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THE ROLE OF LEARNING TECHNOLOGIES IN ENHANCING EDUCATIONAL OUTCOMES

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Annotation. The purpose of the article *is to define gamification as a process of using learning apps for better learning educational material, analyze its potential applications in various academic fields.* ***Methodology of research.*** *The article focusing on the following research methods: critical analysis researchers' scientific papers, analytical analysis learning applications and synthesis insights for further exploration.* ***Findings****. The article presents outlines key data points focusing on revenue generation and user engagement across major educational apps on platforms that support AI-driven design and educational functionality.* ***Practical value.*** *Gamification can help to make learning more interesting for students or employees who want to know something knew.*

Keywords: *Learning technology, educational technology, game-based learning, interactive learning, apps, artificial intelligence.*

General statement of the problem and its connection with the most important scientific or practical tasks.. Gamification refers to the use of game design elements in non-game contexts, such as education, to motivate and enhance user engagement, learning, and problem-solving. In recent years, gamification has emerged as a powerful tool in educational settings, making learning experiences more interactive, engaging, and effective. When learners are involved in point-scoring, challenges, or leaderboards, they are more likely to stay focused and committed. This is especially effective in digital learning environments where attention spans can be limited. Gamification encourages exploration, experimentation, and interaction. It shifts the learning model from memorization to active problem-solving and decision-making, which leads to deeper understanding and retention. Gamified platforms often adapt to a learner's pace and skill level, providing tailored challenges that maintain a balance between difficulty and achievability. This personalization helps meet diverse learning needs. Multiplayer gamified experiences or classroom competitions foster teamwork and communication. Students learn not only from the content but also from each other through peer interaction. Despite the growing integration of digital technologies in education, maintaining learner engagement and improving knowledge retention remain significant challenges in both academic and corporate training environments. Traditional teaching methods good to learners but it should be with adaptive, interactive experiences necessary for effective learning. While gamification defined as the application of game design elements in non-game contexts. It offers a promising solution, its implementation in educational settings raises critical scientific questions regarding its actual effectiveness, optimal design strategies, and long-term impact on learning outcomes.

Analysis of recent research and publications. K. Chen et al. examine how gamification can serve as an effective tool for assessing procedural knowledge. Their research demonstrates that game-based systems are capable of evaluating students' understanding of sequential processes while offering a more engaging and adaptive alternative to traditional assessments [1].

In a related context, J. L. Cosquillo Chida et al. investigate the integration of gamification and artificial intelligence in the teaching of mathematics. Their findings suggest that AI-powered games enhance students' logical reasoning and critical thinking, particularly when dealing with abstract mathematical concepts [2].

Y. Marín et al. take a broader view by analyzing the use of artificial intelligence in higher education. They identify gamification as a central strategy for increasing student engagement, noting that AI-enhanced gamified platforms offer personalized and responsive learning experiences, particularly beneficial in large university settings [3].

In the context of early childhood education, L. Nurhakim explores gamification within Islamic schools. The study incorporates AI, the Internet of Things (IoT), and gamified tools, revealing improvements in attention span and content retention among young learners. These findings indicate that technologically supported gamification can be both culturally adaptable and educationally effective [4].

A. P. Tolentino et al. provide a broader evaluation of digital gamification in educational environments.

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They affirm its role in boosting motivation and participation but also warn of potential drawbacks, such as excessive reliance on extrinsic rewards. Their research stresses the importance of thoughtful instructional design to ensure that educational objectives remain intact [5].

Focusing on primary education in China, Z. Wu, H. Abdul Halim, and M. R. Mohd Saad evaluate a blended learning model that integrates AI and gamification. Their study shows that language and literacy outcomes improve significantly when gamified content is customized to individual student learning paths, underscoring the potential of adaptive learning technologies at the foundational level [6].

A. A. Yusri and M. Z. Zainal conducted a systematic review on the use of gamification in primary schools. Their synthesis highlights increased student engagement, better classroom behavior, and stronger conceptual understanding. However, they also point out regional inconsistencies in implementation and emphasize the need for standardized frameworks to guide gamification efforts [7].

