital Creativity: Designing and customizing robot parts using digital tools.
  - Information Literacy: Researching existing robot designs for inspiration.
- Assessment:**
  - Evaluation of individual robot designs and explanations of design choices.
  - Completion of a 3D model of the robot part.

**Lesson 3: Programming Robots with Blockly**

- Learning Objectives:**
  - Understand block-based programming concepts and their application in robotics.
  - Develop basic programming skills to control a robot's movements.
- Key Digital Competences:**
  - Digital Skills: Operating programming software and writing code blocks.
  - Problem-Solving: Debugging and troubleshooting robot programs.
- Assessment:**
  - Completion of programming exercises to make the robot perform specific tasks.
  - Peer review and feedback on e

**Lesson 4: Sensing and Perception in Robotics**

- Learning Objectives:**
  - Explore various sensors used in robotics and their functionalities.
  - Understand how robots gather data from their environment and react accordingly.
- Key Digital Competences:**
  - Data Literacy: Analyzing sensor data and making decisions based on it.
  - Critical Thinking: Evaluating the effectiveness of different sensors in specific scenarios.
- Assessment:**
  - Practical demonstration of sensor integration in a robot.
  - Quizzes on sensor types and their applications.

**Lesson 5: Robotics Challenge and Showcase**

- Learning Objectives:**
  - Apply knowledge gained throughout the curriculum to solve a robotics challenge.
  - Collaborate with team members to design, program, and present a functional robot.
- Key Digital Competences:**
  - Collaboration: Working as a team to achieve a common goal.
  - Digital Communication: Presenting the robot design and functionality effectively.
- Assessment:**
  - Performance in the robotics challenge based on criteria such as efficiency and accuracy.
  - Presentation and demonstration of the robot's capabilities in the showcase.

The curriculum aims to introduce 6th-grade students to robotics while fostering their interest in STEAM subjects. Each lesson has specific learning objectives, and key digital competences are integrated into the activities. The assessment methods include quizzes, hands-on tasks, individual and group projects, and peer evaluations. This approach encourages active participation, creativity, problem-solving, and collaboration among the students, making the learning experience engaging and enjoyable.

Figure 1. Created STEAM curriculum

Source: Own work.

The next step in the organization of learning in the interest club is the creation of a learning and creativity plan for individual lessons. For example, when requesting the development of a lesson plan for “Robot Design and Construction”, ChatGPT generates the following (Figure 2):

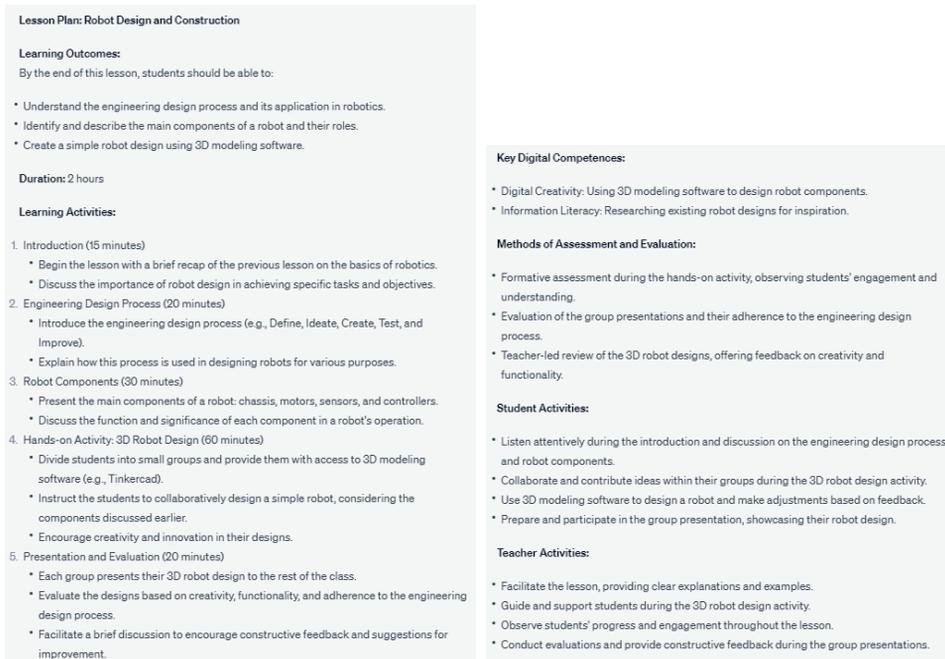


Figure 2. Created Lesson Plan

Source: Own work.

## Support the programming process

Programming the movement and behavior of robots can be realized in various programming languages. In Bulgaria, students study „Computer Modeling and Information Technologies“ as a compulsory subject starting from the 3rd grade of primary school. The two main languages taught in this subject are Scratch and Python. Since both Scratch and Python are widely used in programming educational robots, let us explore some possibilities for supporting the programming process using chatbots like ChatGPT and Copilot. These bots can also be used by teachers in initial preparation for classes and by students in interest clubs. Since students already have a basic knowledge of programming, the application of these AI tools can be mainly aimed at:

- *Idea generation:* Chatbots can help students generate ideas for realizing their robots' „missions.“
- *Coding help:* Chatbots can act as coding helpers by helping students with syntax and logic errors in their Scratch or Python code. On the other hand, students can share some code snippets with the bot and discuss the received suggestions to improve the code.

- *Access to additional information:* Chatbots can provide links to relevant learning resources, tutorials and documentation for both Scratch and Python.
- *Troubleshooting:* When students find errors and inconsistencies in their bot's behavior, they can seek help from the chatbot to identify the problems and find solutions.
- *Organize project work:* Students can discuss the assignment and project goals with the chatbot, and it can offer guidance for achieving those goals, given the capabilities of both Scratch and Python.
- *Real-time code examples:* Copilot, which is designed to generate code, can provide real-time code examples based on student descriptions. This can be especially useful for students who are interested in new programming concepts or techniques.

It is important to note that while chatbots are valuable tools to support the learning process, they should not replace human interaction and guidance. Teachers as moderators and facilitators are the ones who organize the whole learning and research process, they provide personalized feedback, to address individual learning needs, to encourage students with educational difficulties and to provide a supportive environment. Chatbots can serve as additional tools to enhance overall learning.

Microsoft 365 Copilot is only one of the AI tools in the Microsoft's Copilot ecosystem which include Github Copilot (and the new Github Copilot X), Dynamics 365 Copilot, Copilot in Microsoft Viva, Microsoft Security Copilot, and the expected soon Copilot in PowerBI, Copilot in Power Pages, Copilot in Windows, etc. Microsoft also announced the work on new features that will help developers build their own copilots and AI-enabled applications. Github Copilot seamlessly integrates with the widely used programming environments like Neovim, JetBrains IDEs, Visual Studio and Visual Studio Code for Python, JavaScript, TypeScript, Ruby, Go, C#, and C++ programming.

In the preparatory phase in the Robotics club, the teacher can use Copilot, which provides specialized support in the field of programming. He/she can define his/her request to the bot, and get different ideas and solutions to the tasks. The teacher, relying on his/her knowledge and experience, reviews and accepts or rejects the proposed solutions. For example, to consolidate the knowledge of the movement of the turtle in the first lessons of the Robotics club and the drawing of various figures, the teacher can make the appropriate requests to Copilot and receive appropriate suggestions (Figure 3).

```

1 # draw square with turtle
2 import turtle # import turtle module
3 wn = turtle.Screen() # create a turtle screen
4 wn.bgcolor("lightgreen") # set background color
5 wn.title("Turtle Square") # set title
6 tess = turtle.Turtle() # create a turtle named tess
7 tess.color("blue") # set tess color
8 tess.pensize(3) # set tess pensize
9 tess.shape("turtle") # set tess shape
10 for i in range(4): # repeat 4 times
11     tess.forward(100) # move forward 100
12     tess.left(90) # turn left 90 degrees
13 wn.mainloop() # wait for user to close window
14
15

```

```

1 # draw figure with rotation of square 12 times with turtle
2 import turtle # import turtle module
3 wn = turtle.Screen() # create a turtle screen
4 wn.bgcolor("white") # set background color
5 wn.title("Turtle Square") # set title
6 tess = turtle.Turtle() # create a turtle named tess
7 tess.color("blue") # set tess color
8 tess.pensize(3) # set tess pensize
9 tess.shape("turtle") # set tess shape
10 for i in range(12): # repeat 12 times
11     for i in range(4): # repeat 4 times
12         tess.forward(100) # move forward 100
13         tess.left(90) # turn left 90 degrees
14         tess.left(30) # turn left 30 degrees
15 wn.mainloop() # wait for user to close window
16

```

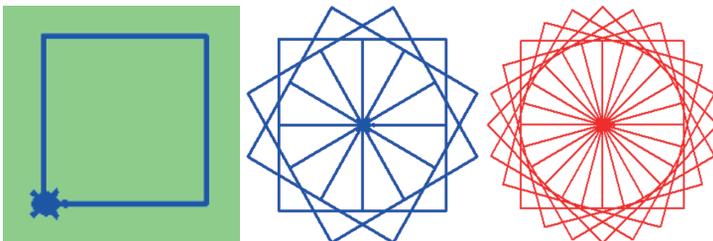


Figure 3. Application of Copilot in programming

Source: Own work.

When working on various assignments in the Robotics Club, students can also use ChatGPT and MS Copilot using some of the options suggested above. The following figures present different proposals for programming the movement of a robot that follows a black line of a script transformation of Scratch and Python, proposed by ChatGPT (Figure 4) and the proposal of Copilot built into the Visual Studio Code programming environment (Figure 5).

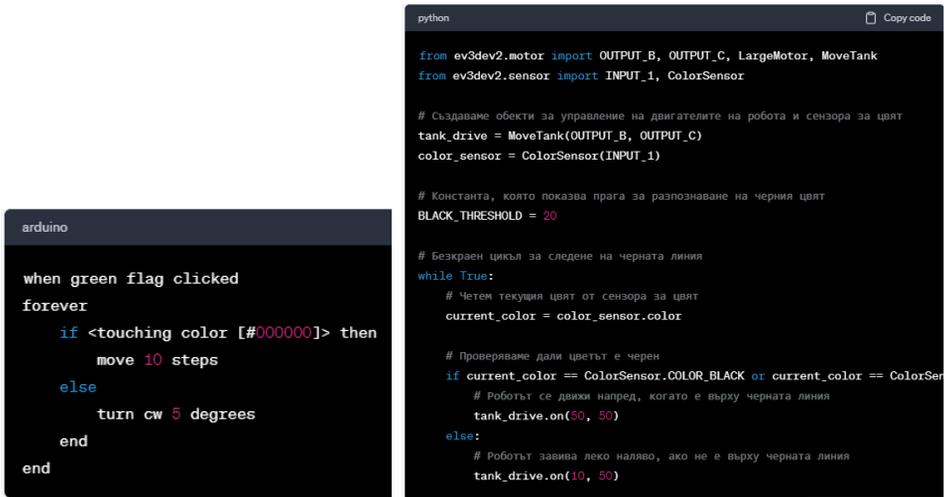


Figure 4 shows two code snippets side-by-side. The left snippet is Scratch code for an Arduino environment, and the right snippet is Python code. Both describe a robot following a black line using a color sensor.

```
arduino

when green flag clicked
forever
  if <touching color [#000000]> then
    move 10 steps
  else
    turn cw 5 degrees
  end
end

python

from ev3dev2.motor import OUTPUT_B, OUTPUT_C, LargeMotor, MoveTank
from ev3dev2.sensor import INPUT_1, ColorSensor

# Създаваме обекти за управление на двигателите на робота и сензора за цвят
tank_drive = MoveTank(OUTPUT_B, OUTPUT_C)
color_sensor = ColorSensor(INPUT_1)

# Константа, която показва прага за разпознаване на черния цвят
BLACK_THRESHOLD = 20

# Безкраен цикъл за следене на черната линия
while True:
    # Четем текущия цвят от сензора за цвят
    current_color = color_sensor.color

    # Проверяваме дали цветът е черен
    if current_color == ColorSensor.COLOR_BLACK or current_color == ColorSensor.COLOR_BLACK_REFLECT:
        # Роботът се движи напред, когато е върху черната линия
        tank_drive.on(50, 50)
    else:
        # Роботът завива леко наляво, ако не е върху черната линия
        tank_drive.on(10, 50)
```

Figure 4. Application of ChatGPT in SCRATCH and Python programming

Source: Own work

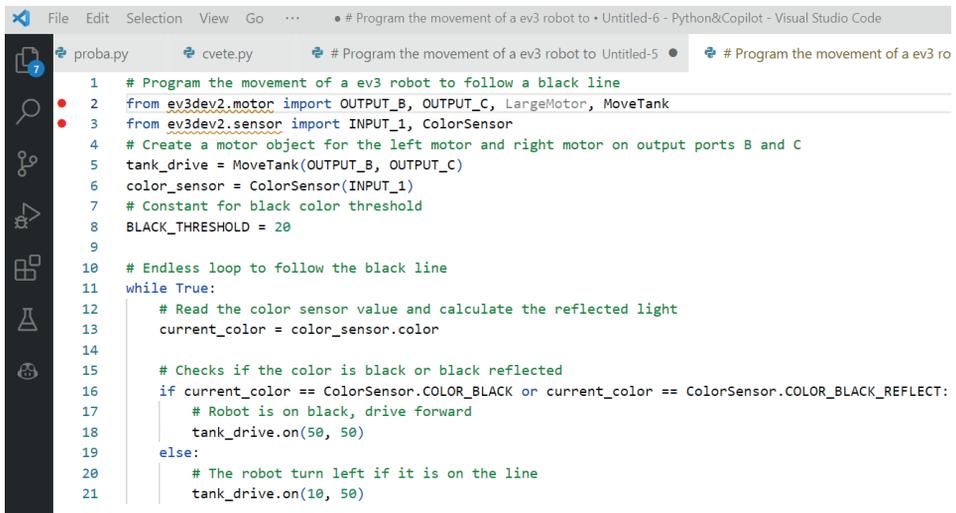


Figure 5 shows a screenshot of Visual Studio Code with Python code generated by Copilot. The code is for a robot following a black line using a color sensor.

```
File Edit Selection View Go ... # Program the movement of a ev3 robot to ... Untitled-6 - Python&Copilot - Visual Studio Code

proba.py cvete.py # Program the movement of a ev3 robot to ... # Program the movement of a ev3 ro

1 # Program the movement of a ev3 robot to follow a black line
2 from ev3dev2.motor import OUTPUT_B, OUTPUT_C, LargeMotor, MoveTank
3 from ev3dev2.sensor import INPUT_1, ColorSensor
4 # Create a motor object for the left motor and right motor on output ports B and C
5 tank_drive = MoveTank(OUTPUT_B, OUTPUT_C)
6 color_sensor = ColorSensor(INPUT_1)
7 # Constant for black color threshold
8 BLACK_THRESHOLD = 20
9
10 # Endless loop to follow the black line
11 while True:
12     # Read the color sensor value and calculate the reflected light
13     current_color = color_sensor.color
14
15     # Checks if the color is black or black reflected
16     if current_color == ColorSensor.COLOR_BLACK or current_color == ColorSensor.COLOR_BLACK_REFLECT:
17         # Robot is on black, drive forward
18         tank_drive.on(50, 50)
19     else:
20         # The robot turn left if it is on the line
21         tank_drive.on(10, 50)
```

Figure 5. Application of Copilot in Python programming

Source: Own work.

## Assessment and evaluation of students' knowledge

Assessment of the learning process and feedback are particularly important for all participants in learning process. And in this process we can use the capabilities of AI technologies. For example, when asked to create a test to check students' knowledge of the above topic, ChatGPT offers the test form in the following Figure 6. The teacher can clear this test and use it in his/her work.

**Assessment Test: Robot Design and Construction**

**Part 1: Multiple Choice Questions**

- What is the purpose of the engineering design process in robotics?
  - To program the robot
  - To build the robot using 3D printing
  - To design and create robots for specific tasks
  - To test the robot's sensors
- Which of the following is NOT a main component of a robot?
  - Chassis
  - Sensors
  - Wheels
  - Software
- The part of a robot responsible for providing structure and support is called the:
  - Actuator
  - Controller
  - Chassis
  - Sensor

**Part 2: Design Challenge**

- In the 3D modeling software provided, design a robot with the following specifications:
  - The robot should have a rectangular chassis.
  - It should have two wheels for locomotion.
  - Include a front-mounted ultrasonic sensor for obstacle detection.
  - The robot should also have a light sensor on top for detecting light intensity.(Note: Students can sketch their designs on paper or use any 3D modeling software available.)

**Part 3: Presentation and Evaluation**

- In the group presentation, each team will present their 3D robot design to the class. Consider the following criteria while evaluating:
  - Creativity: How innovative and unique is the design?
  - Functionality: Does the robot seem capable of performing the specified tasks?
  - Adherence to Design Process: Did the group follow the engineering design process during the creation of the robot design?

**Part 4: Reflection**

- Explain the importance of each of the following components in a robot design:
  - Chassis
  - Sensors
  - Controllers
- Describe the steps you followed during the engineering design process to create your robot design. How did this process help you in the design and construction of the robot?

**Assessment Evaluation:**

- The multiple-choice questions assess students' understanding of key concepts and components related to robot design.
- The design challenge evaluates their ability to apply knowledge and creativity in creating a robot design using 3D modeling software.
- The presentation and evaluation portion assesses their communication skills and adherence to the engineering design process.
- The reflection questions provide insights into their understanding of the significance of different robot components and the design process.

**Note:**  
This assessment can be adjusted based on the specific tools and software available to students. Teachers can adapt the questions to suit their classroom resources and requirements. Additionally, the assessment should be conducted in a manner that aligns with the overall learning objectives of the lesson.

