Computer Networking for Expanding Mathematical Understanding and Reasoning through Computer Games

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Abstract: This study seeks to investigate the effects of computer games on students' comprehension and reasoning in mathematics. To achieve this objective, the research employs various methodologies, such as surveys and interviews conducted with users of computer games. Emphasis is placed on examining the interactive aspects of games and their potential influence on motivation and mathematical proficiency. Additionally, the research explores the correlation between the frequency of game usage and academic performance in mathematics. The findings of this study offer a comprehensive framework for better understanding the impact of computer games on mathematical abilities. Beyond highlighting positive outcomes, the research aims to identify challenges and student needs, providing recommendations for developers and users to enhance the educational value of computer games. This investigation makes a significant contribution to the intersection of education and technology, offering a detailed examination of the educational benefits of computer games in the realm of mathematical skills.

Keywords: Computer games, skills, mathematical reasoning, understanding, students.

1. **Introduction**

Computer games have made a profound difference in the way people build and develop their cognitive skills. In this context, examining the relationship between computer games and the improvement of mathematical understanding and reasoning becomes essential. This scientific paper aims to bring to light the positive impact of computer games on the development of cognitive skills, especially those related to the field of mathematics and mathematical reasoning.

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Computer games are a powerful tool for developing various skills, including math skills. Through the complex and challenging interactions, they provide, computer games encourage users to develop speed of perception, problem-solving, and the ability to understand and apply mathematical concepts.

An important part of this connection is the stimulation of critical thinking and the solving of complex challenges that are often presented in computer games. Through this intellectual challenge, users are forced to develop a permanent interaction between visual perception, strategic planning, and the use of mathematical logic. These skills are developed by trying to understand the rules of the game, strategizing to achieve goals, and building a capacity to analyze and process information.

Also, computer games can provide a suitable environment for learning and perfecting mathematical concepts in an engaging and motivating way. The use of visual elements, animations, and rewards in the game has the potential to make learning mathematics more engaging, making it a more fun and relevant experience for users of all ages.

1.1. Identification problem

One of the main challenges in the field of education is the improvement of the quality of mathematical learning and the development of reasoning skills in students. There are two sides to the discussion on this issue: on the one hand, computer games are seen as a potential source for improving mathematical skills by becoming a fun and motivating environment, while on the other hand, some concerns have emerged regarding their potential for to reward free time and to diminish interest in traditional learning.

In this context, the identification of the problem sought in this research is: "What are the real and potential impacts of computer games on users' mathematical understanding and reasoning skills, especially in the context of learning mathematics in an educational setting?"

Questions aim to address the intersection of computer games and mathematical skills, analyzing how their use can contribute to the development of cognitive skills, through a careful review of the literature, the results of studies, and the analysis of current experiences in the field of education and computer science. This identification of the problem is intended to open a broad and detailed discussion on the influence of computer games in the field of mathematics and how this potential resource can be used to improve the quality of learning in this field.

1.2. Purpose of the Study

The purpose of this research is to analyze and document the impact and effect of computers on the development of mathematical reasoning and comprehension skills. Focusing on the relationship between the use of computer games and the improvement of mathematical skills, the research aims to determine how this entertainment technology can contribute to

increasing the quality and efficiency of mathematical learning in a more motivating environment.

Through careful research and in-depth analysis, it aims to shed light on the concrete mechanisms through which computer games contribute to the growth of mathematical cognitive skills. In addition, the research aims to identify the most efficient practices and strategies that can be used in teaching mathematics through computer games, thus providing concrete recommendations for educators, game developers, and policymakers in the field of education.

This research is intended to help form a clearer and more precise framework for the use of computer games in the context of mathematics learning. The results of the research, it is expected to distinguish sustainable benefits and positive changes in the mathematical skills of the users, bringing an evaluative contribution to the discourse on the ways of improving mathematics education through the technology of computer games.

1.3. Research questions

1. What specific elements of computer games help expand mathematical understanding?
2. What specific elements of computer games help mathematical reasoning?
3. What are the most effective ways to use computer games in expanding mathematical understanding and reasoning?
4. What are the connections of computer game use to mathematical understanding and reasoning?

