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Digital Game-Based Learning's (DGBL) Effect on Students' Academic Performance

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Abstract: Digital game-based learning (DGBL) has redefined education in recent years. Instead of replacing conventional methods of instruction, the aim is to make learning more complex and adapted to how students really engage with the modern world. This study aims to collect data that will assist educators, students, legislators, and creators of digital games in recognizing the value of the DGBL approach to education. Together, they may enhance and modify these approaches to better suit students' requirements and enhance their academic performance. The study's conclusions may significantly affect future applications of digital educational games in educational settings. Since they could offer a deeper comprehension that would enable students' benefit from personalized instruction through artificial intelligence (AI), while at the same time using immersive technologies would increase students' involvement, interest, and motivation for learning in a virtual environment. A questionnaire was emailed to 328 students at all three study levels, as well as faculty and administrative personnel from Megatrend University in Belgrade, who took part in the study. According to the findings, participants believe that a) if digital games and educational content are combined in learning, students are more likely to increase their learning efficiency in this way; b) if a digital game-based learning (DGBL) approach provides a dynamic and engaging learning environment, it is more likely to increase student motivation and participation in the learning process; c) if digital game-based learning (DGBL) includes rewards, feedback, and competition, there is greater potential to significantly improve student learning outcomes; d) if digital game-based learning (DGBL) is supported by artificial intelligence (AI), which enables personalization, the learning is more likely to dynamically adapt to each student's performance.

Keywords: *Digital Game-Based Learning (DGBL), digital games, students, Artificial Intelligence (AI), personalized learning, immersive technologies.*

Introduction

The most common computer activity at home for children and adolescents is playing computer games (Harris, 2002). Digital games have a significant impact on young people's lives by generating a strong sense of excitement and connection (Kirriemuir and McFarlane, 2004). A vast selection of games and instructional apps are continuously being updated on the mobile market. As a result, youth encounter a multitude of educational programs that provide various approaches to comprehension, instruction, and the integration of information, science, math, and artistic creativity (Liao et al., 2019). Statistics on the global game-based learning industry income show that this market has expanded from 3.5 billion USD in 2018 to 24 billion USD in 2024 (Clement, 2021). This market is anticipated to develop at an exponential rate during the next years. At a compound annual growth rate (CAGR) of more than 27%, it will reach nearly $55 billion in 2029 (Thebusinessresearchcompany, 2025).

Students' social conduct and academic performance have been found to be impacted by digital gaming (Rahayu, 2021). According to the National School Boards Association (NSBA), students who join esports programs have better attendance (+10%) and grades than their peers who do not participate in esports (Intenta.digital, 2021). From a theoretical standpoint, there are a number of benefits to using games for education. First of all, games can offer problem-based, active, and multisensory learning. Gamers may engage with wider communities in game worlds and receive responses instantly. Last but not least,

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games can offer score-based self-evaluation (Chen et al., 2018). Research indicates that using games in the classroom has a good impact on learning and can effectively raise achievement (Chen et al., 2018). Playing games improves visual-spatial abilities, which are helpful in engineering and science (Din and Calao, 2001). Educational digital games are more than just teaching tools. Modern games offer students a dynamic learning platform by simulating real-world scenarios, problems, and settings (Sheehy et al., 2014). By engaging in learning-by-doing activities, students may combine their new knowledge with their prior knowledge and experiences. This integrity helps them learn more effectively (Pitarch, 2018).

Digital educational games are computer programs that mimic real-world situations to provide an engaging learning environment (Kapp, 2014). The "stimulus-response" theory, another name for behaviorist theory, is used in digital educational games. These games gradually provide clues from simple to complicated, offering students a variety of learning opportunities at varying levels of difficulty. Scores that serve as feedback encourage students to meet the instructor's expected response by acting as a stimulant (Fokides, 2018). Digital games are advantageous due to their multimodal nature, variety in terms of the authentic environments and experiences they can replicate, autonomy, feedback and reward systems, scaling of difficulty and progression, chances for experimentation, and alignment with constructivist learning theories (Yu et al., 2021). Digital games and educational content are combined in digital game-based learning (DGBL) to pique students' attention and give them the chance to improve the efficacy of their learning. Students consequently have a favorable lifelong perspective on education and information (Cheng et al., 2013). Digital games can assist in molding students' emotions and behaviors by positively impacting their perceptions of control and benefit, as well as their affective and behavioral components. Actually, the goal is to entertain the students and encourage both behavioral and emotional engagement in the activities (Sarıgöz et al., 2018). Furthermore, games may improve students' capacity for problem-solving and analysis as well as their social abilities (Kirikkaya et al., 2010).