Figure 6. Created Test for Evaluation of students on this topic

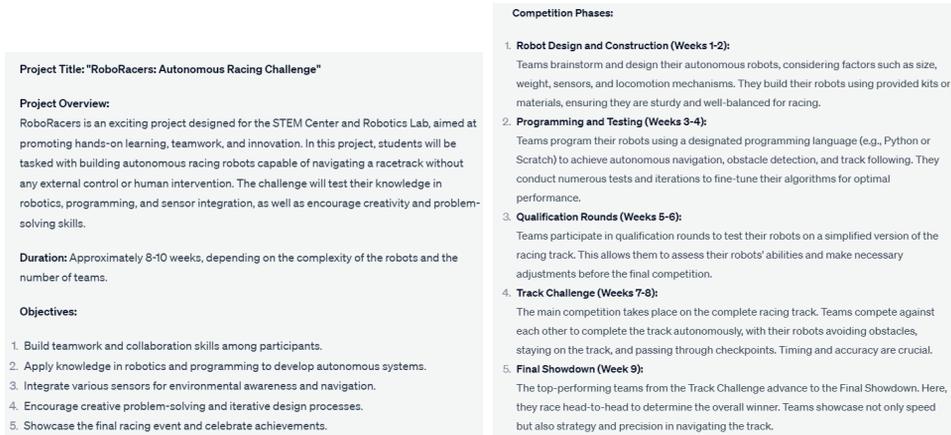
Source: Own work.

## Personalization and project work in STEAM interest club

Personalization of education and differentiated approach are key characteristics of contemporary learning. While in distance, self-paced, or blended learning, personalization is achieved through the use of various educational platforms and technologies (Glushkova, 2015), in project-based teamwork, this personalization is achieved through different approaches. Typically, participants in each team take on formally or informally different roles, such as a leader, speaker, presenter, experimenter, etc. Teachers, acting as moderators and facilitators in this process, can organize role-playing games where participants take on different roles. Each role represents a typical set of characteristics, which, in essence, is very close to the concept of Persona (Nielsen et al., 2013).

## Application of AI Technologies in STEAM School Education

Let us continue with the example of the STEAM robotics interest club. For every robotics club, it is necessary to organize a project work. ChatGPT can give us ideas for work on the project “RoboRacers: Autonomous Racing Challenge” to the school STEAM center (Figure 7).



**Project Title: "RoboRacers: Autonomous Racing Challenge"**

**Project Overview:**  
RoboRacers is an exciting project designed for the STEM Center and Robotics Lab, aimed at promoting hands-on learning, teamwork, and innovation. In this project, students will be tasked with building autonomous racing robots capable of navigating a racetrack without any external control or human intervention. The challenge will test their knowledge in robotics, programming, and sensor integration, as well as encourage creativity and problem-solving skills.

**Duration:** Approximately 8-10 weeks, depending on the complexity of the robots and the number of teams.

**Objectives:**

1. Build teamwork and collaboration skills among participants.
2. Apply knowledge in robotics and programming to develop autonomous systems.
3. Integrate various sensors for environmental awareness and navigation.
4. Encourage creative problem-solving and iterative design processes.
5. Showcase the final racing event and celebrate achievements.

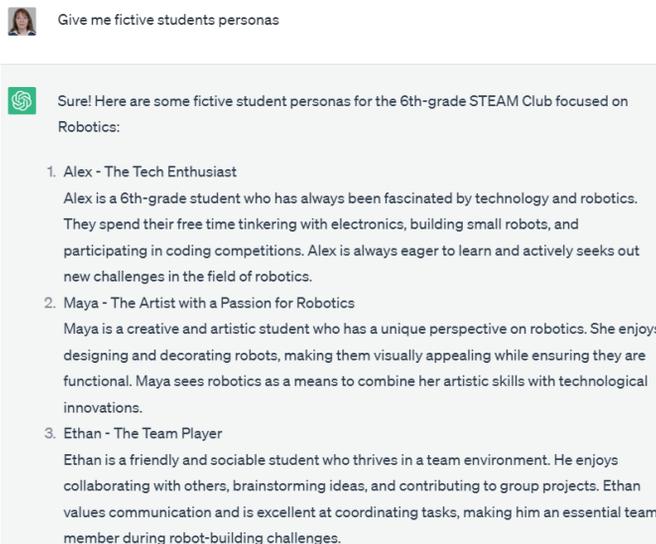
**Competition Phases:**

1. **Robot Design and Construction (Weeks 1-2):**  
Teams brainstorm and design their autonomous robots, considering factors such as size, weight, sensors, and locomotion mechanisms. They build their robots using provided kits or materials, ensuring they are sturdy and well-balanced for racing.
2. **Programming and Testing (Weeks 3-4):**  
Teams program their robots using a designated programming language (e.g., Python or Scratch) to achieve autonomous navigation, obstacle detection, and track following. They conduct numerous tests and iterations to fine-tune their algorithms for optimal performance.
3. **Qualification Rounds (Weeks 5-6):**  
Teams participate in qualification rounds to test their robots on a simplified version of the racing track. This allows them to assess their robots' abilities and make necessary adjustments before the final competition.
4. **Track Challenge (Weeks 7-8):**  
The main competition takes place on the complete racing track. Teams compete against each other to complete the track autonomously, with their robots avoiding obstacles, staying on the track, and passing through checkpoints. Timing and accuracy are crucial.
5. **Final Showdown (Week 9):**  
The top-performing teams from the Track Challenge advance to the Final Showdown. Here, they race head-to-head to determine the overall winner. Teams showcase not only speed but also strategy and precision in navigating the track.

*Figure 7. Suggested Project Idea in Robotics STEAM Club*

Source: Own work.

We organize the group work on projects by creating typical profiles (personas) with which we will organize a role-play (Figure 8).



 Give me fictive students personas

 Sure! Here are some fictive student personas for the 6th-grade STEAM Club focused on Robotics:

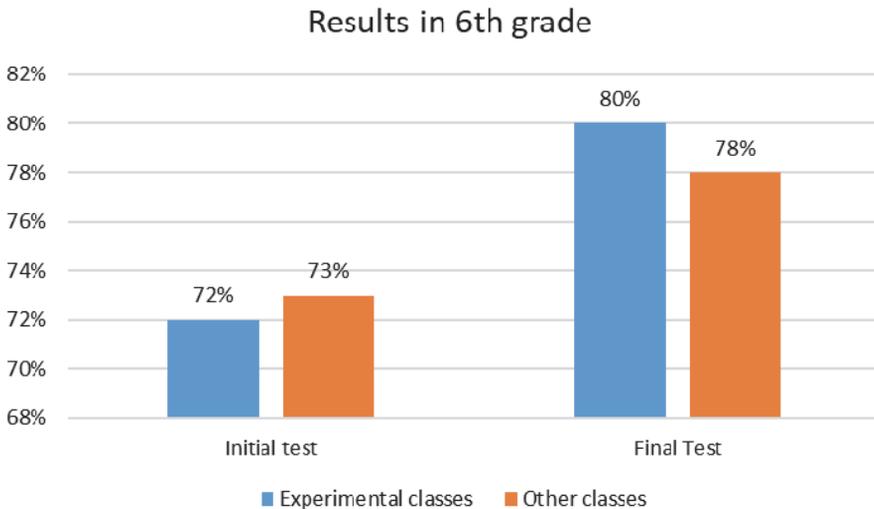
1. **Alex - The Tech Enthusiast**  
Alex is a 6th-grade student who has always been fascinated by technology and robotics. They spend their free time tinkering with electronics, building small robots, and participating in coding competitions. Alex is always eager to learn and actively seeks out new challenges in the field of robotics.
2. **Maya - The Artist with a Passion for Robotics**  
Maya is a creative and artistic student who has a unique perspective on robotics. She enjoys designing and decorating robots, making them visually appealing while ensuring they are functional. Maya sees robotics as a means to combine her artistic skills with technological innovations.
3. **Ethan - The Team Player**  
Ethan is a friendly and sociable student who thrives in a team environment. He enjoys collaborating with others, brainstorming ideas, and contributing to group projects. Ethan values communication and is excellent at coordinating tasks, making him an essential team member during robot-building challenges.

*Figure 8. Suggested by ChatGPT Personas to role play with*

Source: Own work.

## Results, Problems and Discussion

The experimental work carried out on the implementation of AI tools and chatbots in the compulsory classroom training in the subject “Computer Modeling and IT” in some classes of the 6th grade showed the achievement of higher results on the tests conducted at the end of the school year (compared to the results of their classmates who were trained according to the traditional methodology) (Figure 9). 48 students were included in the experimental study.



*Figure 9.* Results of compulsory education in the 6th grade

Source: Own work.

Since students are still in the period of initial accumulation of programming knowledge, despite the increased interest and activity, a tendency to decrease the desire for independent preparation and deepening of knowledge was noticed among some students. For the stability of the results, we conducted an additional experiment with the 12th-grade students (18 students), where the use of chatbots in programming education is much more responsible and critical. There, the results of the students compared to their results from the previous year (without using the AI chatbot) are steadily higher (Figure 10).

Training in the STEM clubs according to interests is optional. Students with interest and motivation to study are included in these clubs, therefore the results are significantly higher. The results are even better when conducting project-based group training. Within the experiment, the students were divided into 5 teams of 4 students and had to program certain missions of the robots. The training results are presented in Figure 11.

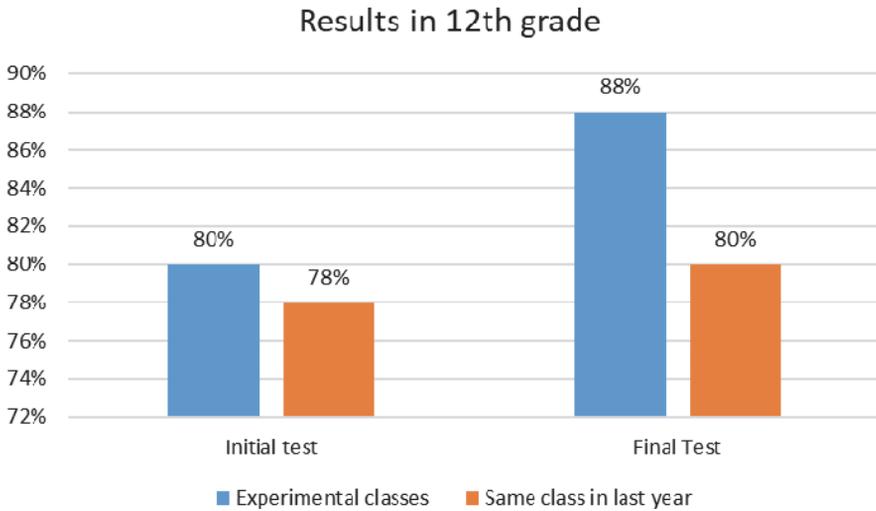


Figure 10. Results of compulsory education in the 12th grade

Source: Own work.

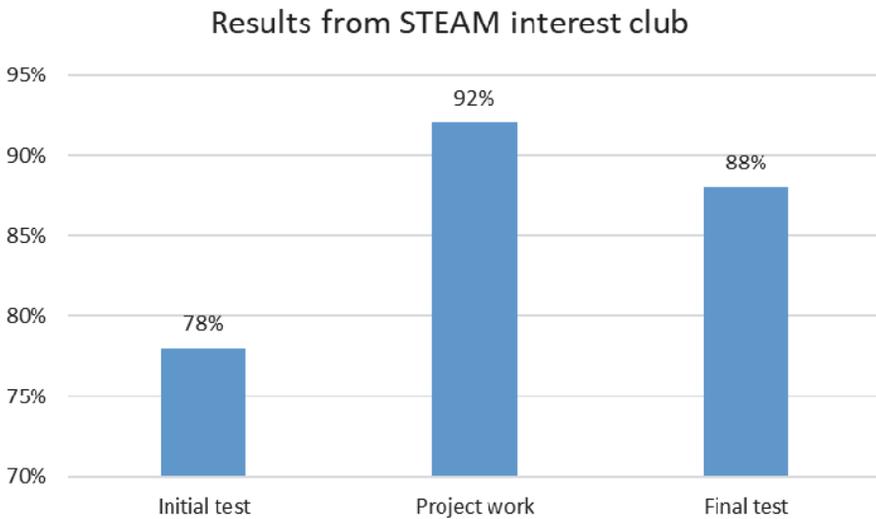


Figure 11. Results of STEAM interest club in AI and robotics

Source: Own work.

Surveys conducted with students, teachers and parents showed the following results:

- 90% of the students with desire and interest use the presented opportunities of chatbots to support the work of teams in solving project tasks.
- In the survey conducted with the students, 92% expressed a desire to work in this way and to use AI technologies to solve specific problems (Figure 12 a).

- 50% of teachers shared that they do not feel confident in the application of these technologies and need additional qualification. Additionally, over 65% of teachers and parents shared concerns about using chatbots freely outside the classroom without teachers present (Figure 12b).

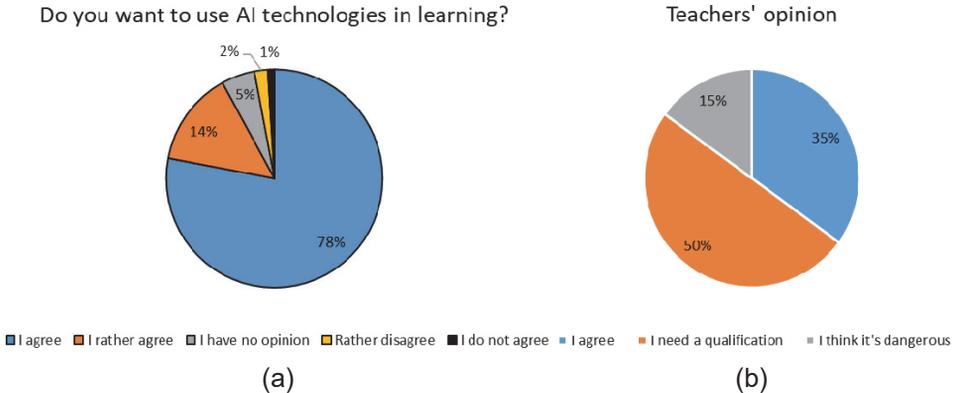


Figure 12. Results of surveys with students (a) and teachers (b)

Source: Own work.

Although the use of AI technologies has many advantages, it is important to carefully assess their limitations, problems and challenges. One of the main concerns of both teachers and parents is the fact that ChatGPT and other chatbots can spread false and unverified information as well as allow plagiarism during exams. Another reason for their fears is the privacy and protection of personal information. World experience shows that these concerns are not groundless and they are reflected in the changes to the AI Act of the European Union ([https://www.europarl.europa.eu/thinktank/en/document/EPRS\\_BRI\(2021\)698792](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698792)).

## Conclusion

The modern development of education poses new challenges and requirements that must be discussed and researched in the conditions of dynamic changes and lack of time. The use of AI in education has many advantages, but also certain challenges. AI can improve learning outcomes, productivity, and student engagement by opening new avenues for personalized education, feedback, collaboration, and support. The conducted research established the need for the training and use of AI technologies in the classroom and extracurricular work.

Given that versions of ChatGPT and Microsoft 365 Copilot can be integrated into Office applications including Word, Excel, PowerPoint, and Outlook, it is not hard to predict that ChatGPT's impact on education will grow rapidly in the coming years.

The study was conducted in classes and groups of students with different ethnic, religious and social affiliations, which gives higher reliability of the obtained results. The students were interested and willing to join the learning activities, but it was found that the younger students took the information from the AI chatbots as completely true and correct, and their cooperation - as a reason not to take responsibility for their own preparation. During training, the chatbots provided sometimes detailed but incomplete information, as well as some poor programming advice and solutions. This was used by the teachers to draw attention to the critical reception of the information received.

Teachers are largely reserved and pay more attention to the problems and challenges of using these technologies. They state that they do not have the necessary knowledge and show readiness for additional training and qualification. Parents are also wary of the rapid introduction of new and insufficiently tested technologies into education. All this determines the need for joint efforts by teachers, researchers, scientists, and politicians to ensure the ethical and responsible use of AI in education.

## Acknowledgements

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## Zastosowanie technologii AI w edukacji szkolnej STEAM

### Streszczenie

Sztuczna inteligencja coraz częściej wkracza w różne sfery naszego życia, także w sferę edukacji. Technologie te oferują wiele możliwości wykonywania różnych czynności i zadań w całym procesie edukacyjnym. W artykule omówiono wybrane aspekty zastosowania technologii AI w celu poprawy personalizacji, dostępności i interaktywności w edukacji szkolnej, a zwłaszcza w nauce przedmiotów STEAM. Celem artykułu jest zaproponowanie podejść umożliwiających skuteczne włączenie sztucznej inteligencji do pracy nauczycieli i facylitatorów na etapie wstępnego planowania lekcji, przygotowywania spersonalizowanych zadań dla uczniów, procesu testowania i oceniania wiedzy, a także nauki w grupach i pracach projektowych. W artykule przedstawiono doświadczenia związane z prowadzeniem obowiązkowego kursu informatyki oraz pracą w kole zainteresowań związanych ze sztuczną inteligencją i robotyką z uczniami szóstej klasy szkoły średniej, podkreślając potencjał niektórych chatbotów do wspierania i wzbogacania procesu programowania.

Słowa kluczowe: Sztuczna inteligencja w edukacji, Chatboty, edukacja STEAM

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## Aplicación de tecnologías de IA en la educación escolar STEAM

### Resumen

La inteligencia artificial está entrando cada vez más en todos los ámbitos de nuestras vidas, incluido el ámbito de la educación. Estas tecnologías ofrecen numerosas ventajas y oportunidades

para realizar diversas actividades y tareas a lo largo del proceso educativo. Este artículo analiza algunos aspectos de la aplicación de tecnologías de IA para mejorar la personalización, la accesibilidad y la interactividad en la educación escolar, y especialmente en el aprendizaje de materias STEAM. Los autores tienen como objetivo proponer enfoques para integrar con éxito la IA en el trabajo de profesores y facilitadores durante la fase de planificación previa de las lecciones, la preparación de tareas personalizadas para los estudiantes, el proceso de prueba y evaluación de conocimientos, así como en grupos y proyectos. aprendizaje basado. El artículo comparte la experiencia de impartir un curso obligatorio de informática y trabajar en un club de intereses relacionados con la inteligencia artificial y la robótica con alumnos de 6º de secundaria, destacando el potencial de ciertos chatbots para apoyar y enriquecer el proceso de programación.