2. Literature Review

Mathematics has a variety of applications in everyday life and is closely related to many components of education, which simultaneously contributes to the realization of these topics: global warming, permanent and inexhaustible resources, knowledge of cultures, sustainable development, coexistence peaceful, budget planning, etc., the student must solve situations and problems, must use mathematical reasoning and elements of mathematical language, to clarify and explain various issues related to their realization. Through the situations presented in the cross-curricular topics, the student has the opportunity to make connections between mathematical competencies with certain examples for the realization of these topics. The student learns to carry out several stages when solving a problem or situation and this ability contributes to his personal growth by helping them find their place in society. The student can use statistical methods such as surveys, and interviews to analyze people's opinions, and can reason and argue a certain decision. Thus, he learns to participate in social life in the classroom and at school and develops an open attitude towards the world while respecting diversity (MEST, 2019).

In our definition of a digital game, we mean any game (including game apps) that can be played on a digital device such as a computer, tablet, mobile device, or game console. The

great variety of games makes it difficult to define a game more precisely. However, we rarely have trouble recognizing a game when we see one (Skaug et al., 2020). GBL in education is now one of the major learning trends of the 21st century (Ahmad & Iksan, 2021) and has received increasing academic attention in recent years (Zou, 2020). GBL is a mathematics teaching technique that creates a balance between classroom learning and educational games by increasing learning efficiency through student-centered learning activities (Lasut & Bawengan, 2020). It is also one of the most creative and fun methods and, indirectly, the students will pay attention to the teacher's lessons. This is because playing games is innate to students. Additionally, educational games can encourage students to enjoy learning, feel comfortable approaching a variety of challenges along the way, and overcome these challenges with focus, confidence, and patience, all of which are crucial to education. high in development. of lifelong learners (Liu et al., 2021).

Playing mathematical games provides an attractive way to develop problem-solving skills (Pintér, 2010), opportunities to improve students' social skills (Koay, 1996), to promote mathematical reasoning (Olson, 2007), to support differentiation (Buchheister et al., 2017), provide targeted instruction (Clarke & Roche, 2010), and create connections between the home and school environment (Russo, et al., 2018). From Orhani (2021) study, it is suggested that mathematics teachers consider using AI applications to provide students with personalized guidance or support and to investigate the impacts of AI-based learning approaches (Orhani, 2021).

Despite the promising possibilities for digital games to support mathematical learning (Devlin, 2011; Ke, 2009), studies have pointed out at least three complexities. The first is whether students become more motivated to learn mathematics when using digital games. Studies disagree on this important question (Monaghan, 2016). A second complexity concerns the use of non-school digital games: that is, games not specifically designed to be played in a mathematics lesson (e.g., Angry Birds, Plants vs Zombies, or The Sims). Avraamidou et al. (2015) have shown that the mathematical elements in these games are largely invisible to the player, as they are integrated into the game's algorithmic design. The math in these games also differs from the math curriculum. Thus, it can be a challenge for both teachers and students to discover the mathematics of a digital game and for teachers to make meaningful connections between the game and the mathematics curriculum. A third complexity is the unpredictability of students' play, which makes it difficult for the teacher to achieve common learning goals.

Along with its popularity among students, computer games have received much attention from educators as a possible way to provide students with effective and fun learning environments (Oblinger, 2006). The results of the study by Orhani (2023) reflect a literature review on the need to integrate digital didactic games in the teaching and learning of basic mathematical concepts (Orhani, 2023). Gee (2005) agreed that a game would be good for learning when the game is built to incorporate learning principles (Gee, 2005). Some

researchers have also supported the potential of games for the affective domains of learning and fostering a positive attitude towards learning (Ke, 2008). Despite general support for the idea that games have a positive effect on the affective aspects of learning, there have been mixed results regarding the role of games in promoting cognitive benefits and academic achievement (Sayan, 2015).

Games can be used in teaching different disciplines. However, it is said that most teachers do not take games seriously. Educators argue more in favor of the social benefits of games and ignore their educational potential (Squire, 2003). Shute (2011) emphasizes the use of educational games to make learning more fun rather than banning them as a solution to education. These types of video games can be produced. Shute also specifies that parents can play computer games with their children and spend time together so that they can learn skills and experience while having fun (Shute, 2011)

3. Methodology

This research will use a multidisciplinary methodology to address the key questions identified in the problem identification. To achieve the goals of the research and to provide an in-depth and comprehensive analysis, several steps and stages will be used in examining the relationship between computer games and mathematical skills.

3.1. Literature review

To know the general context of the research and to identify previous studies and research related to the topic, a literature review will be conducted. This step will help to understand previous advances and identify gaps or disagreements in the existing literature.