Although different scholars may have different definitions of DGBL, most of them concur that it offers a motivating learning environment to improve student performance by utilizing the benefits of digital games (Byun and Joung, 2018). Numerous studies have demonstrated the beneficial effects of DGBL on a wide range of student learning outcomes, including information acquisition, cognitive and perceptual abilities, affective and motivational outcomes, and behavior modification outcomes (Hussein et al., 2022). According to a study by Li et al., students who played educational digital games showed greater motivation to learn. Therefore, these games can be viewed as "stimuli" that have the potential to enhance students' motivation for learning (Li et al., 2024). A major move toward more effective, individualized, and interesting learning experiences is represented by the incorporation of 3D games, virtual worlds, and cutting-edge AI into the classroom. Teachers can construct immersive learning environments that catch students' attention and promote a deeper comprehension of difficult subjects by strategically organizing instructional content around potent gaming dynamics and utilizing the most recent technological breakthroughs (Axon Park, 2024). With technology playing a key part in changing students' learning, the future of DGBL is becoming increasingly fascinating. AI-driven personalization is one of the most exciting developments. In this approach, learning is dynamically tailored to each student's performance and learning preferences, making learning more interesting and enhancing retention as it goes (Paradisosolutions, 2025).

The consistent and repetitive use of the Internet to play games with other players on a regular basis is known as digital game addiction, and it can have detrimental effects on many facets of life. Since gaming is now easily accessible on a wide range of devices thanks to recent technology advancements, digital game addiction has grown in frequency and severity as a major public health concern (Mohammad et al., 2023). Mental tension, poor academic performance, insomnia, suicidal thoughts, a decline in sociability and self-efficacy, and a drop in life satisfaction are all consequences of gaming. The negative effects of excessive gaming extend to a person's emotional, mental, and physical health (Mardian and Hastono, 2019). Due to students' neglect of healthy food and sleeping patterns, digital gaming addiction has had a negative impact on their health. When students spend too much time playing online games, they become distracted and may engage in harmful behaviors like gambling, stealing, threatening others, or even considering suicide (Hanafie and Makassar, 2022). The usage of digital education-based games in communities and schools has grown in popularity in recent years; however, this has also caused families to worry about the creation of uncertainties over the detrimental effects of these games on youth (Konok et al., 2021). Notwithstanding all of the benefits, some experts think that educational games may worsen motor skills, develop addiction, and raise hostility. To better understand how and what factors influence children's use of digital

games, the majority of researchers have called for additional research (Lazarinis et al., 2020).

Literature review

The range of genres and topic areas in which game-based learning is used can make its definition difficult to define. Nevertheless, game-based learning (GBL) can be thought of as a way to improve students' learning experiences by integrating games with course objectives (Roodt and Ryklief, 2019). Using digital games as teaching tools to accomplish learning objectives is known as digital game-based learning (DGBL) (Prensky, 2001). By introducing competitive processes, accomplishment systems, and reward mechanisms, digital game-based learning (DGBL) offers students demanding, dynamic, and engaging learning environments that greatly increase students' motivation and participation in the learning process (Chen et al., 2018).

According to research, DGBL can be more successful than traditional approaches in a number of subject areas, such as math instruction, foreign language learning, science study, and healthcare (Gentry et al., 2019). Virtual characters, challenges, quests, awards, avatars, and other well-designed game features are what make DGBL so appealing, engaging, and inspiring (Abdul Jabbar and Felicia, 2015). According to research in the literature, students' motivation, engagement, attitude, and focus can all be improved by effective game design and planning for digital game-based learning (Cai et al., 2022). Because digital games offer more depth in terms of gameplay and storyline, it is crucial to remember that they are more sophisticated than simple drill/practice games (Ertmer et al., 2012). Simulations that aim to capture the intricacy of real-life circumstances can be found in this kind of game. As an alternative, they can present fictitious or even fantastical situations to encourage involvement and immersion with gripping stories. They have been created to reflect real-life circumstances and to fulfill instructional objectives and key end purposes (Kapp, 2014).