M. Reiter provides a meta-analytical perspective on the motivational impact of gamification in education. The analysis reveals that elements such as point systems, leaderboards, and challenges can significantly enhance motivation, especially in subjects often perceived as uninteresting or difficult. Nevertheless, the study notes that maintaining long-term motivation depends on the careful alignment of game elements with curricular goals [8].

A. Kulik, O. Zeleniak, A. Chukhray, O. Prokhorov, O. Yashyna, O. Havrylenko, O. Yevdokymov, A. Torzhkov, O. Zayarnyi have developed and presented a prototype of an intelligent training system aimed at improving students' preparation for NMT. They highlight that the system's step-by-step problem-solving capabilities and diagnostic models allow for deep identification of student errors. The authors emphasize that AI-driven personalization can significantly enhance individual learning paths. The system can become an accessible and effective tool for strengthening mathematical competence among schoolchildren [9].

Previously unsolved parts selection of the general problem. The concept of gamification in education remains only partially addressed in current research and practice. There is a need for greater clarity in defining what constitutes gamification within educational contexts. Furthermore, it is essential to determine which platforms are most suitable for implementing gamified learning. An additional area requiring exploration is the integration of AI-powered applications and platforms to design effective educational games and tools for student engagement and learning.

Formation of the objectives of the article (task statement). The purpose of the article to clarify the definition of gamification within educational contexts, evaluate appropriate digital platforms for its implementation, and explore the potential of AI-powered technologies in the creation of engaging, effective learning games and applications. Through this analysis, the article aspires to contribute to a more coherent and actionable framework for integrating gamification into modern educational practices.

Presentation of the main research material with full justification of the scientific results obtained. The integration of digital technology has significantly transformed the landscape of education, shifting traditional pedagogical approaches toward more interactive, learner-centered methodologies. With the advent of tools such as Learning Management Systems, virtual classrooms, and educational mobile applications, learning has become more flexible, accessible, and tailored to individual needs. These platforms enable students to engage with content at their own pace and provide opportunities for remote and asynchronous learning, thereby extending educational access beyond geographical and temporal limitations.

Digital technologies collect and analyze real-time data on student performance and adjust the difficulty of material to match the student's progress, promoting more effective and personalized learning outcomes. Within this broader context of digital innovation, gamification has emerged as a particularly impactful strategy in educational environments.

Gamified learning environments typically include progression systems that track and reward advancement, instant feedback mechanisms that help learners correct mistakes in real-time, and recognition systems that acknowledge progress through rewards or status markers. These elements are designed to make learning more engaging and enjoyable, thereby increasing students' intrinsic motivation to participate and persist in their studies. Additionally, social features such as leaderboards or team challenges introduce healthy competition and collaboration, fostering social learning and peer interaction.

The use of gamification in education offers several pedagogical benefits. First, it significantly increases motivation and engagement, particularly in subjects that students may find difficult or abstract. The game-like structure encourages learners to take initiative and remain focused on their goals. Second, gamification promotes active learning by involving students in interactive problem-solving and goal-oriented tasks, which in turn enhances knowledge retention. Frequent repetition and the reward structure help embed content in long-term memory.

Moreover, gamified systems often support personalized learning paths by adapting content to suit individual learning styles and paces. Immediate feedback facilitates formative assessment and continuous improvement, allowing students to learn

from their mistakes without delay. Beyond cognitive benefits, gamification also helps develop essential soft skills such as critical thinking, communication, teamwork, and resilience, which are crucial in today's rapidly changing work environments.

Gamification presents a compelling approach to bridging the gap between student engagement and academic achievement. It aligns with the expectations of digital-native learners for interactivity, autonomy, and immediate feedback, while also supporting effective teaching practices. When implemented thoughtfully and purposefully, gamification has the potential to enhance both the quality and experience of education in meaningful ways.

Gamification is defined as the application of game design elements and principles in non-game contexts to enhance user engagement, motivation, and behavior. This approach involves transforming activities, systems, services, products, or organizational structures to provide experiences, skills, and practices similar to those afforded by games. In Computer Science, gamification has been applied to address complex computational problems. Its relevance is further demonstrated by its use in improving learning outcomes and facilitating behavior change through the incorporation of gameful affordances and motivational features. Since its emergence around 2010, gamification has experienced significant growth and popularity in both industry and academia. It is important to distinguish gamification from games and rewards programs; while games are designed primarily for entertainment, learning games help students to gain knew knowledge.

