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Gamifying Mathematics: A Hermeneutic Phenomenological Study Focused on Role-Playing Games in Linear Equations

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ABSTRACT

The aim of this study is to investigate how the integration of technology, particularly games, in mathematics education serves as an innovation in mathematics learning. The focus of this research is on the integration of technology in mathematics education, particularly concerning the topic of algebra, specifically linear equations in one variable, using gamification media with the assistance of RPG Maker MV application. This research employs a hermeneutic phenomenological approach to understand the subjective meanings contained in individual experiences related to the use of gamification in a learning context. A total of 39 seventh-grade students and 2 educators from a public junior high school in Luwuk were selected as subjects for this study. The research utilized both test and non-test instruments. Data analysis followed the Miles and Huberman model, involving three stages, namely data reduction, data presentation, and conclusion drawing. The results showed that the integration of technology, particularly the use of gamification in mathematics education, has received a positive response from students especially in the field of students' interest, collaboration, and motivation, and serves as an innovation in mathematics learning. RPG games have great potential to be used as an interactive learning tools in the classroom because they contain various interesting features that support the psychological and cognitive development of students. Researchers are recommended to design a didactic design that integrate technology, ensuring that educational practices are both engaging and effective in enhancing students' learning experiences.

Penelitian ini bertujuan untuk mengeksplorasi bagaimana integrasi teknologi, khususnya teknologi berbasis game dalam pembelajaran matematika. Fokus penelitian ini adalah pada integrasi teknologi dalam pendidikan matematika, terutama yang berkaitan dengan materi aljabar, khususnya persamaan linier satu variabel menggunakan media gamifikasi dengan bantuan aplikasi RPG Maker MV. Penelitian ini menggunakan pendekatan hermeneutic phenomenology untuk memahami makna subjektif yang terkandung dalam pengalaman individu terkait gamifikasi dalam konteks pembelajaran matematika. Sebanyak 39 peserta didik kelas VII dan 2 pendidik dari suatu Sekolah Menengah Pertama Negeri di Luwuk dipilih sebagai subjek dalam penelitian ini. Penelitian ini menggunakan 37instrumen tes dan non-tes. Data yang dikumpulkan dianalisis menggunakan model Miles dan Huberman, yaitu reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa integrasi teknologi, khususnya penggunaan gamifikasi dalam pendidikan matematika, mendapatkan tanggapan positif dari peserta didik terutama dalam hal minat peserta didik, kolaborasi, dan motivasi serta berfungsi sebagai inovasi dalam pembelajaran matematika. Media pembelajaran berbasis RPG memiliki potensi besar untuk digunakan sebagai alat pembelajaran interaktif di kelas karena RPG mengandung berbagai fitur menarik yang mendukung perkembangan psikologis dan kognitif peserta didik. Peneliti merekomendasikan untuk merancang desain didaktis yang terintegrasi dengan teknologi guna memastikan bahwa praktik pendidikan berlangsung secara menarik dan efektif dalam meningkatkan pengalaman belajar peserta didik.

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INTRODUCTION

The 21^{st} century is often considered a technological era that reshapes human life paradigms (Raja & Nagasubramani, 2018; Van-Laar et al., 2017). Rapid technological development significantly affects various aspects, including innovative teaching methods (Cloete, 2017; Escueta et al., 2017; Nurdyansyah et al., 2017; Selwyn, 2016). With technological advancements, learning approaches have evolved dramatically over the past decades (Hendriyanto et al., 2024). The digital era has brought a notable paradigm shift in how we access, present, and consume information. Conventional approaches focusing on direct instruction and textbooks as the primary learning materials are being replaced by the use of modern technological tools, such as computers, the internet, and mobile devices. The National Council of Teachers of Mathematics (NCTM) emphasizes that Information and Communication Technology (ICT) is an indispensable resource in 21^{st} century mathematics education. People must achieve proficiency in digital literacy and critical thinking skills (Putri et al., 2024). As a consequence, every schools are expected to ensure that all students have access to technology. Educators are expected to harness the potential of technology to develop students' understanding, stimulate their learning interest, and enhance their classroom learning abilities.

In the context of global education, the integration of technology in education is not only a necessity but also a demand. Through the appropriate use of technology, teaching can become more dynamic, responsive, and capable of accommodating various learning styles of students (Smith et al., 2021). The utilization of digital tools such as interactive learning software, simulations, and online learning platforms allows educators to design engaging learning experiences and expand educational accessibility (Blatch-Jones et al., 2020). Technology-based learning encourages students to actively participate in the learning process, develop social skills, and broaden their horizons through interaction with peers and other learning resources (Chen et al., 2021).

One subject that is often considered difficult and uninteresting is mathematics (Fardian & Dasari, 2023). From elementary school to university level, many students feel anxious or uncomfortable when faced with complex mathematical concepts. This fear and uncertainty often affect their interest in learning as well as their perception of the subject. One of the main reasons why mathematics is considered difficult is because the material taught often feels abstract and irrelevant to students' everyday lives (Phonapichat et al., 2014). Many students struggle to understand these concepts because they do not see the connection between what they learn in class and their real-life experiences (Upadhyay, 2006). Therefore, it is important to find approaches that can make mathematics more relevant, engaging, and easier to understand for students. One promising approach to addressing this challenge is the use of technology in mathematics education.