Research indicates that when game-based learning was used, students spent 93% of class time on task, compared to 72% when it wasn't (Nisbet, 2024). As an indicator of engagement, 81% of students reported having fun while performing game-based activities during the summer semester, according to a study done a few years ago by de Carvalho et al. (de Carvalho et al., 2016). By providing students with instant feedback, games are supposed to help young people enjoy learning, increase their self-esteem, creativity, and imagination, and guide them to the right knowledge (Gurpinar, 2017). Educational games are a learner-centered approach that motivates students, makes instruction more efficient and pleasurable, and allows them to have fun (Boghian et al., 2019). Predetermined rules and objectives, quick feedback on students' activities, and a gradually increasing degree of difficulty are all important components of DGBL environments (Mayer and Johnson, 2010). The results of numerous researches show that adding rewards, feedback, and competition to DGBL can greatly enhance learning (Yang et al., 2022). Learners' critical thinking skills are enhanced via game-based learning, as well. When playing a game with others, students must cooperate and exchange ideas. Because of this, students must listen to and consider the opinions of other students before choosing their next move (Mao et al., 2022). Processes that let students take control of their own education are included in DGBL. When learners receive immediate feedback in the game regarding their knowledge gaps, they are immediately assigned game activities to help fill up these areas that are thought to need more practice (Harding, 2023). In these games, students must complete challenging activities in a set amount of time to receive points. More points are awarded for quicker completion times, and points can be redeemed for exclusive incentives, encouraging students to take charge of their education. Additionally, the digital gaming system shows the names of students who perform well, fostering a sense of accomplishment that encourages good behavior like paying attention in class (Fokides, 2018). According to O'Donovan et al., DGBL leaderboards would encourage competition and a sense of community among like-minded groups (O'Donovan et al., 2013). When their points are displayed on the scoreboard, learners feel motivated to improve (Alhebshi and Halabi, 2020). Students will continue to replay the game in order to enhance their performance, which will improve their learning performance (Behnamnia et al., 2020). Additionally, when students see that their peers have won specific game aspects or have attained a high ranking on the leaderboard, they could try harder to do better in games (Huang and Hew, 2018).

The following are just a few of the many examples of game-based educational platforms that aim to boost student engagement and productivity by integrating gaming components into the training approach. Incorporating game-based learning into educational environments was pioneered by platforms "Blooket"

and "Gimkit." To increase player involvement, they provide a range of game modes. Educators can use Blooket's variety of gaming possibilities to make learning engaging and dynamic. However, Gimkit has a special feature called an in-game economy that allows students to earn points and spend them to buy improvements, creating a fun and competitive learning environment (Miller, 2024). A game-based learning platform called "SC Training" incorporates various engagement components to help students improve their course completion rates while guaranteeing a productive learning environment. This application has an integrated writing tool with interactive templates such as true or false, letter jumble, image/word match, and many more (Bariuad, 2022). Students who successfully complete drill-and-kill grammar and vocabulary activities on the app "Duolingo" earn experience points that may be used to advance to more challenging exercises, gamifying language learning. Students can make their own avatars and inhabit a 3D environment in "Second Life," a virtual reality that can facilitate text communication and lessen speech anxiety (Uwaterloo, 2024). A version of Minecraft called "Minecraft Education" was created specifically for classroom instruction. This edition is educational for students of all ages. Teachers can use the materials they have in-game to make their own lesson plans. Furthermore, a number of lesson plans covering a wide range of topics, including language arts, physics, history and culture, computer science, art and design, and math, are now available (Minecraft, 2025). In order to engage and inspire students to learn science, "Alien Rescue" combines gaming aspects, play, and authenticity to create a lighthearted experience with a purposefully problem-based narrative. Students are asked to participate in an urgent United Nations rescue expedition to save the distraught aliens in the open-ended game scenario, which puts them in the role of young scientists. Through a 3D immersive, sensory-rich method, a playful fantasy experience is combined with this genuine scientific investigation process (Lee and Liu, 2017). Designing gamified content for microlearning is made possible by "Centrical," a powerful gamification training tool. To assist players in adopting the proper behaviors, practicing skills in a risk-free virtual environment, and improving the general knowledge and abilities they require, the platform lets users create narrative mission-based games, set up prize tournaments, or tailor learning challenges (Bariuad, 2022).