**Palabras clave:** Inteligencia Artificial en Educación, Chatbots, educación STEAM

Тодорка Глушкова, Анна Малинова

## **Применение технологий искусственного интеллекта в школьном образовании STEAM**

### **Аннотация**

Искусственный интеллект все активнее входит во различные сферы нашей жизни, в том числе и в сферу образования. Эти технологии предлагают многочисленные преимущества и возможности для выполнения различных действий и задач на протяжении всего образовательного процесса. В этой статье обсуждаются некоторые аспекты применения технологий искусственного интеллекта для улучшения персонализации, доступности и интерактивности в школьном образовании, и особенно при изучении предметов STEAM. Авторы стремятся предложить подходы для успешной интеграции ИИ в работу учителей и фасилитаторов на этапе предварительного планирования уроков, подготовки персонализированных заданий для учащихся, процесса тестирования и оценки знаний, а также в групповых и проектных работах. основанное обучение. В статье рассказывается об опыте преподавания обязательного курса информатики, а также работы в кружке по интересам, связанном с искусственным интеллектом и робототехникой, с учащимися 6-х классов средней школы, подчеркивая потенциал некоторых чат-ботов для поддержки и обогащения процесса программирования.

**Ключевые слова:** Искусственный интеллект в образовании, чат-боты, образование STEAM



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## **Exploring the Educational Efficacy and Potential of 24-Hour Hackathon Programming Marathon – HackEmotion**

### **Abstract**

This paper addresses the issue of modern didactics and student motivation for self-learning as well as tackling significant practical challenges. In technical

and STEAM (Science, Technology, Engineering, and Mathematics) education, achieving high levels of motivation is particularly important, as students often become overwhelmed by the vast amount of information and opportunities which lead to diminished interest. At the Institute of Computer Science at the University of Silesia in Katowice, a Hackathon – a 24-hour programming marathon – was organized to enhance student engagement. During this event, students confronted a critical problem in modern society, i.e. emotion recognition. The goal was to develop solutions and help for fostering emotion recognition skills in young people with real-world implementation potential. Additionally, students tested their abilities under time pressure, honed their group work competencies, and faced real-time problem-solving scenarios. This paper presents an evaluation of the event's impact, and analyzes the results of a post-event survey, providing feedback to improve the quality of future Hackathons. The main research questions we posed during the research were: RQ1: At what level of quality was the Hackathon event organized? Were students well informed and felt cared for during this event? RQ2: What aspects and properties did motivate students most to take part in events organized at the university like Hackathon? RQ3: What competencies, knowledge and skills were developed by participants in the Hackathon? RQ4: Do students consider issues related to recognizing emotions important and the created applications possible to use in practice? In this paper, we answer these questions using statistical analysis as well as simple machine learning models.

**Key words:** Hackathon, Work in teams, Emotions recognition, STEM education, Programming marathon

## **Introduction**

A very important issue in modern higher education is how to teach young people to take responsibility for their own development, how to motivate them for this development and how to train competences such as teamwork and communication skills. One of the most popular methods is Project-Based Learning that engages students in real-world projects where they have to take ownership of their learning process. They set goals, plan their approach, and evaluate their progress, fostering a sense of responsibility. Assigning group projects encourages teamwork and collaboration. Students learn to communicate effectively, delegate tasks, and resolve conflicts. Another method is Problem-Based Learning that presents students with complex, real-life problems that require critical thinking and problem-solving skills. Students work individually or in groups to analyze the problem, propose solutions, and justify their approaches. In a flipped classroom,

students engage with course materials, such as lectures or readings, outside of class, while class time is dedicated to active learning activities. Students take responsibility for their learning by preparing themselves class independently and come prepared to engage in discussions, group work, or hands-on activities that develop teamwork and communication skills. Other very effective methods are Peer Teaching and Peer Assessment. Assigning students to teach and assess their peers encourages a deeper understanding of the material and enhances communication skills. Students take responsibility for their own learning by preparing themselves to teach a topic to their classmates and providing constructive feedback to their peers.

In the context of particularly STEM education and Computer Science studies, it has now also become a very popular teaching method to organize programming marathons. Hackathons are collaborative events where participants come together to work intensively on solving problems or creating innovative projects within a short period, usually ranging from a few hours to a few days. Specific rules may vary depending on the organizers and the nature of the event. Participants may form teams typically consisting of individuals with diverse skills, such as programmers, designers, and domain experts. Teams may be formed before the event. Hackathons often have a specific theme, challenge, or problem statement provided by the organizers. Participants are expected to develop solutions or projects that address this theme. The theme or challenge is usually announced at the beginning of the event, sometimes with additional details or constraints. Participants must work within time limit to develop their projects. Time management is crucial, and participants are expected to allocate time effectively for ideation, development, testing, and presentation. Hackathon projects often involve creating software, hardware, or another intellectual property. Participants should respect intellectual property rights and avoid infringing on copyrighted material. At the end of the hackathon, teams typically present their projects to a panel of judges or to the entire participant audience. Presentations are usually limited to a set duration, and teams are expected to effectively showcase their project, including its functionality, innovation, and potential impact. Judges evaluate projects based on predefined criteria, which may include factors such as creativity, technical complexity, user experience, and relevance to the theme. Hackathons provide opportunities for participants to network, collaborate, and learn from each other. Participants are encouraged to share knowledge, skills, and resources to support each other's projects. This form of teaching soft competences to students is highly motivating, as it incorporates competition and facing a challenge. In addition, computer science students, who are often quite skeptical of didactic innovations, respond positively to such challenges.

From April 11th 2024 to April 12th 2024, the HackEmotion 24-hour programming marathon was organized at the Institute of Computer Science, University of Silesia in Katowice. The aim of HackEmotion was to prepare an application to help to recognize emotions on the basis of faces and body silhouettes.

This topic was chosen because it is extremely important in today's world. Many people have problems recognizing emotions, especially children who spend a lot of time in front of screens or smartphones have problems recognizing emotions in the real world. In order to help such people, psychologists or pedagogues devote many hours of sessions to teach them how to recognize emotions from photos or other scenes played by actors. Automating this process would be very useful and would be a huge support for professionals. Forty-five students from the University of Silesia in Katowice signed up to take part in the programming marathon, forming groups of two to five people. They mainly included students from computer science, but there were also students from pedagogy and psychology. The prizes for winning the event were financial. Depending on whether it was the first or second place and the number of students in the winning group, this ranged from PLN 2,000 to PLN 400 per person.

The hackathon's goals and tasks encompass various aspects integral to STEM education. Hackathons, like HackEmotion, provide a dynamic and immersive learning environment that integrates various aspects of STEM education. They offer students practical experience in tackling real-world problems, foster essential soft skills, and motivate continuous learning and development. The HackEmotion event specifically focused on software creation that would assist people and train their skills in recognizing emotions. The simplest way to build such an application was to display different emotions in a photo or video and ask the user to recognize the emotion. The user's competence could be determined by measuring the time and correctness of the recognition. The learning can be tailored to the user's needs using appropriate algorithms. However, students inspired by the challenge have created much more elaborate applications - from levelled photos and genre scenes containing emotions to multi-level games containing character creation, challenges, and levels to be gained.

A week after the event, a survey was conducted on the quality of the organized hackathon. The questions covered a variety of topics: an evaluation of the way the hackathon was organized, whether the event contributed to the development of the students and, if so, to what extent, and whether the students considered the topics covered by the hackathon to be relevant. The questionnaire was prepared in a Google Form and the link was sent to the students participating in the Hackathon. Completion of the survey was voluntary and anonymous. The results of the questionnaire in no way influenced the students' grades or treatment by the teachers. The aim of the research is to discuss the results of the survey and the conclusions drawn from it.

The purpose of the article is to address modern didactics and student motivation for self-learning, focusing on significant practical challenges. The main objective is to evaluate the impact of a 24-hour programming marathon (Hackathon) called HackEmotion organized at the Institute of Computer Science at the University of Silesia in Katowice. The article aims to analyze the results of a post-event survey

conducted after the Hackathon to provide feedback for improving the quality of future Hackathons.

The structure of the paper is as follows. The second section provides a review of the literature. The following sections present the experimental methodology, research questions and hypotheses as well as the statistical analysis of the obtained results. This is followed by the presentation of the results obtained using selected machine learning models. The penultimate section contains the discussion. The article ends with conclusions.

## Literature Review

Activation teaching methods, also known as active learning strategies, have been extensively studied and implemented in STEM education (Videla et al., 2021). These methods aim to engage students more directly in the learning process, thereby enhancing their understanding and retention of material. Key activation methods include problem-based learning (PBL) (Rehmat and Hartley, 2020), project-based learning (PjBL) (Diana and Sukma, 2021), peer instruction (Prince et al., 2020), and collaborative learning (Salam and Farooq, 2020).

PBL involves presenting students with real-world problems to solve, which helps develop their problem-solving and critical thinking skills. This method has been shown to promote flexible knowledge application, strategic reasoning, intrinsic motivation, and collaboration. Teachers using PBL often report improved student engagement and better learning outcomes, particularly in understanding complex STEM concepts (Attard et al., 2021). Similar to PBL, PjBL requires students to complete projects that often span several weeks. This method encourages deeper learning and the application of interdisciplinary knowledge. PjBL has been effective in promoting teamwork, time management, and practical application of STEM theories (Baran et al., 2021). Collaborative Learning involves students working together in small groups to achieve learning goals. It has been found to improve student attitudes towards learning, increase engagement, and enhance social and cognitive skills. Collaborative learning also helps students develop communication and teamwork skills, which are crucial in professional STEM environments (McCollum, 2020). Peer Instruction strategy involves students teaching each other under the guidance of the instructor. It helps students articulate their understanding and learn from different perspectives, fostering a deeper understanding of the material (Kong and Yang, 2024).

Hackathons, especially in the context of STEM education, serve as intensive, collaborative events where participants work in groups to develop solutions to specific problems within a short timeframe (typically 24-48 hours). These events

are valuable for several reasons (Beretta et al., 2022). Hackathons emphasize practical, hands-on learning. They help students develop technical skills (e.g., coding, engineering design) and soft skills (e.g., teamwork, time management, communication). Participating in hackathons allows students to apply theoretical knowledge in real-world scenarios, which enhances their problem-solving abilities and creativity (Garcia, 2022). The competitive and collaborative nature of hackathons motivates students. The opportunity to work on meaningful, real-world problems in a high-energy environment fosters a sense of accomplishment and enthusiasm for STEM fields. Students are often driven by the challenge and the chance to innovate, which can lead to increased interest in their studies and future careers in STEM (Hacıoğlu and Gülhan, 2021).

Hackathons provide a platform for students to network with peers, mentors, and industry professionals. This interaction can lead to future collaborations, internships, and job opportunities. The collaborative nature of hackathons also teaches students how to work effectively in teams, an essential skill in most STEM careers (Longmeier et al., 2022). Hackathons often include a judging or feedback component, where experts evaluate the projects and provide constructive feedback. This process helps students refine their ideas and improve their projects iteratively, reinforcing the learning cycle of design, feedback, and redesign (Pe-Than et al., 2022).

In conclusion, activation teaching methods and hackathons both play significant roles in enhancing STEM education. Activation methods like PBL and collaborative learning engage students deeply and promote essential skills, while hackathons provide practical, immersive experiences that prepare students for real-world STEM challenges. Both approaches are complementary, fostering a more dynamic and effective learning environment.

## Methodology

The research presented in this paper was conducted through a questionnaire survey performed on students from the University of Silesia who participated in the HackEmotion event. The questionnaire was sent to 45 students. However, 30 students completed the questionnaire. Raw survey data is publicly available at <http://surl.li/oeqcjd>.

The survey was conducted anonymously and on a voluntary basis. It encompassed a range of questions regarding the quality of the organization of the hackathon and the impact of the event on student development. The questionnaire questions were divided into four thematic groups: sociological characteristics, the quality of the event organization, areas of student development and the importance of this topic on the emotions recognition. The segmentation demonstrates thematic cohesiveness

and offers an exhaustive examination of the subject matter. The responses to the majority of inquiries were presented on a 5-point scale, facilitating a broad range of interpretations. Examination of the gathered data involved the utilization of diverse statistical techniques, notably the Kruskal-Wallis test, in addition to various statistical parameters and visual representations, with a specific focus on box-plot diagrams. Depending on the research query being investigated, data was gathered into relevant categories and their attributes were juxtaposed. Additionally, specific machine learning algorithms were utilized to examine latent patterns within the dataset.

The main aim of the research was to find out whether events such as the hackathon are positively perceived by students and whether they motivate them to learn and self-develop. In addition, the research also aimed to find out in which areas participation in a hackathon most influences the development of students' knowledge and competencies. Another aim was to investigate whether students consider the topic of emotion recognition to be important and developmental.

## **Research Questions and Hypotheses**

The following research questions were formulated:

- RQ1: At what level of quality was the Hackathon event organized? Were students well informed and cared for during this event?
- RQ2: What aspects and properties did motivate students most to take part in events organized at the university like Hackathon?
- RQ3: What competencies, knowledge and skills were developed by participants in the Hackathon?
- RQ4: Do students consider issues related to recognizing emotions important and the created applications possible to use in practice?

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

- H1: Most aspects related to the organization of the Hackathon were at the highest level. The only thing that needs to be improved is the system for justifying the jury's evaluation.
- H2: An interesting challenge – a problem to solve and the opportunity to work in groups were the greatest motivation for the students who took part in the event.
- H3: Students developed their group work skills the most by participating in the Hackathon.
- H4: Students consider issues related to recognizing emotions as important and the created applications as possible to use in practice.

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

## Sociological Metrics

In order to study the relationship between student characteristics and attitude towards educational platforms, the questionnaire included sociological questions. The sociological characteristics questions are presented as follows:

- gender – male, female
- field of study – Computer science, Applied computer science, Art therapy, Psychology, Media cultures
- age – <19–20>, <21–22>, <23–24>, <25–26>, >26
- degree of study – Bachelor degree or Engineering (BorE) 1st year, Bachelor degree or Engineering (BorE) 2nd year, Bachelor degree or Engineering (BorE) 3rd year, Bachelor degree or Engineering (BorE) 4th year, Master’s degree (MD) 1st year, Master’s degree (MD) 2nd year
- Place of residence – Countryside, Small city (up to 50 000), Medium city (up to 100 000), Large city (over 100,000)

Descriptive statistics on the responses obtained related to the sociological metrics are presented in Table 1. These data are also presented graphically in Figure 1.

Table 1.  
*Descriptive statistics on responses to sociological questions*

Gender	Quantity/ Percent- age	Degree of study	Quantity/ Percent- age	Age	Quantity/ Percent- age	Place of resi- dence	Quantity/ Percent- age
Male	27/90	BorE 1st	6/20	<19–20>	9/30	Countryside	5/16.7
Female	3/10	BorE 2nd	11/36.7	<21–22>	12/40	Small city	3/10
		BorE 3rd	11/36.7	<23–24>	7/23.3	Medium	8/26.7
		BorE 4th	1/3.3	<25–26>	2/6.7	Large	14/46.7
		MD 1st	1/3.3	>26	0/0		
		MD 2nd	0/0				

Source: Own work.

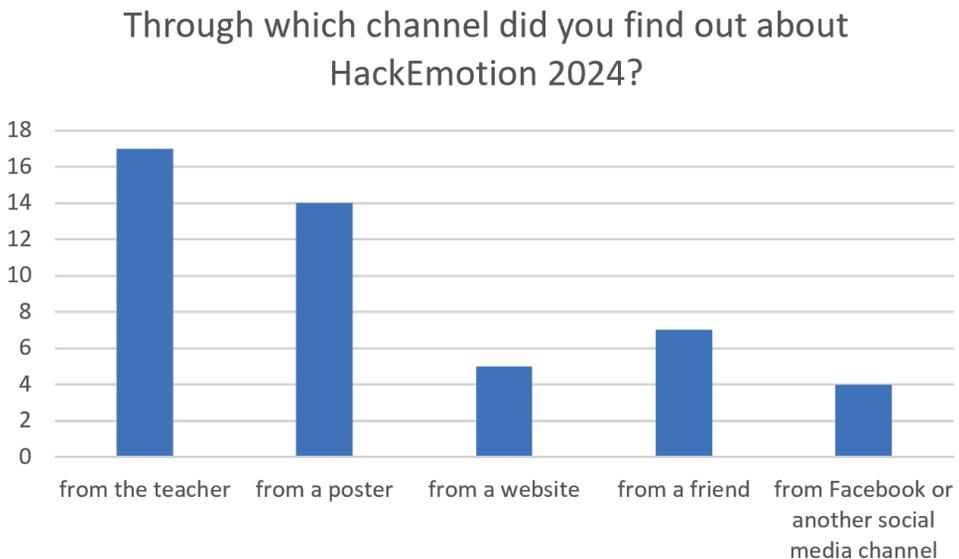
In terms of the field of study, only one respondent was studying Art Therapy, the others were studying Computer Science. There were seven people from Applied Computer Science and 22 students from Computer Science. So the students who took part in the Hackathon and answered the questions were predominantly men in the range of 19 to 22 years old, who live in a large or medium city and are studying in their second or third year of a first-level Computer Science degree. This characterization should not be surprising and is quite predictable considering that the event was targeted at programmers and organized by the Institute of Computer

Science at the University of Silesia. Thus, the information about the event was posted on a public website – it was the students of this particular faculty who were best informed and most motivated to attend the event.

## Results and Statistical Tests

In this section, we will present statistical analyses and their outcomes related to the HackEmotion event, categorized into three themes corresponding to the topics listed above.

An important question we will discuss first is through which channel the students found out about the HackEmotion event. We want to intensify the advertising of the event in the future, so it was crucial for us to know which channel was the most effective. The options from which students could choose were as follows: from the teacher, from a poster, from a website, from a friend, from Facebook or another social media channel and other. Students were able to make multiple choices. The number of students who indicated each channel is presented in Figure 1.