Fundamental components of gamification in include points, which quantify user progression and improvement; badges and achievements, which serve as virtual symbols rewarding achievements; leaderboards, which visualize user achievements and standings; levels, which indicate goal accomplishment and confer status; challenges and quests, which motivate users to complete tasks; feedback loops, which provide users with measurements of progress; social connectivity, which promotes collaboration; and onboarding, which uses interactive tutorials to familiarize users.

Game mechanics refer to the rules, tools, and features that structure the gamified experience, such as points, levels, badges, and challenges, while game dynamics describe the interactions and emotional responses of players to these mechanics, including competition, achievement.

Motivational theories underpinning gamification include self-determination theory, which posits that motivation is driven by autonomy, competence, and relatedness, and distinguishes between intrinsic motivation (engaging in activities for their own sake) and extrinsic motivation (engaging for external rewards).

Gamification is widely applied in education and e-learning to teach, including fundamental concepts, computational thinking, and algorithmic programming. Empirical studies have shown that gamification in programming courses can increase students' interest and facilitate learning. Gamified platforms such as Duolingo, Kahoot! Classcraft, Talent and Moodle LMS have been reported to positively affect students' learning interest, knowledge acquisition, and understanding of scientific concepts.

Using platforms such as Duolingo, Kahoot!, Classcraft, and Talent and Moodle LMS in the educational and learning process provides a range of academic benefits rooted in pedagogical theory and practice. Duolingo supports language acquisition through gamification, spaced repetition, and immediate feedback, which are all well-established in cognitive psychology as effective methods for enhancing retention and motivation. It allows learners to practice at their own pace, supporting differentiated instruction and promoting autonomous learning.

Kahoot! enhances formative assessment and classroom engagement through real-time quizzes and interactive activities. The use of game-based learning in Kahoot! increases student motivation, encourages active participation, and helps educators identify knowledge gaps in a non-threatening and dynamic environment. It also fosters peer learning and competition, which can increase intrinsic motivation and recall.

Classcraft introduces elements of role-playing games into classroom management and instruction, transforming behavior management and teamwork into collaborative challenges. By aligning learning goals with game mechanics, Classcraft supports the development of soft skills such as communication, collaboration, and self-regulation, while also promoting a positive classroom culture. Its integration of rewards and consequences helps maintain student engagement and accountability.

Talent and Moodle LMS serves as a robust learning management system that supports blended and fully online learning environments. It facilitates structured content delivery, progress tracking, and personalized learning paths. Academically, it allows educators to create modular learning experiences, incorporate multimedia resources, and assess learner performance using diverse methods. Talent and MoodleLMS supports asynchronous learning, which enhances accessibility and allows learners to revisit material as needed, thereby supporting mastery learning.

NetMarvel discusses the rapid growth and evolving trends in the global educational mobile app market, particularly influenced by the integration of artificial intelligence (AI) and the expansion into overseas markets. [10]

The global online education market has experienced substantial growth, especially during

the pandemic, with the market size reaching $166.5 billion in 2023. In the mobile app sector, the market size has also steadily increased, with leading products like Duolingo seeing their annual revenue rise from $36 million in 2018 to $531 million in 2023, marking a compound annual growth rate (CAGR) of over 70% [10] (Fig. 1).

In 2023, Duolingo stands out with a dominant revenue of $316 million, far surpassing its competitors. Babbel follows but at a significantly lower figure of $56 million, indicating Duolingo's strong market presence and user base. Moodle LMS and ClassDojo have revenues close to $50 million and $29 million, respectively, suggesting moderate adoption but not at the scale of Duolingo or Babbel. Lingokids and ABC Mouse generate similar revenues around $23-27 million, catering likely to younger audiences or niche educational needs. Udemy and Photomath, with revenues around $20 million, show solid footholds, possibly benefiting from diverse course offerings or specialized educational tools. Classcraft, at $10 million, earns the least, which might reflect its more niche or emerging market status. Overall, Duolingo captures a large percentage of total revenue in this sector, highlighting its leadership, while the rest of the apps share a much smaller portion of the market.