A 2023 study that involved 69 students learning English as a second language tested vocabulary acquisition abilities using "Quizziz," a DGBL tool. Students were divided into two groups for this study: the experimental group practiced vocabulary using Quizziz, while the control group practiced vocabulary in their mother tongue. The experimental group did noticeably better than the control group, according to the data, proving the value of DGBL (Nisbet, 2024). Anderson et al. conducted a study to examine the effect of failure in learning by examining the gaming habits and discussions of 88 middle school students who were playing the educational video game "Virulent." They discovered that players learned more effectively when they worked together, with more accomplished players sharing their techniques with less successful peers (Anderson et al., 2018). According to Khan et al., students are more engaged when instructional design is oriented toward DGBL (Khan et al., 2017). A study by Yurdaarmagan et al. demonstrated that, in contrast to the conventional method, students' academic success is increased when using a DGBL approach. Students (a total of 152) were split up into two groups for their research. While the first group received a standard teacher's lecture, the second group engaged in game-based learning in a laboratory setting. The results of the study demonstrated that the two groups' test scores differed significantly, with the group that engaged in game-based learning in a lab obtaining, on average, 10% higher scores (Yurdaarmagan et al., 2015). Chen et al. investigated the efficacy of digital game-based vocabulary learning in a meta-analysis study. To examine the data from a few chosen studies, they employed Comprehensive Meta-Analysis Version 3. The data gave them an approximation of how well language learning was impacted by DGBL, and it revealed that study participants' vocabulary acquisition had increased (Chen et al., 2018). US students who participated in DGBL and the effect this approach had on their academic performance were examined in a study by Liu et al. The digital game "Alien Rescue," was utilized with the 220 students who took part in the study for three weeks during their regular science class. Throughout the study, a science knowledge test was used to evaluate the learning performance of the students. Participants in the study took the test both before and after playing the digital game. The test results revealed a notable rise in the percentage of right answers (over 80%) in comparison to the results obtained prior to the use of the digital game (around 50%). In this specific study, the results showed that participants who used DGBL significantly increased their scientific knowledge (Liu et al., 2011).

However, there are drawbacks to DGBL as well. These are mainly reflected in the fact that these games require time to learn and play correctly, occasionally require additional, costly materials, and some-

times call for pedagogical and technical support, which naturally calls for more resources (Discoverdigital, 2020). DGBL can be very entertaining and motivating, but it can also be distracting. A clear expectation for learning time must be established with students because some may find the desire to continue playing the game too strong (Harding, 2023). Time, money, and technological resources might not be easily accessible in some educational settings. Furthermore, game distractions can occasionally occur if they are not properly monitored and controlled. Lastly, game-based learning is not a good way to teach every subject or skill. Using games to communicate abstract or difficult concepts could be tough (Callahan, 2024). Another problem that arises with DGBL, but also with playing all digital games in general, is the threat to players' cybersecurity. The following are some of the most frequent cybersecurity threats that students encounter when playing digital games: a) Phishing attacks, in which hackers obtain user credentials. By doing this, an attacker can obtain valuable in-game elements that they can either keep for themselves or sell on the black market; b) A data breach as an attack on the gaming corporation whose systems may include a variety of sensitive data. Personally identifiable information (PII), such as the player's name, address, and credit card information, is often owned by a gaming company. The sites might be targeted by cybercriminals who want to steal data to resell on the dark web or utilize in future assaults; c) To obtain access to user accounts, another popular cyberattack is credential stuffing. The attacker in this instance is making use of weak passwords, which is a frequent issue (Behnke, 2023).

When it comes to learning, artificial intelligence-enabled game-based learning establishes a new paradigm in which the younger generation uses digital technology, including mobile or ubiquitous gadgets (Chen et al., 2022). The role of AI in digital games in education was conceptualized by McLaren and Nguyen in two ways: as games that use AI to function and interact with players and as games that have been created and/or expanded using AI techniques (McLaren and Nguyen, 2023). Scholars have been attracted to the argument that AI applications can enhance adaptability in game-based learning. Personalization, game difficulty balancing, assessment, player analytics, competence modeling, social gamification, language technologies, and emotional computing are just a few of the AI-based features covered by the game design elements that enable learning (Westera et al., 2020). Motivation and engagement, two essential components of effective gamification, can be greatly increased by this personalized approach (Parody et al., 2022). Researchers have discovered that AI-powered chatbots can improve learners' emotional, behavioral, and metacognitive awareness in virtual reality gaming learning environments (Liang et al., 2024). Also, DGBLs are important data sources for AI training, which aims to improve individualized experiences and get a deeper knowledge of learners. The majority of current efforts focus on using digital games to train AI algorithms by taking advantage of the organized progression that is a feature of game design (Silver et al., 2017). In AI-driven DGBL, feedback can be considered an affordance that extends beyond conventional evaluations. Both educators and students can get current and pertinent information through this dynamic and ongoing process. By highlighting not only the informative aspect of identifying potential student misunderstandings but, more importantly, by generating feedback that is practical and encourages a cycle of continuous development, this particular affordance may enhance the quality of feedback given (Romero et al., 2024). To guarantee that AI-driven adaptations continuously serve educational purposes, it is imperative to make sure that game mechanics are in line with learning objectives. This alignment becomes more complicated with AI and calls for careful design (Kingsley and Grabner-Hagen, 2015). The use of AI in education does, however, present some serious difficulties. Careful thought must be given to data privacy and AI bias concerns (Wang et al., 2024). Despite the undeniable benefits that DGLB's application of AI provides to the field of education, extra care must be taken in the near future to safeguard students' cybersecurity. In any event, more precise legislation must be passed at the state level, and those who engage in such illicit cyber activity must be suitably identified and prosecuted (Baltezarević and Baltezarević, 2021). However, the dilemma comes from the potential that resolving security issues could jeopardize privacy protection (Baltezarević and Baltezarević, 2015).