In the current era of advancing technology, methods of learning mathematics are no longer limited to manual approaches. The use of technology has had a significant impact on the paradigm of teaching and learning mathematics (Mahamad et al., 2010). For example, the utilization of Mathematics Software and Applications enables calculations, visualization of mathematical concepts, and problem-solving with higher efficiency (Barwell, 2018). Furthermore, technology has paved the way for the emergence of online mathematics learning communities, where students and teachers can share knowledge, resources, and experiences through various platforms such as forums, blogs, or social media (NCTM, 2020). Technology is considered an effective measure to complement education in addressing all limitations in delivering materials (Lailiyah et al., 2023; Turnbull et al., 2021). Figure 1 illustrates that over the past three years, research on the use of technology in the context of mathematics education has seen significant development.

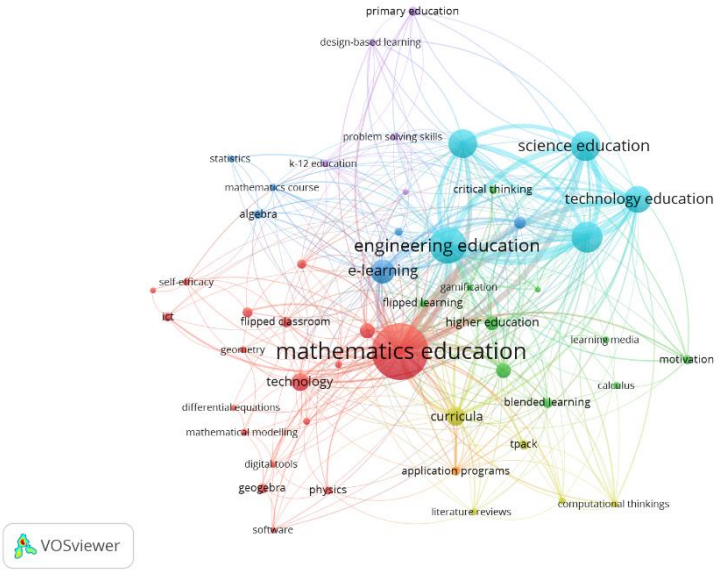


Figure 1. Research trends on the use of technology

Learning topics such as Algebra, Geometry, Calculus, and STEM have remained primary research focuses in the field of mathematics education over the past three years. However, further research on the topic of algebra has significant potential (Fardian et al., 2024) compared to geometry, calculus, and STEM. Based on Figure 1, the algebra symbol is the smallest in size and is positioned the farthest from the mathematics education symbol. This indicates a research gap, highlighting the need for further investigation into the topic of algebra. Additionally, there is no direct connection between algebra content and gamification. This presents a substantial opportunity for an in-depth analysis of gamification in the context of algebra content.

Games have become one of the most popular forms of entertainment among children (Boyle et al., 2012). However, more than just mere entertainment, games have significant potential as tools for creating engaging and effective learning environments, while also eliminating boredom in the learning process (Ge & Ifenthaler, 2018). Through creative and innovative approaches, games can be integrated into the educational curriculum to enhance student engagement and strengthen their understanding of subject matter (Khan et al., 2017). In the context of learning, games can be designed to encompass various aspects of the curriculum, ranging from mathematics to natural sciences, with the goal of stimulating learning interest and facilitating understanding of complex concepts. The use of games in education also provides opportunities for students to learn in a more interactive and enjoyable manner, which can enhance their intrinsic motivation towards learning (Krastev & Voinohovska, 2016).

The integration of technology such as games into education also enables educators to create dynamic and adaptive learning environments, where students can learn in a relaxed yet focused atmosphere (Del-Blanco et al., 2010). By presenting challenging and visually stimulating stimuli, games can increase student engagement and trigger active learning processes oriented towards problem-solving. Thus, games not only serve as entertainment tools but also as powerful instruments in creating enjoyable and meaningful learning experiences for students (Domínguez et al., 2013). With wise and planned utilization, games can become valuable assets in efforts to enhance the quality of education and enrich children's learning experiences in this digital era (Whitton, 2012). Therefore, it is important to develop education-based games as a strategy to boost students' learning motivation. The development of education-based games can be an innovative solution to stimulate students' interest in learning and strengthen their engagement in the teaching-learning process. The use of technology in learning is highly anticipated because in the implementation of the curriculum in each educational unit, it is expected to be carried out using a multi-strategy and multimedia approach as well as adequate learning resources and technology (Satriawan & Wutsqa, 2013).

Based on the literature review of previous studies, there are several research gaps, which are presented in the fishbone diagram in Figure 2 below.