In 2023, Duolingo leads with 500 million registered users, showing its widespread popularity and accessibility across many languages and regions. Brainly follows closely with 400 million users, reflecting its strong position as a collaborative learning platform where students help each other. Coursera and Khan Academy have significantly fewer users only 128 million and 120 million, respectively but these numbers still indicate their importance as providers of more structured, often higher-education-focused content. Busuu and Mondly, both at around 100 million users, highlight solid engagement in language learning, likely benefiting from user-friendly apps and interactive features. Kahoot and Talent LMS have smaller user bases, 24 million and 22 million respectively, possibly due to their more specialized use cases in gamified learning and corporate or institutional training. The large user numbers for Duolingo and Brainly suggest broad appeal and easy entry, while the others tend to serve more targeted educational needs or niche markets (Fig. 2).

Together, these platforms exemplify how technology can enrich instructional practices by making learning more interactive and personalized.

However, some studies note that excessive game elements may distract from actual programming learning, highlighting the need for balanced instructional design. Reasoning strategy games are most effective for academic achievement, while puzzle games best enhance motivation.

In education and professional development, gamification is used to motivate students and practitioners to conform to desired behaviors, such as more frequent use of specific tools, acquiring habits for professional software development, and participating in classroom or collaborative activities. Game elements such as points, levels, and leaderboards are commonly employed to encourage desired behaviors, increase tool usage, and foster participation.

Artificial intelligence (AI) driven virtual agents can assist users with solving problems and achieving computer-mediated tasks, and gamification has been explored to support human-computer cooperation, with some evidence of increased engagement

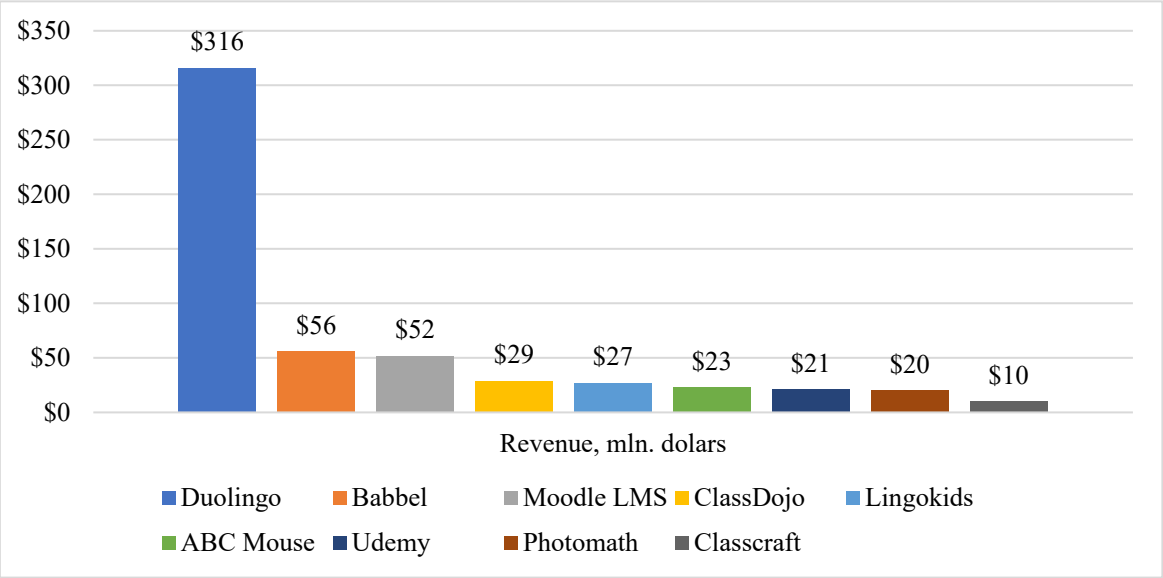


Figure 1. Education annual revenues by app, mln. dolars in 2023

Sourse: [10]