Game-based learning's remarkable effect on students is largely due to its seamless integration with cutting-edge technology like augmented reality (AR) and virtual reality (VR). This tasteful combination improves the educational process overall and opens up new avenues for student participation and interaction (Sharma, 2023). The virtual reality (VR) and generative artificial intelligence (AI) technologies were used to build the immersive game-based learning platform known as "LearningverseVR." Using a shared computer and webcam, this platform offers an immersive learning environment where students may take on the role of avatars to interact with virtual items and other avatars. They can also utilize unique collabo-

ration tools to build activities (Song et al., 2024). Research is still being conducted, but a number of case studies have shown how effective these tools are in classrooms. In science classes, for instance, virtual labs let students perform experiments in a secure environment, and historical reconstruction games let players immerse themselves in past cultures. In addition to enhancing students' comprehension, these experiences pique their interest and cultivate a passion for learning (Axon Park, 2024).

Objective of the research

This study examines how students' academic performance is impacted by digital game-based learning (DGBL).

One main and three supporting hypotheses were developed in order to fulfill the research's objective:

H_0: If digital games and educational content are combined in learning, students are more likely to increase their learning efficiency in this way.
H_1: If a digital game-based learning (DGBL) approach provides a dynamic and engaging learning environment, it is more likely to increase student motivation and participation in the learning process.
H_2: If digital game-based learning (DGBL) includes rewards, feedback, and competition, there is greater potential to significantly improve student learning outcomes.
H_3: If digital game-based learning (DGBL) is supported by artificial intelligence (AI), which enables personalization, the learning is more likely to dynamically adapt to each student's performance.

Materials and Methods

Pattern and procedure

With a disclaimer that the study is being carried out solely for scientific purposes, the questionnaire used to assess participant attitudes was sent to 350 email addresses belonging to students at all three study levels, as well as to professors and administrative staff of a Megatrend University in the Republic of Serbia. A total of 328 accurately and completely filled questionnaires comprise the sample that served as the basis for the research, namely: 186 (56.7%) male and 142 (43.3%) female (M=1.43, SD=.496), of which 8 (2.4%) with elementary school, 98 (29.9%) with secondary school, 136 (41.5%) completed high school/college, 67 (20.4%) completed master's degree, and 19 (5.8%) completed doctorate (M=2.97, SD=0.913). The age-related structure of the respondents demonstrates that 114 (34.8%) were aged 26-35, 76 (23.2%) were aged 18-25, 68 (20.7%) were aged 46-55, 55 (16.8%) were aged 36-45, and 15 (4.6%) were aged 56-65 (M=2.49, SD=1.186) participated in the research.

In order to ascertain the respondents' socio-demographic characteristics, the questionnaire was designed with three questions: gender, age, and professional qualifications. After that, 15 statements were created to investigate the responses from participants regarding the application of digital game-based learning (DGBL) in educational settings. A software program for data processing and analysis (IBM SPSS Statistics) was used to process the data. The analysis of the gathered data was done using descriptive statistics (average value, or M, and standard deviation, or SD) and statistical inference. To assess the obtained values of Spearman's rank correlation coefficient rho and Pearson's correlation r, we used a value scale that states that a correlation is weak when $r \geq 0.1$, moderately strong when $r \geq 0.3$, and strong when $r \geq 0.5$ (Field, 2009, p. 100).