*Figure 1.* The channel by which students found out about HackEmotion 2024

As can be seen, the most effective channel proved to be the contact with the teacher and the oral communication from the teacher, as well as the posters displayed on the campuses in different cities and Departments of the University of

Silesia. In contrast, the least effective channel proved to be the university website as well as Facebook or another social media channel administered by the university. Perhaps this indicates that students rarely visit the university website and the university social media. However, confirming such a hypothesis requires separate research, which we will not deal with now. For us, the most important information is that when organizing subsequent events of this type, special attention should be paid to verbal advertising by teachers and posters.

## **Assessment of the Quality of the Organization of the HackEmotion Event**

In this part of the questionnaire, we explored how students assess the quality of the organized Hackathon, a 24-hour programming marathon. Could the organizers reliably prepare such a demanding event? To the main questions here the responses were as follows:

- Q1. Was communication between the organizers and participants clear?
- Q2. Was the proposed challenge (topic, goal) clearly defined?
- Q3. Were the organizers able to answer your questions and concerns?
- Q4. Do you think the organizers were knowledgeable and experts in the challenge?
- Q5. Was the jury's assessment clear to you?
- Q6. How likely are you to participate in a future hackathon?
- Q7. Do you think the prizes were appropriate for the hackathon?
- Q8. Did the organizers meet all deadlines?
- Q9. Would you recommend our hackathon to your friends?

Possible answers to all these questions were on a scale of 1 to 5, where 1 – absolutely not, very unclear 5 – absolutely yes, very clear.

Descriptive statistics regarding the responses obtained for these questions are presented in Table 2. In order to better visualize the results, box-plot charts were created for the individual questions (Figure 2). The box-plot partially shows the data from the table. For each question, the mean and the confidence interval (95% confidence interval) for the medians are marked as box. In addition, the whiskers represent deviations from the median plus or minus the standard deviation. These values are also given in Table 2. As can be seen, the students rated communication, the proposed challenge during the hackathon, the knowledge of the organizers as well as answering participants' questions quite highly. Students rated the clarity of the jury's verdict the lowest. Therefore, in the future, the transparency of decisions on awarding prizes to hackathon event participants should be increased. This year, the rubrics were created according to which each jury member assessed the solutions created by the groups in terms of various criteria. These criteria are:

innovation, social utility, business potential, design and functionality, ease of implementation, sophistication. Each member of the jury awarded points from 0 to 3 in each criterion. If any of the projects was outstanding, a jury member was allowed to award 5 points in that category. Therefore, the assessment rules were transparent and reliable. A solution to the problem of students not understanding the basis for making jury decisions may be to present them with the results of the evaluation of their projects and the projects created by the winning teams. Similarly, students rated the likelihood of participating in future events of this type low. Unfortunately, we do not know exactly what the reason for such responses is. However, we see that some students would not participate in an event of this type again. This may be due to the difficulty of physical hardness of constant work and programming for 24 hours or due to time pressure. The remaining questions regarding the prizes in the hackathon, meeting the deadlines by the organizers as well as recommending participation in the event to friends were also rated very highly by the students and provide a satisfactory assessment of the event.

Table 2.

*Descriptive statistics on responses to the question related to quality of the organization of the HackEmotion event*

Question	Mean	Std dev	Median	Minimum	Maximum
Q1	4.6	0.6	5	3	5
Q2	4.4	0.7	5	3	5
Q3	4.6	0.7	5	3	5
Q4	4.5	0.8	5	3	5
Q5	3.9	0.9	4	2	5
Q6	4.3	0.8	4.5	2	5
Q7	4.5	0.7	5	2	5
Q8	4.5	0.9	5	2	5
Q9	4.6	0.7	5	3	5

Source: Own work.

To sum up this part of the survey and its results, it can be said that the organization of the event was rated rather highly. However, there is also room for improvement. When organizing subsequent editions of the Hackathon, special attention should be paid to the evaluation of team projects by the jury and ensuring a more transparent presentation of the basis for the awards granted.

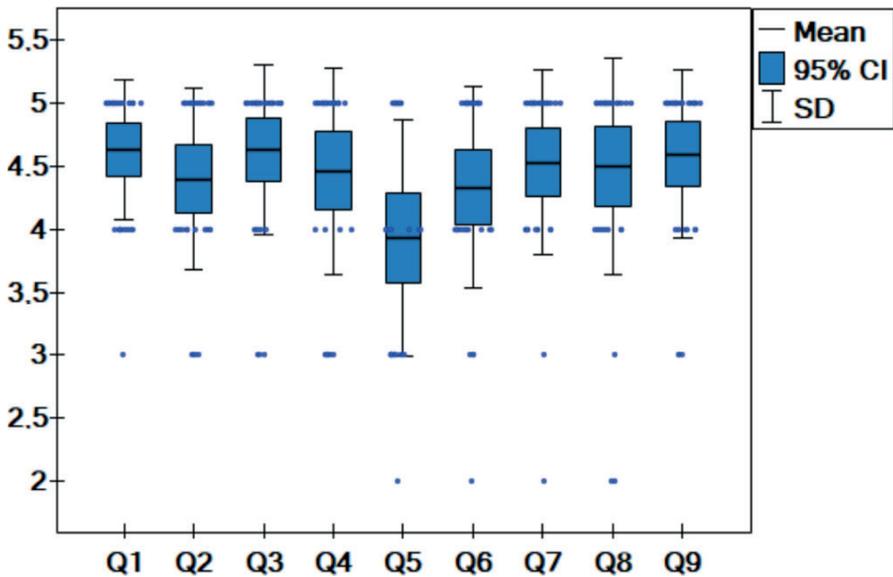


Figure 2. The box-plot charts for questions Q1–Q9

## Aspects that Most Motivate Students to Take Part in Events Organized at the University

The second group of questions we asked the students concerned what motivated the students to take part in the Hackathon. We wanted to know which of the features of the event we organize are most important in terms of attracting participants. This issue should receive the greatest attention in the coming years.

The question asked to the students was as follows: What aspects of the event were most important to you? Please provide your answer on a scale of 1 to 5, where 1 – least important, 5 – most important

- a) Good atmosphere, integration in the student group
- b) Prizes
- c) Possibility of further scientific cooperation at the Institute of Computer Science
- d) Challenge, testing yourself
- e) Competition
- f) Working in a group of students in which I feel good

Descriptive statistics regarding the responses obtained for these questions are presented in Table 3. In order to better visualize the results, box-plot charts were created for the individual answers (Figure 3). The box-plot partially shows the data from the table. For each question, the mean and the confidence interval (95%

confidence interval) for the medians are marked as box. In addition, the whiskers represent deviations from the median plus or minus the standard deviation. These values are also given in Table 3. As can be seen, the most important aspects for the students were the good atmosphere, the challenge and working in a group of students in which students feel good. The least important issues for students were awards, competition and the possibility of scientific cooperation with employees of the Institute of Computer Science. Therefore, when organizing future events of this type, the greatest attention should be paid to interesting issues that will pose as a challenge during the Hackathon. We hope that the good atmosphere of the event will be maintained. Working in groups that students create themselves – decide on the composition of teams is a characteristic feature of hackathons.

Table 3.  
*Descriptive statistics on responses to the question related to motivation and importance of aspects of the event for students*

Question	Mean	Std dev	Median	Minimum	Maximum
Good atmosphere	4.5	0.9	5	1	5
Prizes	3.5	1.3	4	1	5
Scientific cooperation	3.6	1.3	3.5	1	5
Challenge	4.6	0.8	5	1	5
Competition	3.5	1.5	4	1	5
Working in a group of students	4.7	0.5	5	4	5

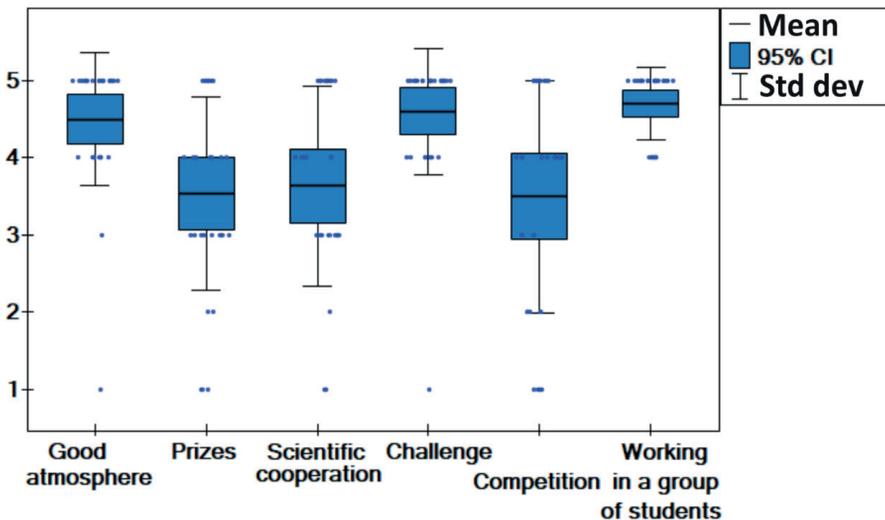


Figure 3. The box-plot charts for question about motivation and importance of aspects of the event for students

Source: Own work.

## **Competences and Skills Developed by Participating in the Hackathon**

In the next group of questions, we wanted to find out what competences, skills and knowledge of students were positively influenced by participation in the Hackathon. For this purpose, the following question was asked: In what areas did HackEmotion influence the development of your knowledge, skills and competences? Please provide your answer on a scale of 1 to 5, where 1 – I did not notice any development, 5 – it significantly influenced the development

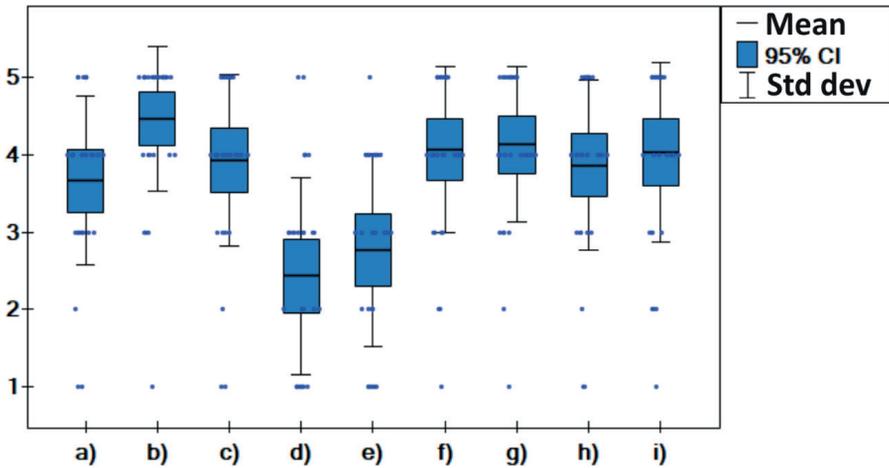
- a) Programming
- b) Group work
- c) Designing the application as a complete and finished product
- d) Knowledge of artificial intelligence algorithms
- e) Sharing applications in the cloud
- f) Managing your own time and that of others
- g) Giving feedback to colleagues in the group
- h) Your own motivation to act
- i) Motivating others to act

Descriptive statistics regarding the responses obtained for these questions are presented in Table 4. In order to better visualize the results, box-plot charts were created for the individual answers (Figure 4). As can be seen, students evaluate that participation in the Hackathon had the greatest impact on their development of group work competences. Only one respondent did not recognize any improvement in this area. Students developed the skills related to Knowledge of artificial intelligence algorithms and Sharing applications in the cloud at a lower level. However, also in these aspects there were students who rated the improvement in their knowledge as 5. The remaining skills were developed at a similar, average level. Therefore, the HackEmotion event had the greatest impact on the development of group work competences. The development of group work competences in IT specialists and programming is crucial for several reasons, given the collaborative nature of most IT projects and the complex, multidisciplinary problems they often address. The key points for which group work skills are important are as follows: enhanced problem-solving capabilities, efficiency and productivity, improved communication and interpersonal skills, increased innovation and creativity, adaptability and flexibility and ,in the end, better project outcomes. Therefore, we believe that this type of event is very important, especially for students of computer science, and it will certainly be organized periodically in the future.

**Table 4.**  
*Descriptive statistics on responses to the question related competences, skills and knowledge of students that were positively influenced by participation in the Hackathon*

Question	Mean	Std dev	Median	Minimum	Maximum
a) Programming	3.7	1.1	4	1	5
b) Group work	4.5	0.9	5	1	5
c) Designing the application as a complete and finished product	3.9	1.1	4	1	5
d) Knowledge of artificial intelligence algorithms	2.4	1.3	2.5	1	5
e) Sharing applications in the cloud	2.8	1.3	3	1	5
f) Managing your own time and that of others	4.1	1.1	4	1	5
g) Giving feedback to colleagues in the group	4.1	1.0	4	1	5
h) Your own motivation to act	3.9	1.1	4	1	5
i) Motivating others to act	4	1.2	5	1	5

Source: Own work.



**Figure 4.** The box-plot charts for question about competences, skills and knowledge of students that were positively influenced by participation in the Hackathon

a) Programming, b) Group work, c) Designing the application as a complete and finished product, d) Knowledge of artificial intelligence algorithms, e) Sharing applications in the cloud, f) Managing your own time and that of others, g) Giving feedback to colleagues in the group, h) Your own motivation to act, i) Motivating others to act.

## The Importance of the Issue Related to Recognizing Emotions

The last group of questions concerned students' assessment of the importance of the issue being a challenge for participants in the HackEmotion 2024 event. Two questions related to this aspect were formulated as follows:

Q10. Do you think that the hackathon's topic of emotions is interesting and an important research problem?

Q11. Do you see any possibilities for practical applications of applications created within HackEmotion?

Possible answers to all these questions were on a scale of 1 to 5, where 1 – absolutely not, 5 – absolutely yes.

Descriptive statistics regarding the responses obtained for these questions are presented in Table 5. In order to better visualize the results, box-plot charts were created for the individual answers (Figure 5). As can be seen, most students consider issues related to recognizing emotions to be important. Only two surveyed students rated this issue as not very important. All students stated that the applications created during the Hackathon can be used in practice to develop competences related to recognizing emotions.

Table 5.

*Descriptive statistics on responses to the question related competences, skills and knowledge of students that were positively influenced by participation in the Hackathon*

Question	Mean	Std dev	Median	Minimum	Maximum
Q10	3.9	0.9	4	2	5
Q11	4.1	0.7	4	3	5

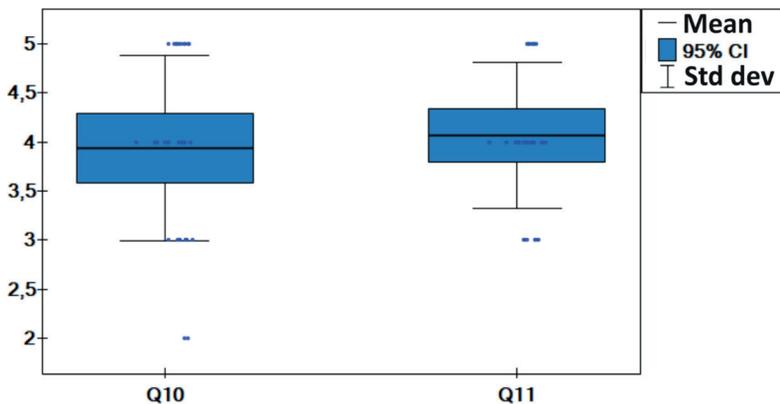


Figure 5. The box-plot charts for question about importance of the issue related to recognizing emotions

Source: Own work.

## Statistical Inference Used for Questionnaire Data

Statistical inference was used to test whether place of residence has a significant impact on differences in perceptions: assessment of the quality of the organization (questions Q1 – Q9 listed earlier in the paper), aspects that most motivate students to take part in events (aspect (a) – aspect (f) also listed earlier in the paper), competences and skills developed by participating in event (competence (a) – competence (i) listed earlier in the paper) and the importance of the issue related to recognizing emotions (Q10 and Q11). For this purpose, we used Kruskal-Wallis ANOVA Tests because we are dealing with more than two comparison groups defined by place of residence (Countryside, Small, Medium and Large City) and we are dealing with an ordinal measurement scale. The results of the tests are shown in Table 6. The table gives the test statistic as well as the p-value. The median in the subgroups is also given. As can be seen, only in some aspects did place of residence have a significant effect on the difference in perceptions of properties regarding the Hackathon (bolded in the table). These were the following competencies:

- b) Group work
- f) Managing your own time and that of others
- g) Giving feedback to colleagues in the group
- i) Motivating others to act

Table 6.  
*The Kruskal-Wallis test results for the questionnaire and groups defined by place of residence*

Question	Countryside	Small city	Medium city	Large city
Q1		H(3,30)=1.88; p-value=0.60		
Median	5	5	4,5	5
Q2		H(3,30)=7.34; p-value=0.06		
Median	4	5	5	4,5
Q3		H(3,30)=6.04; p-value=0.11		
Median	5	5	5	5
Q4		H(3,30)=3.65; p-value=0.30		
Median	4	5	5	5
Q5		H(3,30)=0.67; p-value=0.88		
Median	3	3	4	4
Q6		H(3,30)=7.46; p-value=0.06		
Median	5	5	4	5
Q7		H(3,30)=3.19; p-value=0.36		
Median	5	4	4,5	5

Q8		H(3,30)=2.16; p-value=0.54		
Median	5	5	4,5	5
Q9		H(3,30)=7.33; p-value=0.06		
Median	5	5	4	5
aspect (a)		H(3,30)=1.11; p-value=0.77		
Median	5	5	5	5
aspect (b)		H(3,30)=0.20; p-value=0.98		
Median	3	3,5	4	4
aspect (c)		H(3,30)=5.78; p-value=0.12		
Median	5	5	3	3
aspect (d)		H(3,30)=2.59; p-value=0.46		
Median	5	5	4,5	5
aspect (e)		H(3,30)=5.36; p-value=0.15		
Median	5	4	3	4
aspect (f)		H(3,30)=2.96; p-value=0.40		
Median	5	5	4,5	5
competence (a)		H(3,30)=5.14; p-value=0.16		
Median	4	4	3	4
competence (b)		<b>H(3,30)=14.67; p-value=0.002</b>		
Median	5	5	4	5
competence (c)		H(3,30)=1.99; p-value=0.57		
Median	4	4	4	4
competence (d)		H(3,30)=4.18; p-value=0.24		
Median	3	3	1,5	2
competence (e)		H(3,30)=2.03; p-value=0.57		
Median	3	4	2,5	2,5
competence (f)		<b>H(3,30)=8.61; p-value=0.03</b>		
Median	5	5	4	4
competence (g)		<b>H(3,30)=8.77; p-value=0.03</b>		
Median	5	4	3,5	4,5
competence (h)		H(3,30)=5.36; p-value=0.15		
Median	5	5	4	4
competence (i)		<b>H(3,30)=8.51; p-value=0.04</b>		
Median	5	4	3	5
Q10		H(3,30)=0.05; p-value=0.997		
Median	4	4	4	4
Q11		H(3,30)=3.62; p-value=0.31		
Median	4	4	3,5	4

For these competences, residents of countryside and small cities definitely rated the development of their competencies higher due to participation in the Hackathon than residents of medium and large cities. Perhaps these people just did not have the opportunity to participate in such time pressure and group work before, which is why they rated their experience growth higher after HackEmotion. Analogous tests of differences in terms of other groups (age, year of study or gender) were not performed because there was insufficient representation in subgroups in the research sample.