3.2. Computer games analysis

The selection of computer games to be included in the research will be made through a careful analysis of their educational qualities and potential to improve mathematical skills. The use of different games will help to examine their effects on cognitive skills.

3.3. Survey and interview

To gather the perspectives of users and educators, surveys and interviews will be conducted. These data sources will provide a practical and subjective perspective about user experiences and will help to assess the perceptions and evaluation of the effects of computer games.

The survey will be used to collect data from a total of 15 study participants. The survey questions will be careful and focused on user interaction with computer games and their impact on mathematical skills.

3.4. **Analysis of data and interpretation**

The data collected from the survey and literature review will be analyzed using statistical tools and qualitative methods to arrive at consistent conclusions and interpretations of the collected information.

4. Results

The results chapter includes the analysis and interpretation of the data collected through the research to find out to what extent computer games have influenced the expansion of mathematical understanding and reasoning. The analysis of the results is structured by the research questions that were previously defined.

4.1. **Literature review analysis**

In this section, we conducted a detailed literature review to identify previous studies and findings related to the research topic, "Computer games expand mathematical understanding and reasoning." The literature analysis has provided us with a clear framework for the current context and the combined knowledge of scientists and academics in the field of education and computer games.

Numerous studies have reported a positive impact of computer games on improving students' mathematical skills. These improvements have often been observed in the level of student's motivation and commitment to the subject of mathematics. The literature has identified that different types of computer games have different impacts on students' mathematical skills. For example, educational games focus on mathematical concepts, while strategy games can promote analytical and problem-solving skills.

Most studies in the literature emphasize the importance of technology, including computer games, in improving mathematics learning. The use of technology has emerged as a powerful tool to understand and apply mathematical concepts interactively.

Studies have shown that interactive elements in computer games, such as challenges and rewards, have a positive impact on improving mathematical skills and stimulating students' interest.

In some cases, studies have noted that the impact of computer games on math skills may vary depending on the age of the users and personal experiences with the games.

Beyond the positive aspects, there have been some criticisms and debates regarding the use of computer games in the field of mathematics education. Several studies have emphasized the need for clear and critical assessments of the quality of games and their impact on mathematics learning.

The results of the literature review provide a strong theoretical and contextual basis for our current research. Also, they help frame the discussion and interpretation of our research results, allowing comparison and contrast of our findings with prior knowledge of the field.

4.2. Computer games analysis

After analyzing and interpreting the data collected through the research, the results show a diverse range of impacts and findings regarding the interaction of computer games with mathematical understanding and reasoning. In this segment, the main results of the research will be presented.

The majority of users report that the use of computer games has been associated with a significant improvement in mathematical skills. Users, who consider games as a suitable means to explore mathematical concepts, show a marked improvement in the improvement of understanding and analytical skills.

The results show a positive relationship between the frequency of using computer games and mathematical performance. Users who spend more time playing computer games tend to show an increase in performance on math tasks compared to those who use them less often.

Some users have expressed appreciation for computer games that include interactive elements, such as challenges and rewards. This interactive element has a positive impact on increasing interest and improving mathematical skills through a prepared and engaging experience.

Users have shown a clear sense that types of computer games have different impacts on mathematical skills. For example, educational games are more effective in reinforcing mathematical concepts than other games.

In some cases, personal variables such as age and experience with computer games have modified the impact of games on math skills. New users tend to show a more pronounced improvement in their math skills.

Some users have mentioned some challenges and requirements regarding the features and use of computer games to improve math skills. Some have called for the developers to integrate more math challenges and adjust the level of difficulty according to individual needs.

The results of the analysis of computer games provide an in-depth perspective on how this technology can affect the development of mathematical skills and provide a platform for debate and future improvements in the field of education and technology.