Instruments

For further research on the specific research assignment described in this paper, eight variables out of a total of fifteen were selected, and a subscale was created from them. The reliability of the scale was measured by Cronbach's alpha coefficient, which showed that $\alpha = .913$. The mean values of the subscale range from 2.72 to 3.44., which shows a high value of the internal consistency of the scale (Briggs and Cheek, 1986, p.115).

The analysis employed correlation analysis, scale reliability analysis, and descriptive statistics.

A Likert-type scale with five points was used to analyze the format of the responses to the statements (from 1 = I do not agree at all to 5 = I completely agree).

Results

Using correlation analysis, we examined the responses on the following statements to verify the validity of H_0: (T1) Digital gaming should be part of the learning content (M=3.32, SD=1.091) and (T2) digital games in education contribute to the effectiveness of learning (M=3.44, SD=1.335).

Table 1. *Presentation of correlation data and the coefficient of determination for H_0*

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.602	.046	11.194	.000
	Spearman Correlation	.563	.046	12.289	.000[c]
Interval by Interval	Pearson's R	.571	.046	12.566	.000[c]
N of Valid Cases		328			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

According to Table 1's results analysis, the Chi square test of independence demonstrates the statistical significance of the impact on the result $\chi 2(16,1)$ 483.414[a] =, $p < 0.01$. Significance ($p \leq .05$) indicates how certain one can be that the relationship. $p < 0.01$ shows that the intersection of variables is statistically significant. Spearman's rank correlation coefficient rho = 0.563 and Pearson's linear correlation r = 0.571 indicate how strong the relationship is and in what direction, and in this case reflect a strong positive correlation and a direct connection between digital gaming as a part of the learning content and the effectiveness of learning. Association measure Gamma indicates the extent to which the variation in the changing variable (T1) is explained by the changing variable (T2). Gamma coefficient 0.602 means that knowing the level of acceptance of the first statement improves the prediction of acceptance of the second statement by 60.2%. Given the substantial correlation found between these two variables and the strong correlation found between the statements provided, H_0 was confirmed.

Using correlation analysis, we examined the responses on the following statements to verify the validity of H_1: (T3) A digital game-based learning (DGBL) approach provides a dynamic and engaging learning environment (M=2.72, SD=1.309), and (T4) learning based on digital games has a positive effect on students' motivation (M=3.22, SD=1.214).

Table 2. Presentation of correlation data and the coefficient of determination for H_1

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.640	.044	12.167	.000
	Spearman Correlation	.600	.043	13.540	.000[c]
Interval by Interval	Pearson's R	.624	.035	14.403	.000[c]
N of Valid Cases		328			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

According to Table 2's results analysis, the Chi-square test of independence demonstrates the statistical significance of the impact on the result $\chi 2(16,1) = 371.543^a$, $p<0.01$. Significance ($p \leq .05$) indicates how certain one can be that the relationship. $p<0.01$ shows that the intersection of variables is statistically significant. Spearman's rank correlation coefficient rho=0.600 and Pearson's linear correlation r = 0.624 indicate how strong the relationship is and in what direction, and in this case reflect a strong positive correlation and a direct connection between a digital game-based learning (DGBL) approach that provides a dynamic and engaging learning environment and learning based on digital games that

has a positive effect on students' motivation. Association measure Gamma indicates the extent to which the variation in the changing variable (T3) is explained by the changing variable (T4). Gamma coefficient 0.640 means that knowing the level of acceptance of the first statement improves the prediction of acceptance of the second statement by 64.0%. Given the substantial correlation found between these two variables and the strong correlation found between the statements provided, H_1 was confirmed.

Using correlation analysis, we examined the responses on the following statements to verify the validity of H_2: (T5) Digital game-based learning should include rewards, feedback, and competition (M=3.08, SD=1.305) and (T6) good information, competition, and rewarding students have a positive effect on learning outcomes (M=3.31, SD=1.070).