## Machine Learning Methods Used for Questionnaire Data

Machine learning models were also used to study ability to detect hidden patterns in the questionnaire data. A supervised model – decision tree – was used to classify the place of residence of participants based on the results obtained for all questions except the sociological metric. It was found that the most important attributes that distinguish between participants living in large, medium and small cities and in countryside are:

- A1. In what areas did HackEmotion influence the development of your knowledge, skills and competences? Designing the application as a complete and finished product.
- A2. Was the proposed challenge (topic, goal) clearly defined?
- A3. How likely are you to participate in a future hackathon?
- A4. In what areas did HackEmotion influence the development of your knowledge, skills and competences? Managing your own time and that of others.
- A5. What aspects of the event were most important to you? Possibility of further scientific cooperation at the Institute of Computer Science.

The exact relations that were found are presented in Figure 6. As we can see, there are six decision rules, namely:

If  $A1 \leq 2.5$  then place of residence = Medium city

If  $A1 > 2.5$  and  $A2 \leq 4.5$  and  $A4 > 4.5$  then place of residence = Countryside

If  $A1 > 2.5$  and  $A2 \leq 4.5$  and  $A4 \leq 4.5$  then place of residence = Large city

If  $A1 > 2.5$  and  $A2 > 4.5$  and  $A3 > 4.5$  and  $A5 > 4.5$  then place of residence = Small city

If  $A1 > 2.5$  and  $A2 > 4.5$  and  $A3 > 4.5$  and  $A5 \leq 4.5$  then place of residence = Large city

If  $A1 > 2.5$  and  $A2 > 4.5$  and  $A3 \leq 4.5$  then place of residence = Medium city

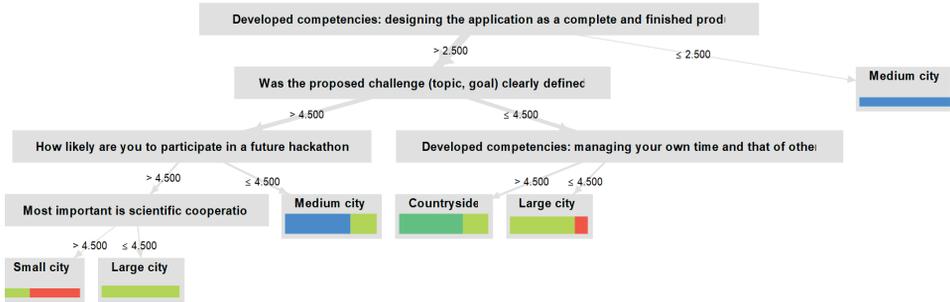


Figure 6. Decision tree obtained for the questionnaire data

The unsupervised k-means clustering algorithm was used to check whether there were groups of similar students in questionnaire participants. Different values of the parameter k (number of groups) were tested, from 2 to 5. It was found that the most consistent groups are formed for k=2. A presentation of the centroids of these groups is shown in Figure 7. The group marked as 0 in the figure contained 28 respondents, while group 1 contained two students. As can be seen, students in group 0 evaluated that through participation in HackEmotion they develop their competences and knowledge. Students from this group, on the other hand, stated that they were unlikely to have developed their knowledge and skills. However, it is important to note the significant disparity between the size of the two groups. Thus, the vast majority of students stated that participation in HackEmotion had positively influenced their development. This information is one of the most important for the event organizers and motivates them to organize events like the 24-hour programming marathon in the future.

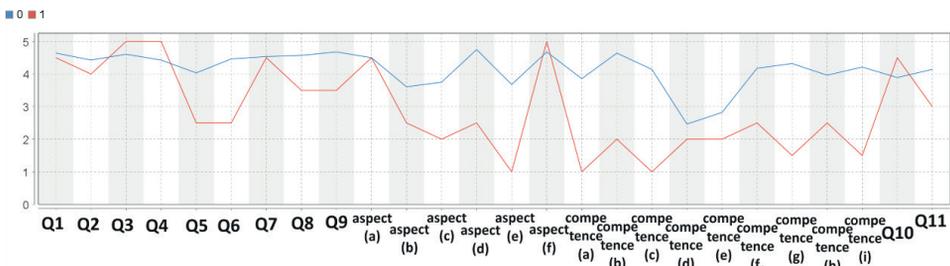


Figure 7. Decision tree obtained for the questionnaire data. Abbreviations used questions Q1–Q9 listed earlier in the paper, aspects that most motivate students to take part in events aspect (a) – aspect (f), competencies and skills developed by participating in event competence (a) – competence (i) and the importance of the issue related to recognizing emotions (Q10 and Q11)

## Discussions

Motivating students for their own learning and development in today's world, where distractions with numerous opportunities, information, compete for their attention and work opportunities instead of studying, is increasingly challenging. Students also have more and more requirements in relation to the challenges offered to them. Traditional, outcome-oriented teaching methods have proven less effective than anticipated. Instead, the entire creative process, team collaboration, and the acquisition of knowledge through problem-solving are crucial for meaningful learning experiences.

The analyses presented highlight the necessity and importance of modern learning approaches, such as organizing 24-hour Hackathon programming marathons. This innovative method offers a non-standard learning environment where students work overnight at the university, collaborating in groups to solve significant, real-world problems. This immersive experience fosters creativity, teamwork, and practical problem-solving skills, all of which are vital for students' development in technical and STEAM education.

The evaluations indicate that the Hackathon was organized in a high standard. However, future events could benefit from more transparent allocation of grading criteria to ensure fairness, clarity and understanding the rules for awarding winners. One of the most critical factors influencing students' participation in the Hackathon is the relevance and practicality of the problem they are faced with during this event. For instance, the issue of society's difficulties in recognizing emotions was considered highly pertinent and engaging by the students.

To maintain and enhance student interest and engagement in future Hackathons, it is essential to select problems that are not only significant and real but also implementable. Future Hackathons should continue to address relevant societal challenges that resonate with students, ensuring that the events remain exciting and educationally valuable. By doing so, we can continue to leverage these innovative learning experiences to motivate students effectively and prepare them for real-world challenges.

The research highlights the importance of students being able to work effectively in groups during a hackathon. They appreciate the opportunity to select their own groups in advance, ensuring they collaborate with those they work best with, and they value the positive atmosphere throughout the event. The competences developed most during events like this are closely tied to group work, including time management, providing feedback to peers, and motivating team members. These skills are crucial in today's world, especially when tackling significant challenges involving large data sets or complex applications, where teamwork is essential.

So definitely organizing hackathons in the future is needed and is an important contribution to the development of students' competences and skills.

## **Conclusions**

This paper presents a novel didactic method concerning organizing 24-hour programming marathons. These events, hosted at the university, engage students in creating software to address significant and current problems within a 24-hour period (one day and one night). The paper specifically describes an event organized by the Institute of Computer Science at the University of Silesia in Katowice, and includes results from an evaluation survey conducted after this event.

The main findings confirmed during the studies are as follows. Most aspects related to the organization of the Hackathon were at the highest level. However, the system for justifying the jury's evaluations needs improvement. An interesting challenge and the opportunity to work in groups were the greatest motivators for the participating students. Students significantly developed their group work skills by participating in the hackathon. Students recognized the importance of emotional recognition issues and considered the applications created to be practical.

Future work will focus on identifying appropriate issues for future hackathons and developing clear rubrics to validate the competition results and enhance student understanding of the awarded rankings.

## **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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## **Badanie skuteczności i potencjału edukacyjnego 24-godzinnego maratonu programistycznego – HackEmotion**

### Streszczenie

Artykuł porusza kwestię nowoczesnej dydaktyki i motywacji uczniów do samodzielnego uczenia się, a także podejmowania istotnych wyzwań praktycznych. W edukacji technicznej i edukacji STEAM osiągnięcie wysokiego poziomu motywacji jest szczególnie ważne, ponieważ uczniowie często są przytłoczeni ogromną ilością informacji i możliwościami, co prowadzi do zmniejszenia zainteresowania. W Instytucie Informatyki Uniwersytetu Śląskiego w Katowicach zorganizowano Hackathon – 24-godzinny maraton programistyczny – w celu zwiększenia zaangażowania studentów w proces nauki. Podczas tego wydarzenia studenci zmierzali się z problemem współczesnego społeczeństwa jakim jest rozpoznawanie emocji. Celem było opracowanie rozwiązań, które miałyby pomóc w rozwijaniu umiejętności rozpoznawania emocji u młodych ludzi. Ważne, aby proponowane rozwiązanie miało potencjał do wdrożenia w świecie rzeczywistym. Dodatkowo, studenci mieli możliwość sprawdzenia swoich umiejętności pod presją czasu, doskonalili swoje kompetencje pracy w grupie i stawiali czoła scenariuszom rozwiązywania problemów w czasie rzeczywistym. Niniejszy artykuł przedstawia ocenę wpływu wydarzenia i analizuje wyniki ankiety przeprowadzonej po wydarzeniu, dostarczając informacji zwrotnych w celu poprawy jakości przyszłych Hackathonów. Głównymi pytaniami badawczymi, które postawiliśmy podczas badania były: RQ1: Na jakim poziomie jakości zorganizowano wydarzenie Hackathon? Czy studenci byli dobrze poinformowani i czuli się zaopiekowani podczas tego wydarzenia? RQ2: Jakie aspekty i właściwości najbardziej motywują studentów do wzięcia udziału w wydarzeniach organizowanych na uniwersytecie, takich jak Hackathon? RQ3: Jakie kompetencje, wiedzę i umiejętności rozwinęli uczestnicy Hackathonu? RQ4: Czy studenci uważają zagadnienia związane z rozpoznawaniem emocji za ważne, a stworzone aplikacje za możliwe do wykorzystania w praktyce? W niniejszym artykule odpowiadamy na te pytania z wykorzystaniem analizy statystycznej oraz prostych modeli uczenia maszynowego.

**Słowa kluczowe:** Hackathon, Praca w zespołach, Rozpoznawanie emocji, Edukacja STEM, Maraton programowania

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## **Exploración de la eficacia educativa y el potencial del maratón de programación de 24 horas – HackEmotion**

### Resumen

Este artículo aborda la cuestión de la didáctica moderna y la motivación de los estudiantes para el autoaprendizaje, además de abordar importantes retos prácticos. En la educación técnica y STEAM, lograr altos niveles de motivación es particularmente importante, ya que los estudiantes a menudo se sienten abrumados por la gran cantidad de información y oportunidades que conducen a la disminución de interés. En el Instituto de Informática de la Universidad de Silesia, en Katowice,

se organizó un Hackathon -maratón de programación de 24 horas- para aumentar el compromiso de los estudiantes. Durante este evento, los estudiantes se enfrentaron a un problema crítico de la sociedad moderna: el reconocimiento de emociones. El objetivo era desarrollar soluciones y ayudas para fomentar las capacidades de reconocimiento de emociones en los jóvenes con potencial de aplicación en el mundo real. Además, los estudiantes pusieron a prueba sus habilidades bajo presión de tiempo, perfeccionaron sus competencias de trabajo en grupo y se enfrentaron a escenarios de resolución de problemas en tiempo real. En este artículo se presenta una evaluación del impacto del evento y se analizan los resultados de una encuesta realizada tras el mismo, con el fin de aportar comentarios para mejorar la calidad de futuros Hackathones. Las principales preguntas que nos planteamos durante la investigación fueron: RQ1: ¿Con qué nivel de calidad se organizó el Hackathon? ¿Si los estudiantes estaban bien informados y se sentían atendidos durante este evento? RQ2: ¿Qué aspectos y propiedades motivan más a los estudiantes a participar en eventos organizados en la universidad como el Hackathon? RQ3: ¿Qué competencias, conocimientos y habilidades desarrollaron los participantes en el Hackathon? RQ4: ¿Consideran los estudiantes importantes las cuestiones relacionadas con el reconocimiento de las emociones y las aplicaciones creadas posibles de utilizar en la práctica? En este artículo, respondemos a estas preguntas utilizando análisis estadísticos y modelos sencillos de aprendizaje automático.

**Palabras clave:** Hackathon, Trabajo en equipo, Reconocimiento de emociones, Educación STEM, Maratón de programación

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## **Исследование образовательной эффективности и потенциала 24-часового марафона по программированию – HackEmotion**

### **Аннотация**

В данной работе рассматриваются вопросы современной дидактики и мотивации студентов к самообучению, а также решаются важные практические задачи. В техническом и STEAM-образовании достижение высокого уровня мотивации особенно важно, поскольку студенты часто оказываются перегруженными огромным количеством информации и возможностей, что приводит к снижению интереса. В Институте компьютерных наук Силезского университета в Катовице для повышения вовлеченности студентов был организован «Хакатон» – 24-часовой марафон программирования. В ходе этого мероприятия студенты столкнулись с критической для современного общества проблемой – распознаванием эмоций. Цель заключалась в разработке решений и помощи для развития навыков распознавания эмоций у молодых людей с возможностью их применения в реальном мире. Кроме того, студенты проверили свои способности в условиях дефицита времени, отточили навыки работы в группе и столкнулись со сценариями решения проблем в реальном времени. В данной статье представлена оценка воздействия мероприятия и проанализированы результаты опроса, проведенного после мероприятия, что позволяет получить обратную связь для улучшения качества будущих хакатонов. Основными вопросами, которые мы ставили перед собой в ходе исследования, были: RQ1: На каком уровне качества было организовано мероприятие «Хакатон»? Были ли студенты хорошо информированы и чувствовали ли они заботу о себе во время этого мероприятия? RQ2: Какие аспекты и свойства больше всего мотивируют студентов принимать участие в мероприятиях, организованных в университете, таких как Hackathon? RQ3: Какие компетенции,

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знания и навыки были развиты у участников Хакатона? RQ4: Считают ли студенты вопросы, связанные с распознаванием эмоций, важными, а созданные приложения - возможными для использования на практике? В данной работе мы отвечаем на эти вопросы с помощью статистического анализа и простых моделей машинного обучения.

Ключевые слова: Хакафон, Работа в команде, Распознавание эмоций, STEM-образование, Марафон программирования



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# **Relationship with Parents, Symptoms of Depression and Internet Addiction among Adolescents During the Pandemic Period**

## **Abstract**

The research presented in this article aimed to answer the following question: *what is the role of social support and quality of family relationships in the context of depressive symptoms and abuse of the Internet during the COVID-19 pandemic and remote learning by adolescents?* The study was conducted among 619 adolescents aged 11–15. The survey questionnaire was constructed from standardized research tools. The study showed that 40.0% of the students who took part in the study had increased depressive symptoms. Heavy Internet use affected 16.0% of the respondents, and there was 9.2% of those who had aggravated symptoms of depression and addiction at the same time. Simultaneously, it was noted that girls, compared to boys, were more often found among adolescents experiencing symptoms of depression. Students belonging to the group with depressive and addictive symptoms experienced significantly more difficulties in their relationships with family members (mothers and fathers) compared to the group without symptoms. Students displayed less severity of depressive symptoms if there was mutual understanding and openness to alternative views and beliefs in their family. The results proved that the quality of family relationships is the most important for the normal functioning of adolescents without depressive symptoms, also in a pandemic situation.

**Key words:** mental health in youth, COVID-19, family relationships, depression, Internet addiction

## **The COVID-19 Pandemic and the Problem of the Functioning of the Youth**

Research conducted during the COVID-19 pandemic has revealed an increase in depressive symptoms and Internet abuse among individuals. A report titled *Symptoms of depression and anxiety among Poles during the COVID-19 epidemic. Longitudinal study report* by Małgorzata Gambin and her co-workers, found that symptoms of depression and generalized anxiety disorder were linked to challenges experienced at home, such as difficult relationships with family members, lack of privacy, and fatigue from excessive responsibilities (Gambin et al., 2020). These symptoms were also associated with anxiety and uncertainty related to the pandemic spread. Furthermore, anxiety about COVID-19 was connected to Internet addiction disorder, involving intrapersonal and interpersonal conflicts (Servidio et al., 2021). Heavy Internet use was found to exacerbate depressive symptoms (Zalewska et al., 2021).

The COVID-19 pandemic introduced new challenges for children and adolescents. Researchers developed several questionnaires to identify stressors associated with functioning during this period, helping to determine the primary difficulties experienced by young individuals. According to the report *Tenure in the network 2.0* (involving 806 students aged 11–18), 62% of surveyed adolescents reported sleep problems, 43% had thoughts of death, 75% worried about the future, and 70% felt more nervous and agitated than before (Białecka & Gil, 2020). The report *Youth during the pandemic* (involving 2476 individuals aged 15–19) revealed an increase in the number of young people experiencing loneliness, school-related stress, depression, suicidal thoughts, and cyberbullying during the pandemic (Grzelak & Żyro, 2021). Another report, *Remote education: what has happened to students, their parents, and teachers?* (involving 1284 participants), indicated that around 10% of the young people surveyed exhibited distinct symptoms of depressive states, with 9% reporting persistent sadness and loneliness. Additionally, 9% acknowledged feeling like crying all the time. Poor relationships with peers, remote learning, and isolation were considered contributing factors to these challenges (Białecka & Gil, 2020; Ptaszek et al., 2020; Grzelak & Żyro, 2021).