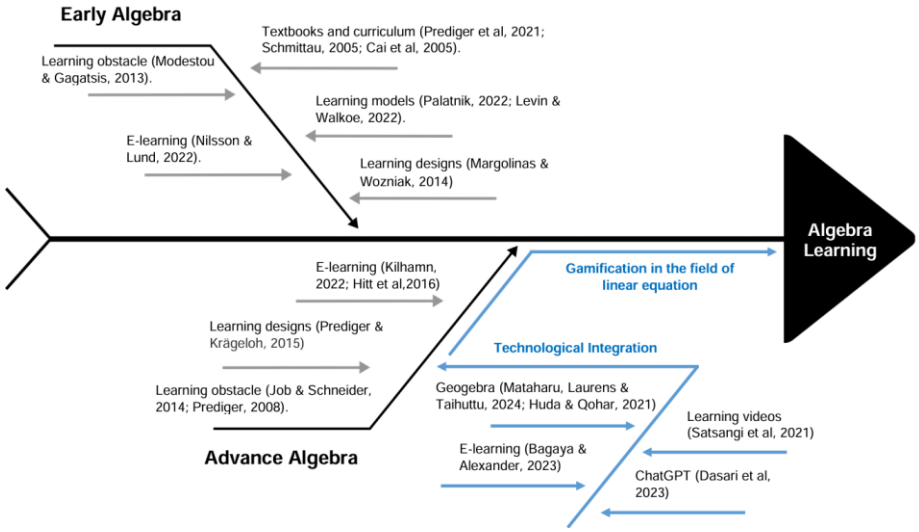


Figure 2. Fishbone diagram

The blue color in Figure 2 represents the focus of the issues that will be examined in this research. The main focus is related to the lack of research examining the integration of technology, particularly gamification, in algebraic materials. The scarcity of research on the integration of technology in algebraic materials is due to a lack of awareness of its potential, resource limitations in some educational institutions, implementation challenges in teaching, and a lack of related research to provide practical guidance (Barwell, 2018; NCTM, 2020). The scarcity of research examining the integration of technology in algebraic materials can also be attributed to a lack of incentives from involved parties, such as insufficient support from educational institutions or a lack of interest from researchers to explore the topic. Additionally, changes in curriculum or education policies can also influence the research focus in this field, making technology integration may not be a top priority in the research agenda (Lee, 2019). However, technologies such as games are one of the technologies that can facilitate educators and learners in understanding algebraic materials.

In the realm of mathematics education today, there is an urgency for researchers to examine the integration of technology, including the use of games in algebra learning. Firstly, the use of games can enhance the accessibility and flexibility of algebra learning by allowing learners to study anytime and anywhere through digital platforms. This can help overcome learning barriers and facilitate distance or self-paced learning, which is increasingly popular in the current educational context (Yang et al., 2021). Secondly, the use of advanced technology such as game applications combined with algebra learning can open up new opportunities to present material interactively and dynamically. This can increase learners' interest and understanding of complex algebraic concepts (Guzdial & Turns, 2000). Thirdly, technologies like games have the ability to provide personalized learning experiences tailored to the needs and comprehension levels of individual learners. This can help improve learning effectiveness by considering the diversity in learners' abilities and learning styles (Lee et al., 2021).

Based on the importance of technology integration in mathematics education, empirical facts, research trends, research gaps, and the urgency outlined, the aim of this study is to investigate how the integration of technology, particularly games, in mathematics education serves as an innovation in mathematics learning. The focus of this research is on the integration of technology in mathematics education, particularly concerning the topic of algebra, specifically linear equations with one variable, using gamification media with the assistance of RPG Maker MV application. This research serves as an initial step to develop justified, true, and belief-related knowledge regarding algebraic material.

METHODOLOGY

Research design

This research employs a hermeneutic phenomenological approach to understand the subjective meanings of individual experiences related to the use of gamification in learning. With this approach, the researcher can explore students' understanding, perceptions, and interpretations regarding the integration of technology, particularly

games, in mathematics education. The focus is on its impact on their motivation, engagement, and interest in learning.

Sample and data collection

A total of 39 seventh-grade students and 2 educators from a public junior high school in Luwuk were selected as subjects for this study using purposive sampling. This sampling method was chosen to enable the researcher to select a group specifically relevant to the material under investigation, namely mathematics learning through a game-based instructional medium focused on linear equations in one variable for seventh-grade students. These educators participated independently, providing their individual perspectives and experiences with gamification in mathematics education. The students' learning in the classroom was facilitated by a Role-Playing Game (RPG) learning tool, developed using the RPG Maker MV application. RPG Maker MV is an application specifically designed for creating 2D RPG games. The decision to use this software is based on its ease of use and understanding, especially for those new to game development. The visual interface (Graphical User Interface/GUI) and the simplified use of the Java programming language make RPG Maker MV an ideal choice for beginners beginning their exploration in game development. The game is designed as an interactive adventure where students can explore virtual environments, complete quests, and face challenges that involve solving linear equations. Each level or quest is crafted to gradually introduce algebraic concepts, allowing students to practice solving equations in engaging, real-world scenarios. Players encounter in-game characters and obstacles that require them to apply their knowledge of one-variable, two-variable, or three-variable equations to progress, reinforcing their understanding through hands-on problem-solving. The adventure genre supports immersive learning, motivating students to persist through challenges and engage deeply with algebraic content. The game framework, as shown in Figure 3, is structured to ensure a progressive learning journey aligned with curriculum standards.