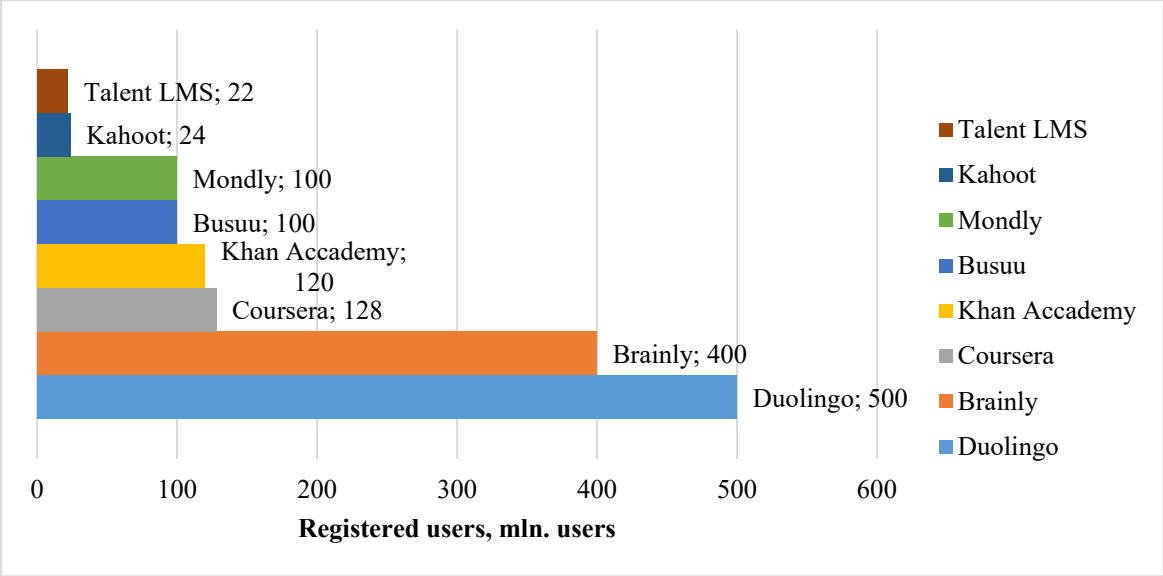


Figure 2. Education registered users by app, mln. users in 2023

Sourse: [10]

in cooperative activity and initial adoption of cooperative gamified systems.

The integration of artificial intelligence into game-based educational environments presents significant opportunities for democratizing educational game development, particularly for users without programming expertise. AI technologies, especially those involving natural language processing, machine learning, and generative design, can be employed to automate various aspects of game creation, including narrative generation, rule-based logic, and user interaction design. This automation enables educators and instructional designers to focus on pedagogical content rather than technical implementation, fostering wider participation in educational game development.

AI-driven platforms can facilitate the creation of adaptive learning experiences by analyzing learner behavior and dynamically adjusting game elements to optimize engagement and knowledge retention. Such systems can also personalize content delivery based on learner profiles, thereby enhancing learning outcomes through tailored educational experiences. Additionally, AI tools can support rapid prototyping by generating game assets such as characters, environments, and dialogue, significantly reducing development time and resource constraints.

Previous gamification research in fields such as education and training has shown that gameful solutions are particularly effective in conveying knowledge and supporting learning, and design aspects from games can afford opportunities for satisfying intrinsic human needs such as competence, achievement, autonomy, or being meaningfully connected with others.

Elements such as multiplayer competition, rankings, and rewards serve as motivations for volunteers in specific citizen science projects, such as Foldit, where players apply problem-solving skills to scientific data.

Designing effective gamification systems in Computer Science requires addressing user diversity and personalization. Tailored gamification, which utilizes techniques such as user modeling and adaptation, has recently emerged to provide individualized experiences corresponding to personal preferences. However, there is little indication of adaptive mechanisms that cultivate cooperation, highlighting the need for future research to explore mechanisms of adaptive or tailored gamification to accommodate different user needs and motives for cooperation in a system.