The research presented in this article aims to answer the following question: what is the role of family relationships in the context of depressive symptoms and

Internet abuse among adolescents during the COVID-19 pandemic and remote learning? Given the complexity of the inter-relationships between the variables analyzed, the study is primarily exploratory.

## **Methodology of Research**

The research was conducted in May 2021 among adolescents aged 11–15, with a sample of 619 respondents. Those surveyed attended schools located throughout Poland. The surveys took place with the permission of the school principals, took place during lessons conducted by remote learning, via an electronic form accessible via the Internet; taking part in the study was anonymous and voluntary.

### **The aim of the study**

The aim of the study was to diagnose and describe (Babbie, 2001) the prevalence of symptoms of depression and/or Internet addiction among adolescents aged 11–15. It was assumed that this age group is one of the most vulnerable to the negative effects of, on the one hand, pandemic structures and the need to study at home and spend more time with parents, and on the other hand, the need to use new tools for learning and interacting with peers/teachers, i.e. fulfilling part of social needs in a way mediated by new technologies. The survey was conducted a little over a year after the introduction of the epi-demographic condition in Poland and internationally, i.e. at a time when the fear of possible contagion had diminished, but adolescents were tired of the restrictions and the need to learn remotely.

### **Research question**

The study sought to answer the question to what extent symptoms of depression and/or Internet addiction declared by adolescents correlate with positive attitudes of a mother and father towards a child. Standardized questionnaires were used to assess symptoms of depression and the level of Internet addiction, as described below, while a tool developed by Solecki was used to diagnose the relationship with parents.

## Methods

The method used in the study was the survey method. The following survey questionnaires were used in the study:

### **a) *Questionnaire for the Diagnosis of Depression in Children and Adolescents (CDI 2)***

The original version of the questionnaire was developed by Kovacs (2003). Its Polish adaptation was made by Wrocławska-Warchala & Wujcik (2017). In the presented study, an abbreviated self-report version was used, which consists of 12 questions relating to various symptoms of depression. Out of 3 possible statements within each question, the respondents were asked to choose the one that reflected their feelings over the past two weeks. An example question implies the following possible responses: I do most things well; I do many things badly; I do everything badly. The scale has satisfactory reliability ratings. For respondents aged 7–12, Cronbach's  $\alpha = 0.74$ , while for those aged 13–18, Cronbach's  $\alpha = 0.80$ .

### **b) *Internet Addiction Test (IAT)***

The original scale (Internet Addiction Test – IAT) in an abbreviated version of 8 questions was prepared by Young (1998). It has been adapted for learners aged 16–17 by Solecki (2016). In his research, the scale obtained a satisfactory reliability index of Cronbach's  $\alpha = 0.70$ . An example item of the scale reads: *do you feel the need to spend more and more time using the Internet in order to achieve the desired degree of satisfaction?* Those completing the questionnaire were asked to answer yes or no to each question. This answer was to be based on their own experience of using the Internet.

### **c) *Questionnaire for the study of relations with parents (Solecki 2016;2021)***

Consisting of 18 items assessed using a 5-point scale (*never, rarely, sometimes, often, always*) and relating separately to relationships with a mum and dad (Solecki, 2016).

### **d) *Demographic data***

The responders were also asked to provide information about their age and gender, and in which grade of primary school they study. We decided to use convenience sampling which is a non-random sampling method of selecting respondents due to their accessibility and proximity. The sample formed using this method is called a convenience sample. The advantage of the convenience sampling is that it allows to identify relations between the phenomena (Christensen, Johnson, 2011).

## Results of Research

Of those taking part in the survey, a slight majority were women (53.2% of respondents). Nearly 90% (86.1%) were rural residents, while 13.9% of the respondents lived in a city. The teenagers participating in the study were studying in sixth (33.8%), seventh (29.4%) or eighth (36.6%) grade. They were therefore 11–15 year olds. Among the respondents, 16% declared high rates indicating Internet addiction. The remaining respondents (84%) report low levels of Internet addiction.

The analysis of the collected data shows that of the respondents, half show “average” symptoms of depression (50%) and 16% of respondents declare “very high” rates of depression, 8% “high”, 16% of respondents have “elevated” rates, while one in 10 respondents declare “low” symptoms of depression. Based on the data collected, 4 subgroups were identified from the respondents: (1) Depression and Internet Addiction, (2) Depression, (3) Internet Addiction and (4) No symptoms.

The analysis shows that more than one in five respondents in this group show symptoms indicating that they suffer from depression. Nearly one in ten students report having symptoms of both depression and Internet addiction. Internet addiction alone is characteristic of 7.1% of respondents. Slightly more than 60% of respondents did not indicate symptoms indicating that they had depression and/or Internet addiction.

Of 329 girls taking part in the survey, 28.3% declared the presence of symptoms indicative of depression. In contrast, 10.3 per cent had test results indicating that they were suffering from depression and were addicted to Internet use. In this group, 6% of the respondents were addicted without symptoms of depression.

Considering the declarations of the boys, the majority (71%) on the basis of the obtained declarations are “normal”, less than 13% (12.8%) experience depression, while 7.9% experience depression and Internet addiction. Addicted to this medium, without symptoms of depression, are 8.3% of the respondents. It is therefore noteworthy that Internet addiction and depression symptoms are overrepresented among girls – there are significantly more girls than boys in the addiction/depression and addiction groups.

The study also examined the extent to which a positive/negative relationship with a parent correlates with symptoms of depression and/or Internet addiction. A test used in the study was developed by Solecki (2016; 2021). In this test adolescents were asked to respond to 18 statements about their relationship with their mum and dad, and mark the frequency of the respective behaviours. The items that tested positive relationships with a mum/dad were, for example: #2: *She/He supports me in developing my talents*; #5 *We agree together on my plans for the future*; #14 *She/He accepts that I don't have to be the best/best at everything*; #18 *I enjoy spending time with her/him*. Against each statement, the respondents were asked to specify the frequency (*never – rarely – sometimes – often – always*).

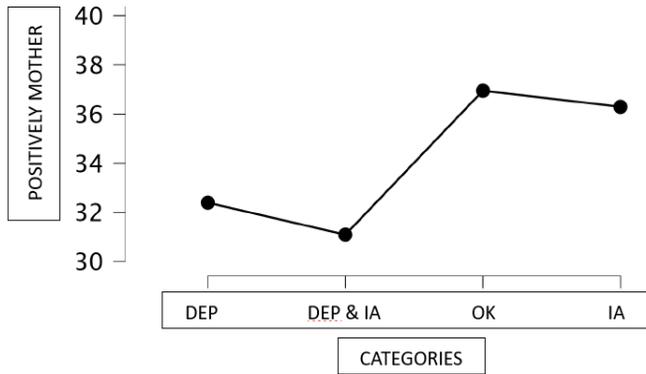


Figure 1. Positive relationship with a mother (test score) vs. depression (DEP), depression and Internet addiction (DEP&IA), adolescents without symptoms of depression and addiction (OK) and Internet addiction (IA)

Source: Own work.

The results show that the best results in the questionnaire about the relationship with parents were achieved by adolescents who did not show Internet addiction and Internet addiction together with depression or depression alone in other tests (referred to in the study as “Teens without symptoms”) (mean in the test 36.954, coefficient of variation 0.166, SD 6.122). However, the relationship with a mum scores were only slightly lower among adolescents who scored as indicative of Internet addiction on the IAT test (mean – 36.295, coefficient of variation 0.187, SD 6.805). In contrast, the relationship with their mother among adolescents who struggle with depression is worse than in the groups analysed above (mean on the test 32.392, coefficient of variation 0.256, SD 8.287) (Figure 1, Table 1). Thus, the test results indicate lower support from a mother. The subgroup of adolescents who are addicted to the Internet and also struggle with depression performed worst on this test (31.088, coefficient of variation 0.308, SD 9.560).

Table 1

Values of Depression and Internet addiction, Depression, Internet Addiction and Without symptoms of depression and/or Internet addiction with the relation with a mother

Categories	N	Mean	SD	SE	Coefficient of Variation
Depression and Internet Addiction	57	31.088	9.560	1.266	0.308
Depression	130	32.392	8.287	0.727	0.256
Internet addiction	44	36.295	6.805	1.026	0.187
Without depression and/or Internet addiction	388	36.954	6.122	0.311	0.166

Source: Own work.

Regarding the relationship with a dad, the averages in the test were slightly different – adolescents scored significantly lower in this test than when analysing the relationship with a mum, meaning that they have a less positive relationship with their dad and less support from their dad (Figure 2, Table 2). The worst relationships with a dad are declared by young people who suffer from depression (mean in the test 28.008, coefficient of variation 0.355, SD 9.951; for a mum 32.392). Similarly, low scores in the relationship with a father were obtained by students who are addicted to the Internet and show symptoms of depression (mean on the test 29.053, coefficient of variation 0.383, SD 11.130; cf. relationship with the mother – 31.088). For students with an Internet addiction, the mean of the test on the relationship with a dad was 33.591 (with a coefficient of variation of 0.213, SD 7.170; cf. relationship with a mum – 36.295), while for students without symptoms of addiction and/or depression it was 34.077 (coefficient of variation of 0.25, SD 8.507; cf. relationship with a mum – 36.954). The results, therefore, show that adolescents who experience depression have a significantly worse relationship with their father than adolescents without symptoms of depression and/or Internet addiction. This means that adolescents in crisis experience less support from their father than from their mother (relationship scores with their mother are higher). Perhaps fathers do not cope with the difficult emotions experienced by their children, especially daughters (as the results of the analyses show – in all groups: Depression – Internet Addiction – Depression and Internet Addiction – there are more girls than boys).

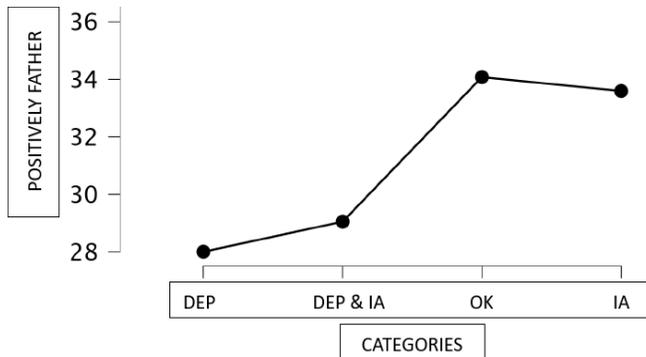


Figure 2. Positive relationship with a father (test score) vs. depression (DEP), depression and Internet addiction (DEP&IA), adolescents without symptoms of depression and addiction (OK) and Internet addiction (IA)

Source: Own work.

It is clear that in order for teenagers to cope with difficulties such as depression or Internet addiction, support from professionals is needed, but also a good atmosphere in the family home and support from both parents.

Table 2

*Values of Depression and Internet addiction, Depression, Internet Addiction and Without symptoms of depression and/or Internet addiction with the relation with a father*

Categories	N	Mean	SD	SE	Coefficient of Variation
Depression and Internet Addiction	57	29.053	11.130	1.474	0.383
Depression	130	28.008	9.951	0.873	0.355
Internet addiction	44	33.591	7.170	1.081	0.213
Without depression and/or Internet addiction	388	34.077	8.507	0.432	0.250

Source: Own work.

The ANOVA results reveal the existence of a relationship between positive parental attitudes, symptoms of depression and Internet addiction among students. In the case of mum's positive attitude, the ANOVA test explains 9.5% of the variance in the results, while in the case of a dad, the amount of explained variance is smaller at 7.9% (see Table 3).

Table 3

*Positive mother's and father's attitude versus groups experiencing specific difficulties; results of ANOVA*

Positive attitudes	1. OK <i>n</i> = 388	2. DEP <i>n</i> = 130	3. DEP&IA <i>n</i> = 57	4. IA <i>n</i> = 44	Differences between groups			
	<i>M</i> ( <i>SD</i> )	<i>M</i> ( <i>SD</i> )	<i>M</i> ( <i>SD</i> )	<i>M</i> ( <i>SD</i> )	<i>F</i> <sub>(3, 615)</sub>	<i>p</i>	$\eta^2$	<i>Post hoc</i> <sup>a</sup> <i>Gamesa-Howella</i>
Mother	36.95 (6.12)	32.39 (8.28)	31.08 (9.56)	36.29 (6.80)	21.58	< .001	0.095	2-1,4; 3-1,4
Father	34.07 (8.50)	28.08 (9.95)	29.05 (11.13)	33.59 (7.17)	17.63	< .001	0.079	2-1,4; 3-1

*Annotation.* OK – group without symptoms; DEP – group with depression; DEP&IA – group with depression and Internet addiction; IA – group with Internet addiction.

<sup>a</sup> The table lists the groups between which there were statistically significant differences.

Source: Own work.

Statistical inference was further complemented by post hoc multiple comparisons. These made it possible to assess the significance of the differences between the groups in the assessment of the respondents' relationship with their parents. Table 3 details the statistically significant differences between the separate groups and the variables studied. The results indicate that a positive relationship with a mother is

associated with the absence of depressive symptoms of the students. No significant differences were found between the group without difficulties and the group with symptoms of Internet addiction alone in terms of the assessment of mother's positive attitude towards the children. A similar picture of interdependence is also found with regard to the respondents' relationships with their fathers.

## Discussion & Conclusions

Adolescence is a period of major changes in psychological and somatic aspects, opening up to new experiences and building a personal identity. An important role in this process is played by new technologies, which are very popular among young people as a means of promoting social relationships and freely exploring the 'wider world'. However, the period of the COVID-19 pandemic and the austerity associated with it, as well as the need to use new technologies to satisfy needs that have hitherto been met without the mediation of the virtual world, is challenging young people.

The study presented here obtained results that lead to the following conclusions:

1. The proportion of young people who experience depression, Internet addiction or both depression and Internet addiction in a COVID-19 pandemic situation is high. More research is needed to determine whether this percentage of adolescents experiencing problems now – in the post-pandemic reality – has decreased or increased.
2. Girls are statistically more likely to experience symptoms of depression or depression and Internet addiction. In the case of Internet addiction, on the other hand, there are still more cases in the girl population than in the boy population, but the differences are not so significant. The reason for these significant gender disparities in the distribution of traits indicative of Depression/ Internet Addiction/Depression and Internet Addiction should therefore be investigated.
3. Those experiencing Depression/ Internet Addiction/Depression and Internet Addiction have poorer relationships with both their mum and dad. However, rates of positive relationships with a mum are higher than rates of these relationships with a dad. This means that a mum is more likely to be the person who provides support and cares more about the teenager in crisis.
4. The results of the study indicate that a positive relationship with a mother is associated with the absence of depressive symptoms in students. However, they do not rule out dependency. A similar picture of interdependence is also found with regard to the respondents' relationships with their fathers. The analyses further showed that the experience of positive attitudes on the part of a mother

by the respondents has a slightly higher correlation with depressive symptoms than is the case in relation to the relationship with a father.

Numerous research results show that relationships with parents and parental attitudes are correlated with Internet use (cf. Mróz & Solecki, 2017). Furthermore, the research by Niedorys and colleagues (2018) showed that approximately one in ten adolescents is addicted to the Internet. In this group, one in five students is raised in a single-parent family. Furthermore, recurrent conflicts with parent(s) are significantly more frequent in the group of adolescents who are addicted to the Internet or are at risk of addiction – however, there is a lack of systematic research on the causes of Internet addiction or whether the adolescent’s addiction leads to the emergence of family conflicts. Other studies, on the other hand, have shown that lack of a positive bond with a mother, low availability of a mother in a crisis situation, correlate with the rate of Internet addiction (Trumello et al., 2018).

The study by Kilińç and colleagues (2019) showed that Internet addiction occurs on every continent and in almost every social group. The research also showed that in a pandemic situation, young people had a need for support especially from family and teachers (Gawrych, Cichoń, Kiejna, 2023). Relating this to the results of the presented research, it can be concluded that the lack of support and positive relationships with parents may be a cause, rather than an effect, of seeking solutions to their problems in virtual reality.

Researchers focus on the social support of young adults as a factor in reducing the occurrence of mental health problems. Qi and colleagues (2020) showed that low levels of support were associated with an increase in the prevalence of depression. To the best of the authors’ knowledge, there is a lack of studies that have made correlations between symptoms of depression, addiction and depression and addiction among young adults and support/relationship with their parents. This opens up the possibility for further exploration and a more in-depth research.

## **Limitations and Further Research**

Like any survey, the presented one also has its limitations. First of all, the research sample was not representative, but such a sample is difficult to obtain in social research. It should also be remembered that the survey research is based on the declarations of the people participating in the study – their subjective perception of reality, which is a certain limitation of social research carried out in this paradigm.

In order to delve deeper into the issue under analysis, further research should be carried out – taking the COVID-19 pandemic situation out of context as a factor – to determine what the cause and effect in the relationship with a mum/dad is, and

the occurrence of symptoms such as depression, boarding school addiction or both depression and addiction. It is also important to look for protective factors against the occurrence of the indicated phenomena, and to find out how parental support/ positive relationships with a mum and dad can protect adolescents from depression and addiction crises.

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Roman Solecki, Anna Mróz

## **Relacje z rodzicami a objawy depresji i uzależnienia od Internetu wśród młodzieży w okresie pandemii**

### **Streszczenie**

Badania, których wyniki zaprezentowano w artykule, miały na celu odpowiedź na pytanie: jaka jest rola wsparcia społecznego i jakości relacji rodzinnych w kontekście objawów depresji i nadużywania Internetu w czasie pandemii COVID-19 oraz uczenia się na odległość wśród młodzieży?