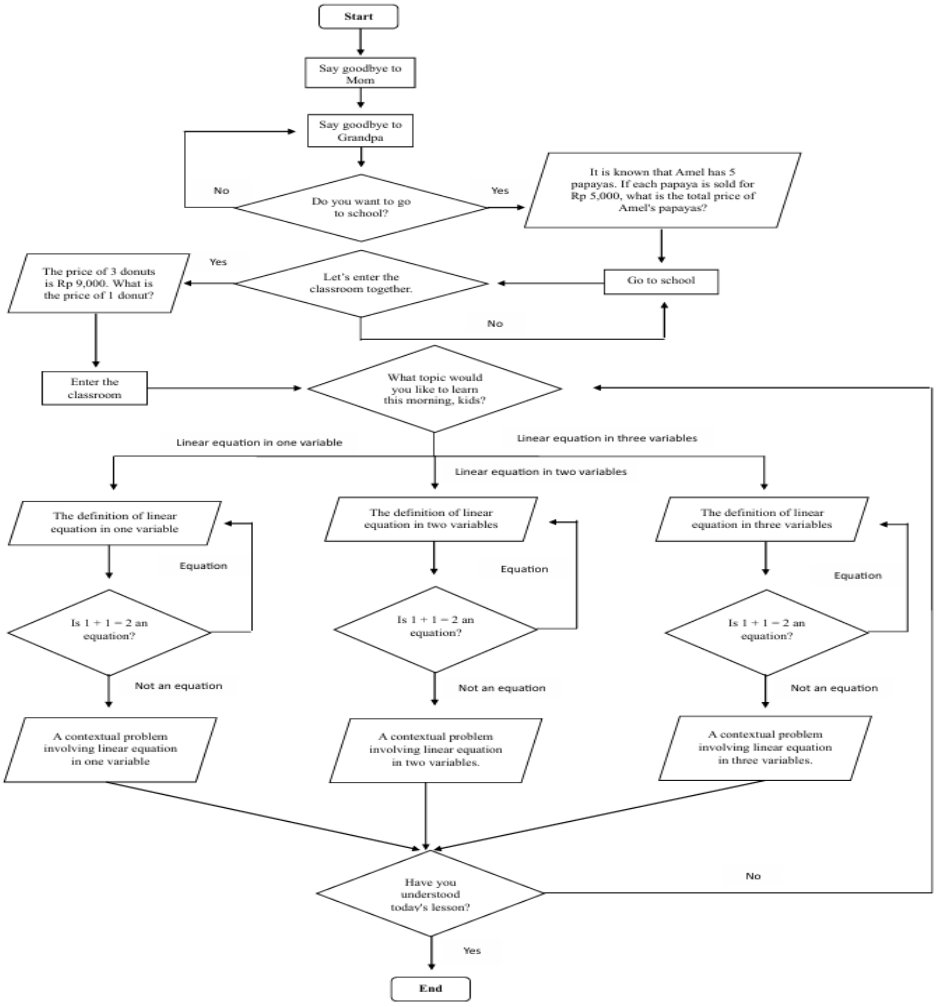


Figure 3. Game flowchart

This game was meticulously crafted and validated by experts in both the subject matter and educational media. Data collection techniques in this study included administering questionnaires to assess the views of educators and students regarding gamification in education. Additionally, in-depth interviews were conducted to explore the extent of technology integration, particularly gamification as an innovation in mathematics education.

Data analysis

The research utilized both test and non-test instruments. For the test, questions on linear equation problems were given within an RPG context. The test consisted of 12 multiple-choice questions designed to help students understand the basic concepts of introductory algebra. The study was conducted over two sessions, each lasting 90 minutes. This duration was chosen to allow sufficient time for students to engage fully with the RPG-based learning activities, explore the problem-solving tasks, and apply linear equation concepts within the game context. Non-test techniques, such as questionnaires and interviews, were employed to gather qualitative insights. The questionnaire was designed using a Likert scale of 1 to 4 (1 = Strongly Disagree; 2 = Disagree; 3 = Agree, 4 = Strongly Agree). Three indicators were developed to assess students' perceptions regarding gamification in education. The first indicator focused on learning interest, with the statement, "Gamification in mathematics learning can make learning more engaging for students". The second indicator related to student interactivity, with the statement, "Gamification makes classroom learning more interactive". The final indicator focused on student collaboration, with the statement, "The use of technology in mathematics learning helps enhance interaction between educators and students". In the interview section, we sought to gather information from subjects based on three key indicators: first, their experiences using game-based technology; second, the benefits of integrating technology into classroom learning; and third, the challenges or difficulties encountered in adapting technology for educational purposes.

Data analysis followed the Miles and Huberman model (1994), which involved three stages. First, data reduction documented all student responses regarding linear equations and technology use in the classroom. Next, data presentation categorized and identified various types of responses, and finally, conclusions were drawn to examine the integration of games in mathematics education as a pedagogical innovation.

RESULTS

Students' perspective about the integration of gamification in the learning process

Role-playing games (RPG) are one type of game that places players in the roles of fictional characters within a fictional world. Players have control over the development of their characters, including abilities, skills, and moral decisions or strategic actions. RPGs offer rich and complex storylines, allowing players to explore the game world, interact with non-player characters, and undertake diverse tasks and missions. RPGs can encompass a variety of themes, ranging from fantasy to science fiction, and often allow players to customize their experience according to individual preferences.

In the initial stage of data analysis, data reduction was conducted to simplify, focus, and organize the raw data into a more structured and meaningful format. This process aimed to emphasize students' perspectives on gamification in mathematics learning and the impact of technology integration on their understanding, motivation, communication skills, and digital competencies. In this stage, data from questionnaires and interviews were organized into two primary themes: the affective domain and the cognitive domain. The affective domain included learning interest, motivation, interactivity, and collaboration, while the cognitive domain encompassed conceptual understanding, communication skills, and digital skills. This categorization allowed for a more focused examination of how gamification influenced both students' emotional engagement and cognitive development. Following the initial grouping, only data directly relevant to the research objectives and main topics were retained. Irrelevant or redundant information was excluded to streamline the analysis process and ensure that the final data set remained aligned with the study's focus. This selection process helped to sharpen the analysis by concentrating on responses most pertinent to the study's aims. Lastly, the refined data were organized into distinct categories, ready for data presentation and conclusion drawing. By following this structured approach to data reduction, the study ensured that the data presented in the results section remained focused, coherent, and aligned with the research objectives, thus providing a solid foundation for analyzing students' responses to technology integration in education. Figure 4 depicts the viewpoint of students regarding the incorporation of gamification within the learning process.