4.3. Analysis of survey and interview results

4.3.1. Results from the interview with students

Interviewees with students provided a detailed perspective on the impact of computer games on their math skills. The students, who were asked about their personal experiences, had expressed several reflections and evaluations about this topic. Some of the main results are:

Table 1. Results from the interview with students

Answers	Indicators	Coding
Students reported that the use of computer games encouraged them to be more motivated and engaged in learning mathematics. They often mentioned that the interactive elements and challenges of the games made them feel more involved and engaging.	Improving motivation and engagement	Motivation Commitment
Students reported positive changes in the way they understand and use mathematical concepts. Most rated educational games for their role in improving their understanding of various mathematical disciplines.	Changes in the way of mathematical understanding:	Mathematical understanding
The interviews part showed that the use of computer games has an impact on their performance in school mathematical tasks. They said that the mathematical skills and strategies they gain from playing computer games have helped them with the tasks learned at school.	The connection between games and school mathematical tasks	Correlation between games and mathematics
Students conveyed their appreciation of the interactive elements in the games. They said that this characteristic boosts motivation and improves concentration in efforts to solve mathematical problems presented in the games.	Interactive Elements as a resource	Interactivity
Some students called for more diversity in computer games to address the variety of their mathematical needs. They also state that teachers can use computer games more actively in teaching mathematics and use them to deepen the knowledge gained in the classroom.	Requirements for developers and teachers:	Developer Teacher

4.3.2. Results from the interview with teachers

Interviews with teachers provided substantial insight into the impact of computer games on students' mathematical skills, deepening their experience and evaluation as educators. Here are some of the key results:

Table 2. Results from the teacher interview

Answers	Indicators	Coding
The teachers claimed that the use of computer games is an effective tool to engage and motivate students in learning mathematics. They especially appreciated the educational features of the games that help improve math skills.	Assessment of computer game use	Evaluation of computer games
Teachers emphasized the role of interactive elements and challenges in games to improve students' understanding and concentration in mathematics. They confirmed that the use of these elements promoted a perceived improvement in students' mathematical skills.	Benefits of interactive elements	Benefit Challenge
In some cases, teachers observed that the use of computer games had a positive effect on the traditional teaching of mathematics. They state that students have transferred the skills and strategies acquired from the games to solving mathematical problems in the classroom.	Impact on traditional learning	Impact on traditional learning
Some teachers express the need for improvements in the quality and diversity of computer games available. They emphasized the importance of developers creating games that complement the curriculum and address the specific needs of their classroom.	Need for improvement and diversity	Improve
Teachers claimed that they play a key role in the successful use of computer games in teaching mathematics. They emphasized their role in guiding students, monitoring progress, and integrating games into the curriculum.	The role of the teacher in the use of computer games	The role of the teacher

Teachers mentioned an important concern regarding the availability of games in the Albanian language. They suggested that a greater number of games in their natural language, Albanian, would be beneficial, considering that not all students in Kosovo have sufficient knowledge of the English language.	The need for games in the Albanian language	Games in the Albanian language

4.4. **Interpretation of collected data**

The results of the interviews with students provided an in-depth and familiar picture of the impact of computer games on their mathematical skills and perceptions. Students expressed a high level of motivation and engagement when using computer games, particularly appreciating the interactive elements and challenges offered. This finding indicates that the use of technology in the form of games is a powerful tool to promote student participation and interest in mathematics learning. Regarding the understanding of mathematical concepts, students reported a positive change, emphasizing that educational games and visual elements contribute in a known way to the development of these skills. Moreover, the results showed that the use of computer games has a positive impact on the performance of students in school mathematical tasks, helping to transfer the acquired skills to the classroom context. Students expressed a particular liking for interactive elements as sources of motivation and learning. The challenges and rewards offered by the games make them feel involved and enjoy the process of solving mathematical problems. This aspect deepens the importance of a teaching experience that combines intellectual challenge with fun. For more diversity and adaptability, students express the need for computer games suitable for their levels of mathematical knowledge. This comment indicates that a better example of games aligned with their curriculum and grade level is required. In general, the results of interviews with students argue that the use of computer games can be an effective tool to improve learning and mathematical reasoning, improving students' motivation and engagement in this area. These discoveries bring an optimistic window into the potential of technology to change the paradigm of mathematical learning in a more attractive and innovative context.

The results from the teacher interviews provided a rich perspective on the role and impact of computer games in mathematics learning. The teachers expressed a high appreciation for the use of computer games as an effective tool to motivate and engage students in the subject of mathematics. They particularly valued the educational features and interactive elements of the games, seeing them as an innovative tool to deepen students' mathematical understanding and reasoning. One of the main findings is that the use of computer games has brought about a positive change in the way their students understand and apply mathematical concepts. The teachers expressed that the students have transferred the skills and strategies acquired from the games to solving mathematical problems in the classroom, helping to improve their mathematical skills. Interactive elements, including challenges and rewards,