Badanie przeprowadzono wśród 619 nastolatków w wieku 11–15 lat. Kwestionariusz badania został skonstruowany w oparciu o wystandaryzowane narzędzia badawcze. W badaniu wykazano, że u 40.0% uczniów biorących udział w badaniu wystąpiły objawy depresji. Intensywne korzystanie z Internetu dotyczyło 16.0% ankietowanych, a u 9.2% osób występowało jednocześnie nasilenie objawów depresji i uzależnienia od Internetu. Jednocześnie zauważono, że wśród adolescentów częściej stwierdzano objawy depresji u dziewcząt w porównaniu z chłopcami.

Nastolatki należą do grupy z objawami depresyjnymi i uzależnienia od Internetu doświadczali istotnie większych trudności w relacjach z członkami rodziny (matkami i ojcami) w porównaniu z grupą nastolatków bez objawów. Adolescenci wykazywali mniejsze nasilenie objawów depresyjnych, jeśli w ich rodzinie panowało wzajemne zrozumienie i otwartość na alternatywne poglądy i przekonania.

Wyniki wykazały, że jakość relacji rodzinnych jest najważniejsza dla prawidłowego funkcjonowania młodzieży bez objawów depresyjnych, także w sytuacji pandemii.

**Słowa kluczowe:** zdrowie psychiczne młodzieży, COVID-19, relacje rodzinne, depresja, uzależnienie od Internetu

Roman Solecki, Anna Mróz

## **Relación con los padres y síntomas de depresión y adicción a Internet entre adolescentes durante el período de pandemia**

### **Resumen**

La investigación presentada en este artículo tuvo como objetivo responder a la siguiente pregunta: ¿cuál es el papel del apoyo social y la calidad de las relaciones familiares en el contexto de síntomas depresivos y abuso de Internet durante la pandemia de COVID-19 y el aprendizaje remoto entre adolescentes?

El estudio se realizó entre 619 adolescentes de entre 11 y 15 años. El cuestionario de la encuesta se construyó a partir de herramientas de investigación estandarizadas. El estudio mostró que el 40.0% de los estudiantes que participaron en el estudio tenían un aumento de los síntomas depresivos. El uso intensivo de Internet afectó al 16.0% de los encuestados, y hubo un 9.2% de los que presentaron síntomas agravados de depresión y adicción al mismo tiempo. Al mismo tiempo, se observó que entre los adolescentes que experimentaban síntomas de depresión eran más frecuentes las niñas que los niños.

Los estudiantes pertenecientes al grupo con síntomas depresivos y adictivos experimentaron significativamente más dificultades en sus relaciones con los miembros de la familia (madres y padres) en comparación con el grupo sin síntomas. Los estudiantes mostraron menos gravedad de los

síntomas depresivos más leves si había comprensión mutua y apertura a puntos de vista y creencias alternativos en su familia.

Los resultados demostraron que la calidad de las relaciones familiares es lo más importante para el normal funcionamiento de los adolescentes sin síntomas depresivos, también en situación de pandemia.

**Palabras clave:** salud mental en jóvenes, COVID-19, relaciones familiares, depresión, adicción a Internet

(Translated by Lucia Lozano Garcia)

Роман Солецкий, Анна Мроз

### **Отношения с родителями и симптомы депрессии и интернет-зависимости у подростков в период пандемии**

#### **Аннотация**

Главной целью исследований, представленных в статье, является ответ на вопрос: какова роль поддержки в обществе и качества семейных отношений в контексте симптомов депрессии и злоупотребления Интернетом во время пандемии COVID-19, а также удалённой учёбы?

Исследование проводилось среди 619 подростков в возрасте 11–15 лет. Анкета разработана согласно стандартным инструментам исследования. Исследование доказало, что у 40.0% учеников, принимающих участие в исследовании, усилились симптомы депрессии. Активное использование Интернета касалось 16.0% опрошенных, а у 9.2% появилось одновременно усиление симптомов депрессии и зависимости. Одновременно замечено, что среди подростков чаще были обнаружены симптомы депрессии у девушек, чем у парней.

Ученики, принадлежащие к группе с симптомами депрессии и зависимостями, испытывали больше трудностей в отношениях с членами семьи (матерями и отцами) в сравнении с группой, в которой этих симптомов не было. Если у учеников в семье было взаимопонимание и открытость к альтернативным убеждениям и взглядам, то у учеников симптомы депрессии были выражены меньше.

Результаты показали, что качество семейных отношений является важнейшим фактором для отсутствия симптомов депрессии у молодёжи, в том числе во время пандемии.

**Ключевые слова:** психическое здоровье молодежи, COVID-19, семейные отношения, депрессия, интернет-зависимость

(Translated by Arkadiusz Wojtal)





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## **E-tutors' Understanding and Level of Confidence in Using a Technological Pedagogical Knowledge Model in Open Distance E-Learning**

### **Abstract**

The article aimed to investigate the perspectives of e-tutors regarding the importance of Technological Pedagogical Knowledge in an Open Distance e-Learning Institution. The article employs a quantitative survey method to allow students to articulate their impressions of how e-tutors leverage their topic expertise to impart knowledge. The study includes 350 students who are enrolled in a module. Its objective was to gain insights, using quantitative analysis, into the techniques used by e-tutors in delivering content. During the delivery of content, e-tutors provided explanations and support for different viewpoints, taking into account students' input on the choice, execution, and overall impact of teaching methods. The collected data were arranged and presented in tables. E-tutors recognized the use of Technological Pedagogical Knowledge (TPK) to assist and enhance online student activities. Therefore, it was found that constructivism could help to incorporate the TPK framework, thereby enhancing students' understanding of the instructional design process. However, the study discovered a lack of comprehension among e-tutors regarding the TPK concept in relation to curriculum design.

**Key words:** Technological Pedagogical Knowledge (TPK); Open Distance e-Learning (ODEL); e-tutors; constructivism

Technological Pedagogical Knowledge refers to integrating technology into pedagogical practices to facilitate effective teaching and learning (Koehler & Mishra, 2009). The model is based on the pedagogical knowledge components of the TPACK framework (Mishra, 2006; Misha & Koehler, 2009). TPK takes a broader perspective encompassing the understanding of how to leverage technology to attain instructional objectives, it involves a nuanced awareness of the strengths and limitations of different technologies in specific educational contexts (Ali et al., 2024). In Open and Distance e-Learning (ODeL) institutions, where virtual interactions are central, TPK enables e-tutors to design engaging and interactive learning experiences (Liaw, 2008). The trained learning facilitators are the first point of contact for the students and fulfil various tasks, e.g., motivation, feedback, and conflict resolution (Langesee & Ukhova, 2023). E-tutors are crucial facilitators of online learning, requiring a nuanced understanding of TPK to navigate digital platforms and engage learners effectively (Ally, 2008). Their perspectives shed light on the practical application and challenges of integrating technology with pedagogy. The research objective is to investigate e-tutor perceptions of TPK during the facilitation of content in an ODeL space. How do e-tutors perceive TPK during the facilitation of content in an ODeL space?, became the research question of the paper.

The aim of the paper is a dual purpose where at first it aims to develop and validate an instrument to examine e-tutors' perspectives about their TPK in an ODeL context. In addition, it aimed to develop a model to investigate TPK influence on constructs describing: 1) e-tutor usage abilities of digital media for online assessment; 2) e-tutor abilities to encourage students to do online classroom platform discussions; 3) e-tutor abilities to encourage students to use online technologies for content learning. The constructs statements were topic-specific and aimed to seek clarity for specific competence. It is common to adapt TPACK for different purposes (Celik, 2023).

TPK framework best-suited e-tutors in this paper based on the assumption that they serve as agents to facilitate technological communications with students at a distance. E-tutors have a firm grip and skills for technological pedagogical choices which will allow creative capacity to build appropriate instructional strategies for the students they teach (Foulger et al., 2022; Lyublinskaya & Kaplon-Schillis, 2022). The generation of students at a distance is imbued with technological DNA, making the pedagogy with technology and associated strategies critical to consider (Tanyi, 2022).

At the outset of its existence, the idea that technology might exist while at the same time also becoming an educational instructional tool for teaching and learning was a far-fetched one. Knowing which technologies are well-aligned with teaching and learning methodologies as well as which technologies adapt themselves best to educational situations is beneficial for students (Harris et al., 2009). The same technology has become a most influential force in shaping the world of education in

that its pedagogy in classrooms is being highlighted as a necessary need to optimize 21st-century abilities (Imaduddin & Astuti, 2022). The technology exists in various forms of tools including software and hardware and can be effectively employed through a range of teaching methods (Karsenti, 2009; Nsouli & Vlachopoulos, 2021). The diverse technologies can affect teaching and learning including their pedagogical instructional affordances and limits (Radmehr & Goodchild, 2022). Studies, (Wu et al., 2022; Zhang & Chen, 2022) results alluded that technologies and pedagogy are fundamental principles that positively influence pedagogy when technology is involved. Because of the COVID-19 epidemic the need for technology pedagogy during teaching, particularly in a virtual setting, became even more vital in 2020 when the entire world moved to online instruction (Lyublinskaya & Kaplon-Schillis, 2022).

## **Review of Related Literature**

This section presents a literature review from previous studies. The initial presentation of this section is focused on e-tutor usage abilities of digital media for online assessment. The second focal point is based on e-tutor abilities to encourage students to do online classroom platform discussions. The final section presents a construct based on e-tutor abilities to encourage students to use online technologies for content learning.

### **E-tutor usage abilities of digital media for online assessment**

TPK accounts for 30 percent of the variance of technology integration practices for online assessment (Knezek & Christensen, 2015). Evidence exists on the positive impacts of digital media on online assessment. The era of Covid-19 provided development opportunities where e-tutors used digital media to enable online assessments since they were not all new to assessing online (Coker et al., 2024). The sampled 3 e-tutors indicated their positive abilities in using digital learning media for online assessment with a score of 61.6% of their TPK (Taek et al., 2024). There was a moderate relationship between e-tutors' attitudes toward online assessment and digital media where the association could be attributed to their skills in linking pedagogy with technology (Alhamid & Mohammad-Salehi, 2024). Additional positive study results were linked to e-tutors and students. E-tutors played an active pedagogical role in instructing students with digital abilities for online platform discussions and directly influenced their TPK (Oikarinen et al., 2022). In the results, more e-tutor participants in online classrooms demonstrated

online platforms cooperation and discussions with the students rather than instructor-centeredness (Cheng et al., 2022). E-tutors' influences benefited students to manipulate technology to benefit their online classroom platform discussions during a course module content delivery (Nuruzzakiah et al., 2022). The online students were positively influenced by knowledge of Web 2.0 technologies and pedagogy (platform technology discussions) which contributed to developing a new understanding of content in the modules they were taught (Mohammad-Salehi & Vaez, 2022).

Some literature arguments presented non-positive results about e-tutor usage abilities of digital media for online assessment. The integration of digital media for online assessment from the e-tutors did not appear to influence the ICT literacy of the students (Kastorff & Stegmann, 2024). E-tutor participants preparations for digital media programs needed development so that they could develop critical skills that would allow them to use new and creative technologies for the students' online assessment (Tafazoli & Meihami, 2022). E-tutors were unaware of their digital media online assessment skills levels important in a course program (Ogalo et al., 2022). E-tutors believed that more weight could be put on programs that nurtured how digital media could be exploited to assist them with obstacles to build their digital media skills for online assessment (Radmehr & Goodchild, 2022). E-tutors felt that their technical knowledge was not adequately developed for their heightened usage abilities of digital media for online assessment (Lee & Ogawa, 2021). It was observed that the e-tutors' digital skills were at the lowest and influenced their preparations for online assessments preparations for students (Nguyen et al., 2022).

### **E-tutor abilities to encourage students to do online classroom platform discussions**

This construct was developed to evaluate the e-tutor abilities to encourage students to do classroom platform discussions. Online learning platforms pose comprehension and navigation challenges for students, leading to them feeling excluded during the online learning process discussions (Sun & Zhang, 2024). Students' participation levels for online platforms were generally at the lowest based on the limited technical knowledge of online platforms (Guzmán et al., 2024). Students felt that their e-tutors were unfamiliar with technology in workshops on how to create online breakout rooms for online platform discussions (Lee & Ogawa, 2021). There were some non-similar arguments about the construct above. All the students could participate to do online platforms processes and were almost equally actively involved in the learning process from their e-tutors 'encouragements (Keramati et al., 2024). Encouragement influences that the students received from online platform discussions from their e-tutors positively influenced their positive online classroom platform discussion (Vanacore et al., 2024).

## **E-tutor abilities to encourage students to use online technologies for content learning**

The construct was developed to ascertain the levels of e-tutor encouragement for students to use online technologies. Students improved their learning performances significantly in content where the number of students exhibited high scores from the encouragement to use gamification online technology (He et al., 2024). E-tutor respondents stated they could guide and encourage students towards online technologies that supported and improved their content learning (Alsayed et al., 2022). E-tutors used online technologies to reinforce the traditional delivery of content, their students can perform procedures with technologies outside of the teachers' intervention after the initial encouragements (Filho & Gitirana, 2022). Students were at an average, indicating that the value was a positive result after the online students were encouraged to use online technologies for their content learning (Ferdiansyah et al., 2022).

Some contrasting results were obtained contrary to the positive results that grounded the construct, some non-preferred results were also obtained from the literature. The different characteristics of the students were lowered based on their under-engagement with online technologies and how adaptable technologies underscored the online education which did not cater for achievements for content learning (Shofiyyah et al., 2024). E-tutor participants felt less confident in their technological applications and experienced inadequacies for students who were engaged with online learning for module content (Wea & Budiraharjo, 2022). E-tutors lacked knowledge of technologies knowledge to encourage student engagement with online technologies during content learning (Ma et al., 2021). There was a need for additional mentorship for technology-based learning for e-tutors as well as to develop abilities to encourage students to use online applications relevant to their course contents (Imaduddin & Astuti, 2022).

## **Theoretical Framework**

### **Constructivism**

Constructivism learning theory grounded an understanding of how e-tutors understood TPK knowledge forms during the facilitation of content in an ODeL space. Constructivism teaching prioritizes the students and emphasizes their active involvement in the learning process, along with the integration of ICT has become more prevalent in the current paradigm of teaching (Barak, 2014, 2017; Leshem et al., 2018). Technology-enhanced constructivist learning environments advanced

educational technologies that have enabled the development of interactive and multimedia-rich constructivist learning environments in ODeL (Bates & Poole (2003). The intersection of constructivism and TPK advances towards leveraging technology for active learning where students engage in hands-on activities and exploration. TPK helps educators select and use appropriate technologies (e.g., simulations, and interactive platforms) that promote active learning experiences (Mishra & Koehler, 2006). An anticipation is that the students who engage with e-tutors online might construct new knowledge based on their comprehension of the theory.

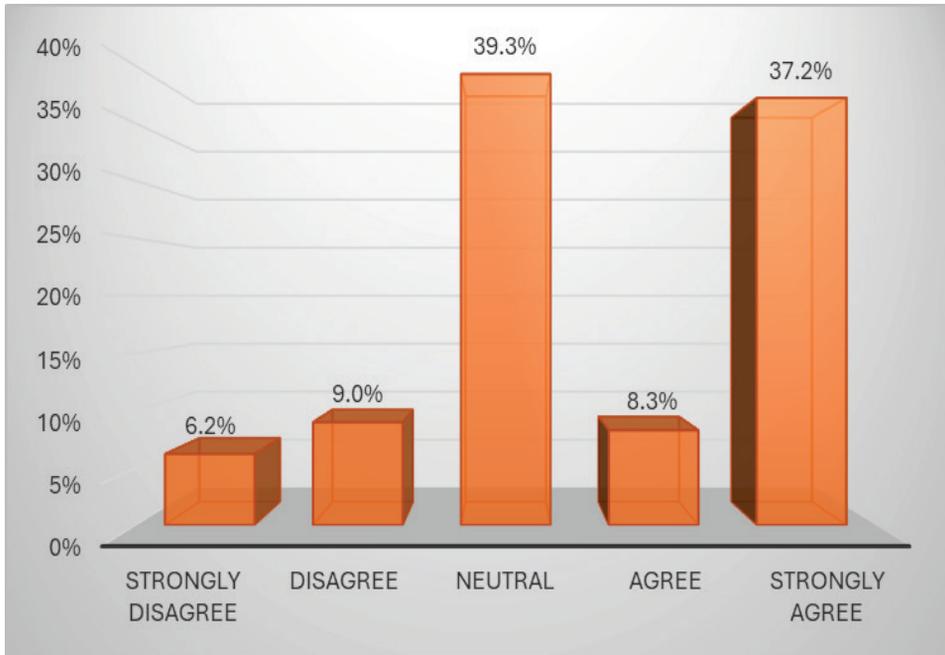
## **Method**

The study employed both quantitative and web questionnaires for data collection. Questionnaires were used as data collection instruments designed to gather specific information from respondents (Babbie, 2016). The Microsoft forms assisted with the collection process. Within the forms, a five-point Lickert Scale with rating scales was used. The scale's simplicity ranges typically from "Strongly Disagree" to "Strongly Agree"; "Disagree to Agree" and "Neutral"), which makes it easy for respondents to understand and respond to survey items (Jamieson, 2004). For this study, the three constructs were based on the data obtained from a research project. The original instrument contained TPACK sections (Section A: biographic information with gender, age qualifications, Section B: contained 8 aspects of Technological Knowledge, (TK), Section C: contained 6 items on Pedagogical Knowledge, PK), Section D: contained 4 items on Content Knowledge, CK). The last sections were based on TPK, Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK), each containing 6 items. This paper focused on three constructs within TPK where each needed to ascertain a particularised competency guided by the main research question formulated for the study. The validity and reliability of the measurement instruments accurately assess intended constructs and yield consistent results from the design and pretest by senior experts in the field specialization (Bryman, 2016; Trochim & Donnelly, 2008)

## **Participants**

This study included a total of 350 students who were enrolled in a module. The primary goal was to provide detailed accounts based on a quantitative analysis of how their e-tutors teach the content in the modules. During the teaching process, e-tutors clarified and attempted to defend viewpoints that gave information from students on their selection, usage, and general application of their technology integrations and methodologies.