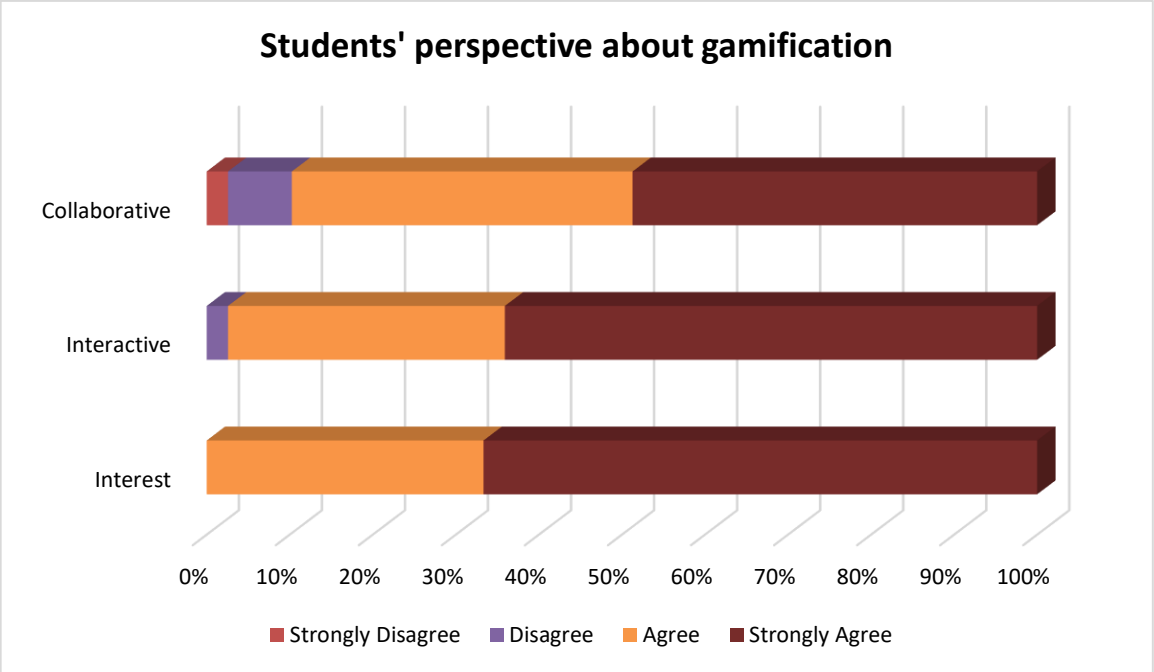


Figure 4. Students' perspective about gamification in linear equations

Figure 4 illustrates the overwhelmingly positive student response to technology integration in education. Specifically, 33.3% of students agree, and an additional 66.67% strongly agree, that technology, particularly the use of gamification in mathematics learning, enhances the engagement of the learning experience. Among the dimensions assessed, interest receives the highest level of endorsement for gamification. The vast majority of students "strongly agree" that gamification increases their interest in learning, indicating that they find gamified activities and methods to be both highly engaging and motivating. A smaller proportion of students "agree," further reinforcing the overall positive response. Notably, no students "disagree" or "strongly disagree," demonstrating near-universal approval of gamification as an effective approach to capturing and sustaining interest in educational content. However, 33.33% of students agree, and 64.1% even strongly agree that gamification in mathematics learning makes classroom learning more interactive. The largest group "strongly agrees" that gamification makes learning more interactive, suggesting that students appreciate the dynamic and engaging aspects of gamified learning environments. This positive reception is supported by a moderate group that "agrees," further indicating that interactive elements of gamification are well-received. In stark contrast, 2.6% of students disagree that gamification will impact classroom interactivity. The presence of a small group that "disagrees" and an even smaller group that "strongly disagrees" suggests only a minor reservation or reluctance towards gamification's interactive nature among the students surveyed.

A substantial proportion of students perceive the integration of technology, particularly through role-playing game-based gamification, as an effective means to enhance classroom collaboration. Specifically, 41% agree, and 48.7% strongly agree, that gamification fosters a more collaborative environment, indicating a strong consensus on its value in promoting teamwork and joint efforts among students. Only a small percentage express dissent, with 7.7% disagreeing and 2.6% strongly disagreeing, suggesting that opposition to gamification's collaborative aspects is minimal. This data reflects a generally positive view of gamification as a tool to encourage cooperation in classroom settings, with a vast majority endorsing its collaborative benefits and only minor reservations among a limited group of students. Figure 4 reflects a clear and strong student endorsement of gamification as a valuable educational tool across all three dimensions. Students perceive gamification as not only fostering collaboration and enhancing interactivity but also significantly boosting their interest in learning. The overwhelmingly positive responses, with very few negative views, suggest that students find gamification both engaging and effective in enriching their educational experience. This insight supports the potential integration of gamification into more educational contexts to leverage these positive effects on student engagement and motivation.