Table 3. *Presentation of correlation data and the coefficient of determination for H_2*

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.510	.053	8.705	.000
	Spearman Correlation	.450	.049	9.087	.000[c]
Interval by Interval	Pearson's R	.445	.049	8.973	.000[c]
N of Valid Cases		328			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

According to Table 3's results analysis, the Chi-square test of independence demonstrates the statistical significance of the impact on the result $\chi 2(16,1) = 153.727^a$, $p<0.01$. Significance ($p \leq .05$) indicates how certain one can be that the relationship. $p<0.01$ shows that the intersection of variables is statistically significant. Spearman's rank correlation coefficient rho=0.450 and Pearson's linear correlation r=0.445 indicate how strong the relationship is and in what direction, and in this case reflect a strong positive correlation and a direct connection between the digital game-based learning (DGBL) that includes rewards, feedback, and competition and its great potential to significantly improve student learning outcomes. Association measure Gamma indicates the extent to which the variation in the changing variable (T5) is explained by the changing variable (T6). A gamma coefficient of 0.510 means that knowing the level of acceptance of the first statement improves the prediction of acceptance of the second statement by 51,0%. Given the substantial correlation found between these two variables and the strong correlation found between the statements provided, H_2 was confirmed.

Using correlation analysis, we examined the responses on the following statements to verify the validity of H_3: (T7) Digital game-based learning (DGBL) supported by artificial intelligence (AI) enables personalization (M=3.30, SD=1.117), and (T8) personalization of learning contributes to dynamically adapting learning to the performance of each student (M=3.21, SD=1.008).

Table 4. *Presentation of correlation data and the coefficient of determination for H_3*

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.669	.048	12.092	.000
	Spearman Correlation	.577	.045	12.747	.000[c]
Interval by Interval	Pearson's R	.582	.044	12.936	.000[c]
N of Valid Cases		328			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

According to Table 4's results analysis, the Chi-square test of independence demonstrates the statistical significance of the impact on the result $\chi 2(16,1) = 216.022^{a}$, $p<0.01$. Significance ($p \leq .05$) shows how certain one can be that the relationship. $p<0.01$ indicates that the intersection of variables is statistically significant. Spearman's rank correlation coefficient rho=0.577 and Pearson's linear correlation r =0.582 indicate how strong the relationship is and in what direction, and in this case reflect a strong positive correlation and a direct connection between digital game-based learning (DGBL) supported by artificial intelligence (AI) that enables personalization and personalization of learning, which contributes to dynamically adapting learning to the performance of each student. Association measure Gamma indicates the extent to which the variation in the changing variable (T7) is explained by the changing variable (T8). Gamma coefficient 0.669 means that knowing the level of acceptance of the first statement improves the prediction of acceptance of the second statement by 66.9%. Given the substantial correlation found between these two variables and the strong correlation found between the statements provided, H_3 was confirmed.

Discussions

In recent years, digital learning games have emerged as an established practice in the field of education. With the greater understanding of gaming that young people today possess, educators can design engaging learning environments to increase student interest. Drawing students' attention is one of the main benefits of DGBL in the classroom. Students are thus encouraged to actively engage in their education, in contrast to textbooks and conventional classroom instruction, which are occasionally insufficiently compelling to grab and hold students' attention. DGBL methods provide instant feedback on the choices students make while playing games, in contrast to traditional ways of testing and verifying students' knowledge for evaluation by their instructors. In this way, students are able to improve their problem-solving abilities almost immediately by learning from their failures in real time. Additionally, DGBL promotes cooperation among participants since social contact rises when students collaborate to solve game difficulties or when they compete against other student groups. Communication, cooperation, teamwork, and social interaction can all contribute to deeper learning, which in turn can improve grades and test scores. DGBL can be used for purposes other than schooling, it speeds up the effects of healthcare, civic participation, and staff training (Sharma, 2023). Thanks to DGBL, students from many countries are working together on projects and learning about each other's cultural perspectives, which is increasing the appeal of global collaboration. This creates an inclusive, multicultural classroom that broadens students' horizons and increases their awareness of the world (Paradisosolutions, 2025).

However, depending on the individual learning style of each student or the educator's approach to teaching, there may be drawbacks to learning through digital games. These negative aspects include the fact that students spend excessive amounts of time in front of computers. Playing games can disrupt their other daily activities, and digital games aren't always in line with the objectives of their studies. Finally, students may be exposed to possible threats to their cybersecurity through DGBL. To obtain unauthorized access, cybercriminals frequently employ techniques like password cracking and security vulnerability exploitation. Proper student engagement and learning outcomes are obviously impacted by this. Phishing schemes in-game frequently take the shape of emails that appear authentic and deceive gamers into divulging personal information or login credentials. Additionally, social engineering in games refers to coercing users into disclosing private information or taking activities that jeopardize their security (Cooper, 2024).