Quantitative evaluation of gamification effectiveness commonly involves metrics such as time-related performance variables and the number of badges, points, or leaderboard positions, which are frequently examined in empirical studies. Qualitative assessments include enjoyment or fun, usefulness or effectiveness, and experiencesor attitudes, often measured through instruments developed for specific studies, though there is little consistency across measurement tools.

Conclusions from these problems and prospects for further research in this area. Gamification in education, presents as a dynamic approach to enhancing student engagement, motivation, and learning outcomes across a variety of educational settings. Gamification, while broadly understood as the application of game design elements in non-game contexts, requires a more precise definition

when applied to learning environments. It is not merely about entertainment or competition, but rather about leveraging structured game mechanics and dynamics—such as points, levels, badges, feedback, and challenges—to create more interactive and immersive educational experiences that foster active learning, self-regulation, and sustained attention.It enhances knowledge retention through immediate feedback and repeated practice, and motivates learners through personalized challenges and rewards. By aligning game mechanics with learning objectives, lecturers can improve both cognitive outcomes and the development of essential soft skills like collaboration, communication, and critical thinking.

The analysis of widely adopted platforms such as Duolingo, Kahoot!, Classcraft, and Moodle LMS demonstrates the practical value of gamified systems. These platforms illustrate how gamification can be tailored to different learning contexts, whether language acquisition, formative assessment, classroom behavior management, or digital content delivery. Duolingo, in particular, stands out due to its large user base and market share, reflecting its success in combining gamified learning with accessibility and ease of use. Gamification, when thoughtfully implemented and supported by emerging technologies such as AI, offers a powerful response to enduring challenges in education, particularly those related to student engagement, individualized learning. By moving beyond superficial game elements toward intentional, sound design, educators and researchers can harness gamification to foster deeper learning and more meaningful educational experiences.

The future of gamified education lies in interdisciplinary collaboration among educators, computer scientists, and instructional designers to co-create learning environments that are not only engaging and enjoyable, but also equitable and effective.

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Хілуха О. А., *Луцький національний технічний університет.* ***Роль навчальних технологій у розвитку освітнього процесу.***

Анотація. *У цій статті розглядається проблема використання навчальних додатків, в тому числі у вигляді комп'ютерної гри чи гри у смартфоні в освіті.* ***Метою статті*** *є визначення потреби використання навчальних додатків для кращого засвоєння навчального матеріалу і аналіз їх потенційного застосування в різних сферах освітнього процесу.* ***Методика дослідження****. Досягнення поставленої у статті мети здійснено за допомогою таких методів дослідження: критичний аналіз праць вчених, аналітичний аналіз навчальних додатків і синтез наукових поглядів для подальших досліджень.* ***Результати.*** *Пропонуються впровадження інтерактивних методів та технологій навчання: завдяки включенню таких елементів, як бали, значки, таблиці лідерів та виклики, відбувається перетворення традиційного навчання на більш інтерактивний та корисний досвід. У статті також висвітлюються провідні гейміфіковані платформи, включаючи Duolingo, Kahoot! Classcraft та TalentLMS, демонструються приклади застосування таких*

платформ як в академічних, так і в корпоративних організаціях. У статті проаналізовано доходи та кількість користувачів ринку великих освітніх додатків, що використовують ігри як метод навчання. Такий ринок стрімко зростає. У статті зазначається, що за допомогою інструментів на базі штучного інтелекту користувачі можуть автоматично створювати навчальні додатки на платформах, які підтримують дизайн на основі штучного інтелекту та освітні функції. Навчальні технології полягають не в тому, щоб зробити освіту грою, а в тому, щоб зробити навчання ефективнішим, використовуючи найкращі можливості ігор для мотивації, прогресу з використанням зворотного зв'язку. ***Практичне значення результатів дослідження.*** *Незалежно від того, чи працівник обіймає посаду викладача, який прагне підвищити рівень знань умінь і навичок студентів, бізнес-лідер чи менеджер, який навчає свою команду, гейміфікація може допомогти зацікавити студентів та персонал, який постійно навчається новому.*

Ключові слова: *технології навчання, освітні технології, ігрове навчання, інтерактивне навчання, додатки, штучний інтелект.*

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