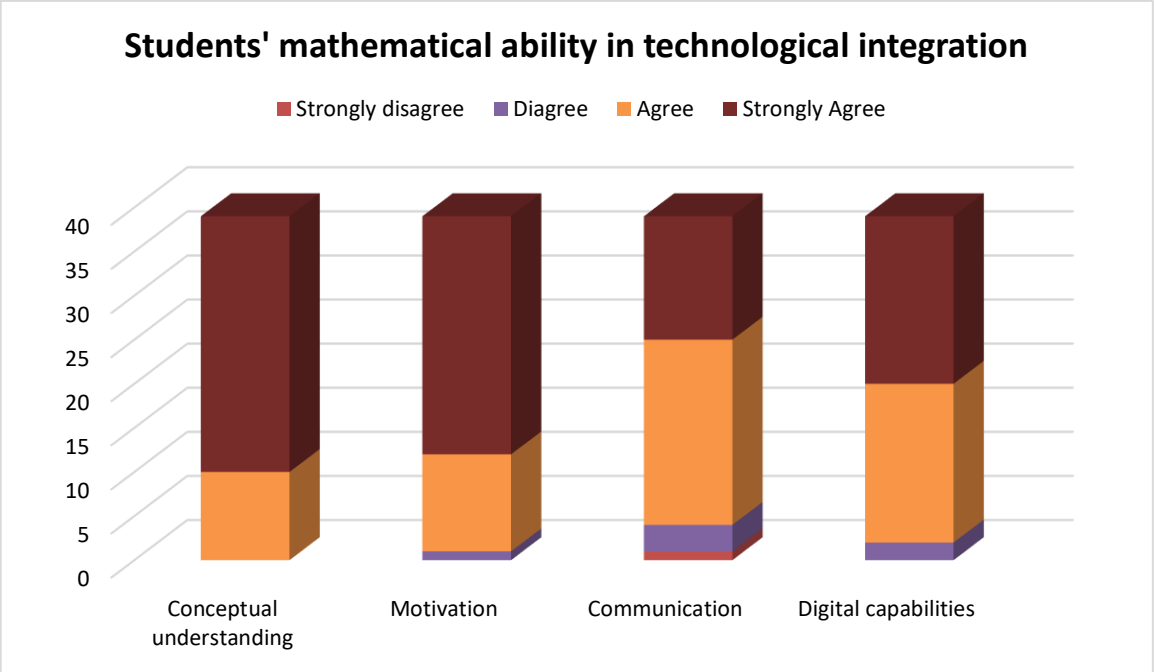


Figure 5. Students' skills in the integration of gamification

Based on Figure 5, it is evident that students also exhibit a positive response regarding the integration of gamification in enhancing their mathematical ability. 35.9% of students agree, and 59% of them strongly agree that technology-based mathematics applications help students understand mathematical concepts better. The data indicates that a significant number of students "strongly agree" that technology positively impacts their conceptual understanding of mathematics. This majority reflects a belief that technological tools, such as educational software or interactive applications, help students grasp complex mathematical concepts more effectively. This alignment with technology suggests that students find these tools beneficial for visualizing abstract ideas, engaging with mathematical models, or practicing problem-solving in a more accessible format. The smaller segment of students who "agree" further supports the positive reception, suggesting that even if students do not find technology transformative, they still perceive it as a useful supplementary aid. Moreover, a total of 2.6% of students disagree and strongly disagree, respectively, that gamification helps in teaching mathematical concepts to students. Only a very small number "disagree" or "strongly disagree," indicating limited opposition to this view. This slight resistance might stem from students who either prefer traditional learning methods or who find that technology adds unnecessary complexity to their learning.

Motivation is another area where students express strong support for technological integration. Additionally, 28.2% of students agree, and 69.2% strongly agree that students are more motivated to learn mathematics when using games or technology-based applications. Only 2.6% of students feel that gamification is not capable of increasing learning motivation in the classroom. A large proportion of students "strongly agree" that technology enhances their motivation in mathematics, possibly due to the interactive and engaging nature of technological tools. Gamification elements, interactive learning modules, or instant feedback mechanisms could be motivating factors, as they make learning mathematics more dynamic and less monotonous. Students who "agree" reinforce this positive trend, indicating that technology encourage them to persist in mathematical tasks, even if they find them challenging. The slight presence of students who "disagree" suggests that, for a small subset, technology might not provide the same level of motivation or could even act as a distraction, depending on how it is used. This divergence might be attributed to varying personal learning styles, where some students may be more motivated by traditional teaching methods than by technology-based tools. The results align with the questionnaire findings, which indicate that 95% of students are more interested in using technology-based math applications or games, with only 5% preferring conventional learning methods. Additionally, of the 95% of student responses, 70% strongly agree with the integration of technology in learning over conventional methods (see Figure 6).

There are 53.8% of students agree, and another 35.9% strongly agree that technology-based math games help students develop mathematical communication skills. This indicates that students view technology as a tool

that enhances their ability to articulate mathematical ideas and collaborate with peers. Digital tools such as collaborative platforms, discussion forums, and interactive applications may provide avenues for students to discuss solutions, ask questions, and express their reasoning more effectively. The increased ability to communicate through technology can be crucial in helping students develop clarity of thought and precision in expressing mathematical concepts, which are valuable skills in both academic and real-world settings. Meanwhile, 7.7% of students disagree, and the remaining 2.6% strongly disagree that integrating technology can enhance students' mathematical communication. The small percentage of students who "disagree" or "strongly disagree" might suggest that for some, technology still present barriers, potentially due to a lack of digital literacy or comfort with online interactions. This highlights the importance of providing adequate support and training in digital communication skills to ensure that all students benefit from these tools.

However, students also have positive responses regarding the improvement of digital skills through the integration of gamification in the classroom. A total of 46.2% of students agree, and 48.7% strongly agree that the use of gamification-based applications can enhance the digital skills of both educators and students. Only 5.1% of students disagree that the improvement in digital skills is a result of technology integration in education. This finding implies that students recognize the importance of digital skills in today's technology-driven world and view the integration of technology in mathematics as a valuable way to strengthen their digital competencies. Proficiency in digital tools, data analysis, and computational thinking are increasingly important skills across disciplines, and students feel that using technology in their math classes prepares them for future academic and career opportunitiesThe data indicates that students overwhelmingly view technology as beneficial to their mathematical learning experience across multiple dimensions. Technology functions not only as an instructional aid but also as a motivator, a communication facilitator, and a medium for developing essential digital skills. The minimal levels of disagreement within these categories reflect a strong endorsement of technology's role in contemporary education. This suggests that students feel better equipped to address mathematical challenges, engage more thoroughly with content, and effectively communicate their understanding when technology is integrated into their learning process. Furthermore, these findings underscore the potential of educational technology to accommodate diverse learning needs, foster collaboration, and prepare students for a technology-oriented future. This emphasizes the importance of continuously integrating and adapting technology within educational environments to further enhance students' engagement and development in mathematics.