were valued by teachers as an important resource to improve students' motivation and concentration in mathematics. This finding shows that a successful approach to computer games in teaching mathematics is closely related to their ability to engage and motivate students through challenges and rewards. Teachers mentioned the need for diversity and quality in the computer games used in the classroom, emphasizing the importance of a good fit with the curriculum and students' knowledge levels. This suggests that the use of computer games in mathematics education requires a suitable and improved approach to meet the specific needs of each class. The use of games in the Albanian language ensures the widest involvement of students. This is important to avoid any feeling of discrimination or any negative impact it may have on the motivation and involvement of those students who are not very familiar with the English language. In general, the teachers expressed the conviction that the use of computer games can be a valuable addition to the teaching of mathematics, contributing to the creation of an attractive and innovative learning environment. These findings highlight the importance of integration between technology and traditional instruction to improve the quality and effectiveness of mathematics instruction in schools.

4.5. Review of research questions

Reviewing the research questions was a critical step in the process of this research. The research questions were what guided the direction and focus of the research, and their review ensured that they were clear, appropriate and rich about the objectives of the study. The answers to the research questions are described here.

1. What specific elements of computer games help expand mathematical understanding?

The results of the research on the impact of computer games on the expansion of mathematical understanding showed that key elements such as appropriate mathematical challenges, interaction and collaboration, adaptation to the curriculum, and interactive and visual elements have an important role. Games that provide skill-level appropriate challenges, use interactive and visual elements to make concepts more understandable, encourage collaboration between students, and align with the school curriculum have a positive impact on motivating and improving students' math skills. These results emphasize the importance of a targeted and careful use of computer games in the learning context, thus improving the quality and effectiveness of mathematics teaching in schools.

2. What specific elements of computer games help mathematical reasoning?

Based on research results, computer games influence students' mathematical reasoning through elements such as complex challenges, interaction and strategy, mathematical modeling, rewards and assistance, and the influence of time and pressure. Complex challenges encourage a deep understanding of mathematical concepts, while interactive elements and the opportunity to use strategies develop analytical and reasoning skills. Mathematical modeling helps to use mathematics to describe real situations, while rewards and assistance

encourage the use of strategies and the development of reasoning skills. The impact of time and pressure promotes the ability to make efficient decisions in a limited amount of time. These elements of computer games create a rich learning experience that helps improve students' mathematical reasoning.

3. What are the most effective ways to use computer games in expanding mathematical understanding and reasoning?

Based on research results, the most effective ways to use computer games in expanding students' mathematical understanding and reasoning include adapting to the curriculum, using progressive challenges, encouraging collaboration and interaction, integrating visual and interactive elements, and monitoring and feedback. personalized, as well as the use of educational scenarios. These methods promote personalized learning, adaptation to the needs of individuals, and the integration of mathematics in a fun and practical context. The use of progressive challenges and interaction contributes to dynamic learning, while visual and interactive elements make mathematical concepts more understandable. Personalized monitoring and feedback improve student performance, while the use of educational scenarios promotes a prepared approach to real situations. The combination of these strategies provides a more sophisticated and effective use of computer games to advance students' mathematical understanding and skills.

4. What are the connections of computer game use to mathematical understanding and reasoning?

Based on the research results, the connections of computer game use in mathematical understanding and reasoning are deep and complex. Computer games provide an interactive and motivating platform for students, improving their understanding of mathematical concepts through diversified challenges and situations. User interaction with visual elements and practical applications of mathematics in games contribute to building a deeper and lasting understanding of the subject. In addition, computer games encourage an active approach to learning, allowing students to develop analytical and reasoning skills by facing different challenges. Cooperation and interaction between students through games are rewarded with collective learning and a deeper understanding of mathematical concepts. To summarize, the use of computer games creates strong and positive links between mathematics learning, student motivation, and the development of analytical and reasoning skills.

5. Conclusion

In conclusion, the research has evidenced that computer games have an important role in expanding students' understanding and mathematical reasoning. Elements such as complex challenges, interaction and collaboration, adaptability to the curriculum, visual and interactive elements, as well as personalized feedback are essential in improving students' mathematical

skills. To achieve this, it is important to use effective ways of using computer games, adapting to the needs and abilities of students, and integrating them into the learning context. Mathematical understanding and reasoning through computer games is seen as a successful way to engage and motivate students, influencing the improvement of performance and sensitivity to the subject of mathematics. Thus, the results of the research confirm the important potential of using computer games in building an innovative learning culture suitable for the demands of mathematical learning.

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