## Results of Research



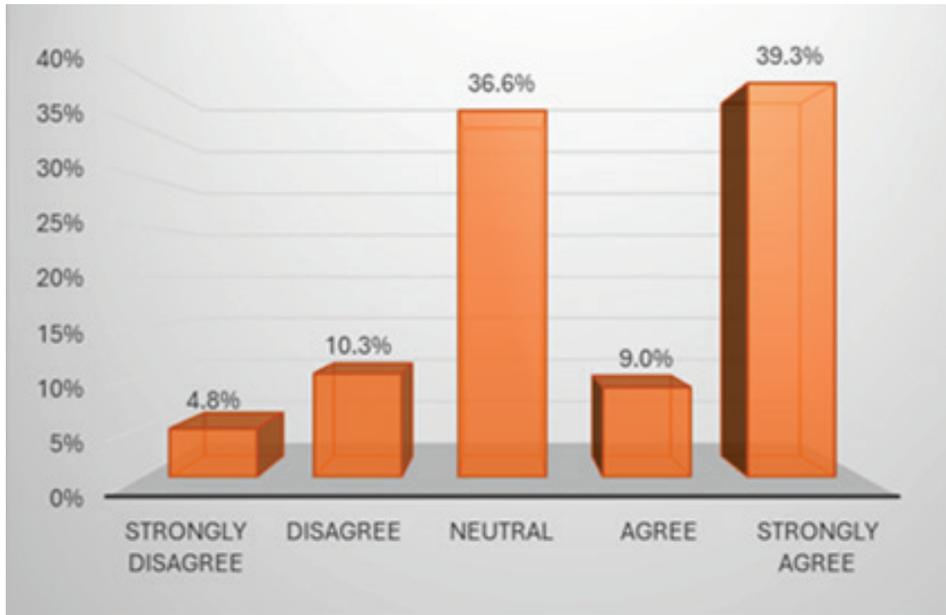
*Figure 1.* My e-tutor uses digital media for online assessment

Source: Own work.

Figure 1 displays the responses to an item in which students were asked to rate their e-tutors' proficiency in using digital media for online assessment. According to the figure, 45.5 percent of students highly agreed or agreed on their e-tutors' skill level, particularly when it came to the usage of digital media for online assessment. Those who highly disagreed or disagreed were worth 11.2 percent of the total, with no direct influence on those who strongly agreed or agreed. Another notable category was those who were undecided about the construct, accounting for 39.3 percent of the total. Based on the percentage of those who strongly agreed or agreed at a percentage less than half, it can be concluded that the e-tutors cannot still use digital media for online design process assessment.

Figure 2 shows the responses to the question on whether e-tutors had sufficient expertise to encourage students to participate in online classroom platform discussions. In terms of the construct, the figure showed that 48.3 percent of the students highly agreed or agreed that their e-tutors' level of expertise encouraged them to participate in online classroom platform conversations. The number of people who became ambivalent regarding the construct increased to 36.6 percent.

Finally, those who strongly opposed or disagreed were valued at 15.1 percent in the table, with no direct influence on the conclusions acquired earlier from the two sets of concept outcomes. Based on the information that only 48.3 percent of students strongly agreed or agreed about their e-tutors' competence level, it can be concluded that e-tutors' proficiency levels were insufficient to encourage students to participate in online classroom platform conversations.



*Figure 2.* My e-tutor encourages students to do online classroom platform discussions

Source: Own work.

Figure 3 shows the responses to the item that asked for evidence of e-tutors' ability to encourage students to use online technologies to solve their learning. The issue received a favourable reaction, with 51% of students strongly agreeing or agreeing that their e-tutors' competence level should encourage them to employ online technologies for their design process challenges. The students who were neutral about the item at a 33.8 percent value produced a non-influential consequence. In addition, 15.2 percent of respondents either strongly agreed or disagreed with the contents of the topic, according to another set of results. The positive responses from 51% of the respondents offered useful information about the construct, allowing us to conclude that e-tutors perform on par with the average in terms of their ability to inspire students to adopt online technologies for their design process issues.

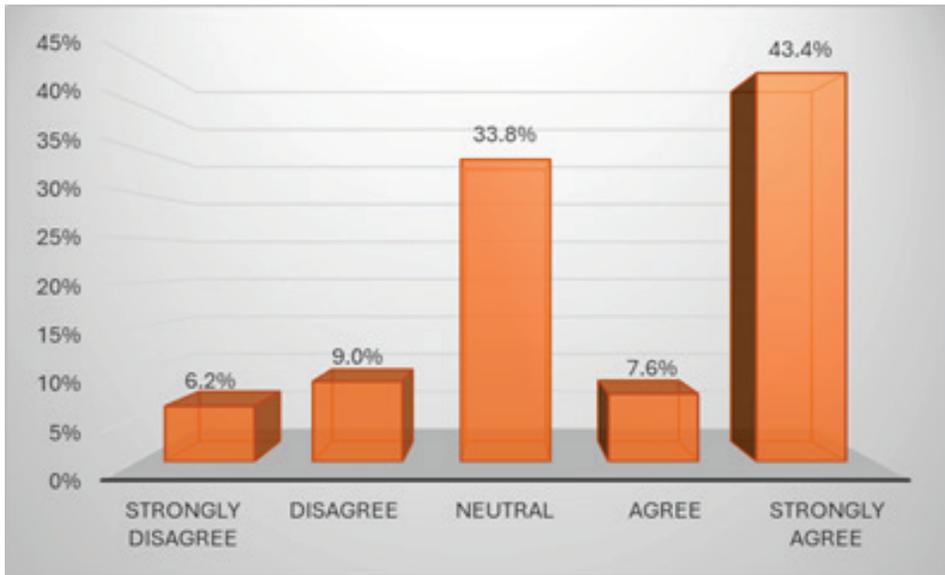


Figure 3. My e-tutor encourages students to use online technologies for learning

Source: Own work.

## Data Analysis

The results of the quantitative research aimed to identify differences and similarities by way of qualitative presentation. The analysis was based on each figure in comparison to other results of the same construct. The results together with the conclusions were compared to those which were available from the literature.

A single aim guided the arguments in this article, which were expanded utilizing three tables. Each of the three tables was built around a specific construct that dealt with a specific problematized issue related to the paper's goal of including TPK specificity.

Figure 1 was prepared as a result to determine the skill level of e-tutors' use of digital media for online assessment. Figure 1 shows that the percentage of those who strongly agreed or agreed was lower than half of those who strongly disagreed. The results lead to the conclusion that the e-tutors still could not use digital media for online assessment of the design process. Kastorff and Stegmann (2024) confirmed the results in Figure 1 with findings that the e-tutors' professional knowledge of TPK despite the integration of digital media for online assessment did

not influence the ICT literacy of the students for learning the content. Some more papers (Ma et al., 2021; Mutmainnah & Nurkamilah, 2021; Nguyen et al., 2022) support the findings in Figure 1 and provide additional insight into the goal stated in this study. Currently, Nguyen et al.,'s (2022) report revealed that the participants' TPK was at its lowest in comparison to other constructs under investigation, and Mutmainnah and Nurkamilah's (2021) report also revealed that teachers indicated that they needed development programs to improve their TPK because, while they use technology in their classrooms, they could not mention such technologies to conduct practical lessons during online learning. Furthermore, Ma et al.,'s (2021) study corroborated (Mutmainnah & Nurkamilah 2021; Nguyen et al., 2022) reports with the assertion that teachers lacked TPK, with the recommendation that teachers should be provided with regular professional development that focused on continuous online teaching capabilities.

A curricular study by Cheng et al., (2022) found that more participants demonstrated higher performance and confidence as a result of increased group cooperation, which led to an increase in TPK. The reports mentioned (Cheng et al., 2022; Ma et al., 2021; Mutmainnah & Nurkamilah, 2021; Nguyen et al., 2022) were less than positive resultant indicators' catalysts for this paper, but they did provide some direction on how the design process curriculum benefits from such engagements in various ODeL classrooms.

Figure 2 produced a report based on the finding that e-tutors had poor competence levels to encourage students to participate in online classroom platform conversations. This outcome was in line with what was published in the literature about TPK priority research.

The direct implications were seen with low TPK scores during learning. Results from Sun and Zhang (2024) indicated that online learning platforms posed comprehension and navigation challenges to some students, leading to them feeling excluded during the online learning process with the consequences of low TPK. A report by Radmehr and Goodchild (2022) indicated that teachers believed that greater emphasis should be placed on programs that nurtured how technology could be integrated into education to assist obstacles for students to experience and build their TPK. Simultaneously, Imaduddin and Astuti (2022) revealed that there was still a need for additional mentorship for instructors in the management of technology-based learning as well as the use of applications relevant to particular approaches during the mentoring activities. Lee and Ogawa (2021) found that lecturers believe their technology-related knowledge is not well-developed enough to combine with teaching during courses. In TPK research, several sets of less favourable outcomes were produced. One was from Wea and Budiraharjo (2022), who stated that the teacher participants in an English class felt less confident in her technological applications. The findings were supported in a previous study by Lee and Ogawa (2021), who found that some other participants were still unfamiliar with technology in workshops on how to create teaching breakout rooms. At the

same time, Tafazoli and Meihami (2022) found that teacher participants in teacher preparation programs needed TPK development so that they could develop critical skills that would allow them to use new and creative methods of teaching a course online more practically than theory-based methods. Studies (Lee & Ogawa, 2021; Tafazoli & Meihami 2022; Wea & Budiraharjo 2022) were supported by Ogalo et al., (2022), who found that teachers in the study were unaware of their TPK levels and lacked enough TPK for integrating ICTs into a course program. The few authors who made justifiable criticisms of their results in the TK domain were in line with the construct that was defined in Figure 2. It is reasonable to assume that the authors' conclusions about TPK outcomes are similar to what this section of the paper discovered.

Figure 3 shows submissions with favourable TPK domain results, with 51 percent of total respondents providing useful information on the construct. Based on the responses, it was determined that e-tutors outperform the average in terms of their ability to persuade students to adopt online technology for their design process issues. In study reports, more positive additional reports about TPK were acquired.

In the report from He et al., (2024) students were at a better chance to adopt gamification as an online tool from the encouragement of their e-tutors. The results improved learning performances in content with students who exhibited high scores in TPK. Further reports were recorded. According to the report by Alsayed et al., (2022), more survey respondents stated they could choose technology that supported and improved their teaching and learning process. Filho and Gitirana (2022) supported Alsayed et al., (2022) with their findings, which found that when teachers use technology to reinforce traditional practices, their students can perform procedures with technologies outside of the teachers' intervention, which increases the potential for TPK. Teachers' TPK was immediately and positively influenced by knowledge of Web 2.0 technologies and pedagogy contributed to developed new pedagogical practices with Web 2.0 technologies, according to Mohammad-Salehi and Vaez (2022) Dalili's study. Studies by Alsayed et al., (2022), (Filho & Gitirana, 2022), (Mohammad-Salehi & Vaez-Dalili, 2022) were corroborated by Ferdiansyah et al.,(2022), where it was reported that the TPK of students was at an average, indicating that the value was positive as a result At the same time, Hasanuddin et al., (2022) reported that the TPK of student teachers in a course was in a very good category in terms of how technology might affect a classroom's teaching style. In TPK research, several sets of less favourable outcomes were produced. Oikarinen et al., (2022) added to the evidence by stating that the students' TPK was at the greatest level for particular themes, confirming the e-tutors' active pedagogical role in instructing students with digital skills.

## Recommendations

### *Enhanced professional development programmes*

It is advised to put in place through frequent professional development programmes in light of the findings that the e-tutors have difficulty using digital media for online assessment. Enhancing the e-tutors' TPK, especially as it relates to online assessment procedures should be the main goal of such programmes.

### *Encouragement of e-tutor engagement*

TPK results and student outcomes may be enhanced by putting tactics into place to raise e-tutors' levels of interactions with students on online platforms.

### *Integration of collaborative learning:*

Promoting cooperative learning activities on online platforms may increase self-assurance and output which will increase the efficacy of e-tutors when they are teaching online.

### *Encourage creative pedagogical practices:*

More effective teaching practices may result in encouraging online e-tutors to investigate and apply innovative technology-integrated teaching strategies.

## Conclusion

The study undertaken aimed to examine the Technological Pedagogical Knowledge (TPK) of e-tutors during the facilitation of content in an Open and Distance e-Learning (ODeL) environment. The survey respondents provided insights that led to two key conclusions: E-tutors still struggled to effectively use digital media for online content evaluation. This suggests a gap in their understanding of how to leverage technology to enhance the learning experience. E-tutors did not fully comprehend the significance of TPK in their implementation practices for the given context. This meant that students were not provided adequate opportunities to actively participate in the creation of new knowledge during content learning, as per the constructivist approach that guided the study. The findings reveal a ripple effect, where e-tutors' lack of TPK in content facilitation negatively impacted the students' ability to benefit from distance learning. This implies that the students were not cognitively equipped to profit from the ODeL setting, as their e-tutors lacked the necessary digital teaching skills.

The study also highlighted a potential disparity in how students from different cohorts (practicing and learning) were supported in the curriculum. However, the findings did indicate that e-tutors were able to effectively encourage students to adopt online technologies for content learning, suggesting some positive aspects in their pedagogical approach. Overall, the study underscores the importance of enhancing e-tutors' TPK to ensure that students in ODeL environments can fully engage in the construction of new knowledge and benefit from the affordances of technology-enabled learning.

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Mpipo Zipporah Sedio

## **Zrozumienie i poziom pewności e-tutorów w korzystaniu z technologicznego modelu wiedzy pedagogicznej w otwartym e-learningu na odległość**

### Streszczenie

Artykuł miał na celu zbadanie perspektyw e-tutorów dotyczących znaczenia Wiedzy Technologiczno-Pedagogicznej (TPK) w Instytucji Kształcenia na Odległość (ODL). W artykule zastosowano metodę ankiety ilościowej, aby umożliwić studentom wyrażenie swoich opinii na temat tego, jak e-tutorzy wykorzystują swoją wiedzę fachową do przekazywania wiedzy. Badanie obejmuje 350 studentów zapisanych na moduł. Jego celem było uzyskanie wglądu, przy użyciu analizy ilościowej, w techniki stosowane przez e-tutorów w dostarczaniu treści. Podczas przekazywania treści e-tutorzy dostarczali wyjaśnień i wsparcia dla różnych punktów widzenia, uwzględniając opinie studentów na temat wyboru, wykonania i ogólnego wpływu metod nauczania. Zebrane dane zostały uporządkowane i przedstawione w tabelach. E-tutorzy podkreślali wykorzystanie TPK w celu wspierania i ulepszania działań studentów online. W związku z tym stwierdzono, że konstruktywizm może pomóc w włączeniu ram TPK, co z kolei zwiększa zrozumienie procesu projektowania instrukcji przez studentów. Jednak badanie wykazało brak zrozumienia wśród e-tutorów koncepcji TPK w odniesieniu do projektowania programu nauczania.

**Słowa kluczowe:** Wiedza Technologiczno-Pedagogiczna; Kształcenie na Odległość; e-tutorzy; konstruktywizm

Mpipo Zipporah Sedio

## **Comprensión y nivel de confianza de los tutores electrónicos en el uso de un modelo de conocimiento pedagógico tecnológico en el aprendizaje electrónico a distancia abierto**

### Resumen

El artículo tenía como objetivo investigar las perspectivas de los e-tutores respecto a la importancia del Conocimiento Pedagógico Tecnológico en una Institución de Aprendizaje a Distancia Abierta. El artículo emplea un método de encuesta cuantitativa para permitir a los estudiantes articular sus impresiones sobre cómo los e-tutores aprovechan su experiencia temática para impartir conocimiento. El estudio incluye 350 estudiantes que están inscritos en un módulo. Su objetivo era obtener una comprensión profunda, utilizando análisis cuantitativos, de las técnicas utilizadas por los e-tutores en la entrega de contenido. Durante la entrega del contenido, los e-tutores proporcionaron explicaciones y apoyo para diferentes puntos de vista, teniendo en cuenta las opiniones de los estudiantes sobre la elección, ejecución e impacto general de los métodos de enseñanza. Los datos recopilados se organizaron y presentaron en tablas. Los e-tutores reconocieron el uso del Conocimiento Pedagógico Tecnológico (CPT) para asistir y mejorar las actividades en línea de los estudiantes. Por lo tanto, se encontró que el constructivismo podría ayudar a incorporar el marco de CPT, mejorando así la comprensión de los estudiantes del proceso de diseño instruccional. Sin embargo, el estudio descubrió una falta de comprensión entre los e-tutores respecto al concepto de CPT en relación con el diseño del currículo.

Palabras clave: Conocimiento Pedagógico Tecnológico (CPT); Aprendizaje a Distancia Abierta (ADA); e-tutores; constructivismo

Мриво Ципора Седидо

**Понимание и уровень уверенности электронных преподавателей  
в использовании модели технолого-педагогических знаний  
в открытом дистанционном электронном обучении**

**Аннотация**

Статья нацелена на изучение точек зрения электронных репетиторов относительно важности технологических педагогических знаний в учреждении открытого дистанционного обучения. Статья использует количественный метод опроса для того, чтобы студенты могли выразить свои впечатления о том, как электронные репетиторы используют свою тематическую экспертизу для передачи знаний. Исследование включает 350 студентов, которые обучаются на модуле. Его целью было получение глубоких инсайтов с использованием количественного анализа в техниках, используемых э-тренерами при доставке контента. Во время доставки контента электронные репетиторы предоставляли объяснения и поддержку различным точкам зрения, учитывая вклад студентов в выбор, выполнение и общее влияние методов преподавания. Собранные данные были упорядочены и представлены в таблицах. Электронные репетиторы признали использование технологических педагогических знаний (ТПЗ) для помощи и улучшения онлайн-активностей студентов. Таким образом, было обнаружено, что конструктивизм может помочь в интеграции фреймворка ТПЗ, тем самым улучшая понимание студентов процесса конструктивизма. Однако исследование выявило недостаток понимания среди электронных репетиторов относительно концепции ТПЗ в контексте разработки учебных планов.

**Ключевые слова:** технологические и педагогические знания (ТПЗ); дистанционное обучение; электронные репетиторы; конструктивизм



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