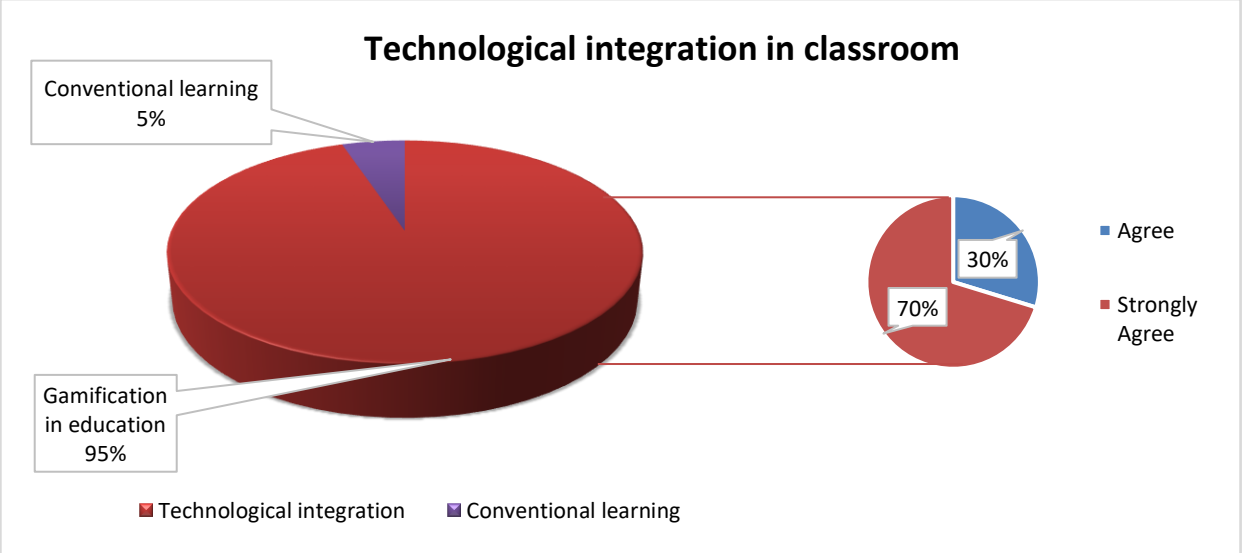


Figure 6. Results of technological integration and conventional learning in the classroom

Teachers' perspective about the integration of gamification in the learning process

To gather comprehensive data on teachers' perspectives regarding gamification, the researcher conducted in-depth interviews. These interviews aimed to delve into educators' experiences and insights on integrating technology into the educational environment. By exploring their firsthand accounts, the researcher sought to understand the challenges and benefits associated with the adoption of gamification in teaching practices.

Researcher : *As a teacher, have you ever integrated technology into classroom learning?*
Subject 1 : *Every day. At the school where I teach, each student is provided with a laptop for learning. Google Classroom is a mandatory application for both teachers and students in the learning process. Other applications/websites I frequently use in the classroom include GeoGebra, PhET simulations, MathPads, RoboCompass, and Google Spreadsheet. Some of these applications are also used for project assessments, which at our school are conducted at least once per semester. These projects involve integrating mathematics with other subjects or with everyday life.*
Researcher : *As a teacher, what are your thoughts on technology in the field of education?*
Subject 1 : *Technology has a significant impact on education, as we can see today with even toddlers being able to use gadgets. Children now spend more time on their gadgets, so the utilization of technology in education is an extraordinary innovation. If educational materials are presented in digital form, students will find it easier to access learning through their gadgets rather than having to carry and read conventional textbooks. Additionally, digital resources can be accessed anytime and anywhere, making it more efficient. Moreover, with the help of technology, we as future educators can present learning in an engaging format, which can increase students' interest in learning.*

Based on interviews with educators, technology has a positive influence on enhancing classroom learning. By utilizing the appropriate technology, educators can make learning more interactive, increase student engagement, prevent monotony, and make learning enjoyable. According to educators' experiences in the classroom, technology in education greatly assists teachers in creating engaging and interactive learning experiences for students. Students are more enthusiastic and interested in learning when technology is incorporated into instruction.

Based on the researcher's exploration of games integrated by educators into the classroom, several advantages were found that can enhance students' interest and motivation to learn, as shown in Figure 7 and Figure 8.

(a) (b)

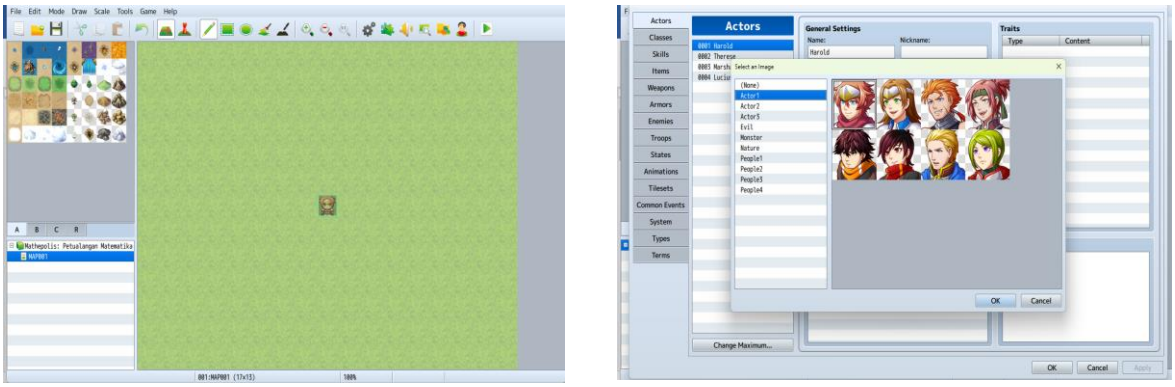
Figure 7. Role-Playing Games in the classroom