The ongoing integration of cutting-edge digital technology (such as artificial intelligence and immersive technologies) is what DGBL's future holds. AI-enhanced virtual worlds and more complex 3D games create new opportunities for individualized, interesting, and successful education. With technology greatly influencing how students learn, the future of DGBL is becoming very interesting. AI-driven personalization is one of the most exciting developments. It allows learning to adjust in real time to each student's performance and preferred method of learning, generating dynamic learning routes that suit each student's needs, increasing learning engagement, and enhancing retention as it goes (Paradisosolutions, 2025). The current study suggests that when learning is personalized using AI, students are more likely to identify their own abilities and inventiveness (Baltezarević and Baltezarević, 2024).

Participants provided their attitudes, for the study's purposes, about the effects of digital game-based learning (DGBL) on students' academic performance. According to the results, students are more likely to improve their learning efficiency when they combine educational content with digital games.

This is in line with earlier research showing that digital gaming affects young people's social behavior and academic achievement (Rahayu, 2021). Additionally, DGBL combines instructional information with digital games to attract students' interest and provide them with opportunities to enhance their learning effectiveness. As a result, students have a positive outlook on learning and information for the rest of their lives (Cheng et al., 2013). The study also shows that if a DGBL strategy provides a dynamic and engaging learning environment, it is more likely to boost student motivation and involvement in the learning environment. This outcome is consistent with research by Li et al. which demonstrated that students who played educational digital games were more motivated to learn. Consequently, it is possible to consider these games as "stimuli" that could increase students' learning motivation (Li et al., 2024). The next finding of this study, that DGBL, which includes rewards, feedback, and competition, has greater potential to significantly improve student learning outcomes, finds its basis in the finding of Chen et al. They claim that DGBL provides students with challenging, dynamic, and captivating learning environments that significantly boost students' motivation and involvement in the learning process by implementing competitive processes, accomplishment systems, and reward mechanisms (Chen et al., 2018). Regarding the result, according to whom artificial intelligence (AI) that facilitates personalization through digital game-based learning (DGBL) increases the likelihood that the learning will dynamically adjust to each student's performance. This supports a previous study by Westera et al. that discovered AI applications can improve game-based learning's adaptability. Game design aspects that facilitate learning encompass a variety of AI-based features, including social gamification, language technologies, emotional computing, competence modeling, evaluation, player analytics, personalization, and game difficulty balancing (Westera et al., 2020). There is a connection between this remark and the assertion made by Parody et al. that this personalized approach may significantly increase motivation and engagement, two crucial elements of successful gamification (Parody et al., 2022).

Conclusions

The aim of this study was to investigate participants' perspectives on the effects of digital game-based learning (DGBL) on students' academic performance for the purpose of gathering information that will assist educators, lawmakers, game designers, and artificial intelligence developers in improving the educational role of digital games in order to enhance student achievement. According to this study, participants believe that DGBL can increase student learning efficiency and that such a dynamic and engaging learning environment can increase their motivation and participation. If DGBL includes rewards, feedback, and competition, it can further improve student learning outcomes. Finally, if DGBL is supported by AI, personalization can be enabled, and in this way, learning may be dynamically adapted to each student's performance. The DGBL approach is currently in its initial phases of application; therefore, more time is required for its continued development and adaptation. Moreover, all current obstacles must be rectified before this approach may realize its full potential. Additional studies would also more thoroughly analyze how DGBL affects students and instructors as well as the educational sector as a whole, providing a better grasp of all the benefits and drawbacks of these methods of instruction. With a solid basis for further research and real-world applications, this study contributes notably to the fields of educational technology, artificial intelligence (AI), and immersive technologies (which are known as augmented reality (AR) and virtual reality (VR)). Additional research involving other respondent demographics, implementation and evaluation techniques could broaden the conclusions of this empirical study.

Based on our results, we suggest that future studies thoroughly examine the function of immersive technologies in DGBL, paying special attention to the potential applications of the latest technology that can arouse students' senses in an augmented or virtual reality setting (e.g., haptic gloves and suits). This would increase students' involvement, interest, and motivation for learning while reducing the sense that they are not a part of the virtual environment. Under these virtual circumstances, students can visit museums or well-known historical locations, work on group projects, or carry out difficult tasks (like practicing virtual surgery in authentic settings). In any event, this virtual experience makes learning more memorable, efficient, and enjoyable.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, B.R., and B.I.; methodology, B.R.; software, B.R.; formal analysis, B.R.; writing—original draft preparation, B.R. and B.I.; writing—review and editing, B.R. and B.I. All authors have read and agreed to the published version of the manuscript.

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