Based on Figure 7a, students can complete various quizzes scattered throughout the game arena. Additionally, the quizzes within the game are designed to enhance students' understanding of concepts related to linear equations with one variable. If a student answers a question incorrectly in the game, they are automatically assisted in solving the problem to obtain the correct answer. Besides solving problems, the game also presents definitions of the material being studied, allowing students to learn not only through textbooks but also through educational RPG-based games (see Figure 7b). Thus, this game is able to shift the traditional paradigm of learning where the main role is played by the teacher to a more modern approach where the student becomes the center of the learning process.

The game not only provides structured and in-depth learning content but also presents an interactive and enjoyable learning experience. When students answer questions correctly, they are recognized for their

achievements, giving them positive reinforcement to continue learning. However, if they answer incorrectly, they are not left alone. With the automatic assistance provided in the game, students are guided to solve problems and achieve better understanding. Furthermore, with additional features such as material definitions presented in the game, students have access to diverse learning sources. They learn not only through text or teacher explanations but also through practical experiences presented in the form of games. This not only enhances their understanding of the material but also helps them internalize the concepts more comprehensively.

The use of educational games is also aligned with the goals of current curriculum development in Indonesia. The "*merdeka*" curriculum aims to provide more freedom to teachers and students in the learning process, as well as encouraging the use of more innovative and adaptive approaches according to students' needs. Thus, this game not only becomes an effective learning tool but also a step towards a more inclusive, dynamic, and age-appropriate education.



(a) (b)

Figure 8. Role-Playing Games in the classroom

The integration of Role-playing games (RPG) within educational contexts has created substantial opportunities to enhance students' interest and motivation in learning. With the features provided by these games, educators have the freedom to adapt genres and themes according to the needs of learning (see Figure 8a). This allows them to create a more profound and relevant learning experience for students. Furthermore, active participation of students in designing the storyline and maps in their own games not only stimulates their creativity but also triggers a deep curiosity about the development of the story and adventures they create (see Figure 8b). Thus, students are actively involved in the learning process, as they feel in control of their own learning experience. The game implemented in this research is titled "*Mathepolis: Petualangan Matematika*" with an adventure genre. To capture the attention of students, educators can develop various storylines and genres within the game, ranging from comedy, magic, battles to drama, to enhance students' motivation in learning using RPG-based games.

Through this approach, learning no longer feels monotonous or limited by traditional constraints. Instead, students feel engaged and inspired to explore the concepts taught through the game, increasing engagement and retention of learning material. Thus, the integration of RPG in education not only stimulates students' imagination but also opens the way to a deeper and more sustainable understanding.

To obtain more in-depth data regarding the positive and negative impacts of using technology in education, researchers interviewed other subjects to explore their experiences related to the integration of technology in the classroom.

Researcher : *As a teacher, have you ever integrated technology into classroom learning?*
Subject 2 : *Yes, I have used technology-based applications in learning mathematics*
Researcher : *What are the positive impacts of integrating technology, especially gamification, into the world of education?*
Subject 2 : *By integrating technology, especially gamification effectively into the world of education, educators can create more engaging, effective, and relevant learning experiences for students. Additionally, the use of technology can increase student engagement and encourage collaboration."*
Researcher : *Are there any negative impacts of integrating gamification into the world of education?*

Subject 2 : *Gamification can potentially have negative impacts if its use brings about adverse effects in terms of students' understanding, such as students solely focusing on the game aspect without grasping the underlying material. Additionally, students might engage with the game only during specific times or for the sake of completing tasks within the game, rather than for meaningful, sustained learning.*

Researcher : *As a teacher, how do you overcome those negative impacts?*

Subject 2 : *For questions with high complexity, it can be difficult to manage. Therefore, typically, for gamification, I often use it in the initial stages of introducing the material as a form of engagement or simply to grab students' attention.*

In addition to having positive impacts, the use of gamification also requires special attention from educators. Integrating gamification into the world of education can lead students to experience technology addiction, which may result in dependence on certain devices and applications, disrupting self-directed learning and creativity. Moreover, excessive focus on technology can sideline more traditional yet effective teaching and learning methods, such as classroom discussions, hands-on practice, and collaborative problem-solving. Additionally, inadequate explanation provided to students may lead them to perceive the learning process merely as a stepping stone to overcome obstacles and obtain a reward, thereby neglecting the importance of successful learning. If used or implemented excessively, social interaction may be threatened if not balanced, the role of books may diminish, lack of educator supervision may jeopardize students from accessing inappropriate content, and an imbalance between material and technological roles may threaten the effectiveness of learning. As a consequence, teacher must approach gamification thoughtfully, integrating it judiciously into their teaching practices while maintaining a balance with traditional methods to ensure effective and holistic learning experiences for students.

DISCUSSION

The research results indicate that there is a positive correlation between the integration of technology in mathematics learning and students' interest, collaboration, and motivation. This is in line with Huang et al. (2020), which stated that implementing gamification enhances student engagement, interest, and motivation in educational settings while also fostering collaborative learning processes. Bai et al. (2020) conducted a study confirming that students who engaged in a course integrating gamification techniques demonstrated notably superior academic performance compared to those in a course without gamification. Putri et al. (2024) stated that the integration of technology offers opportunities to boost student engagement, deepen comprehension of mathematical concepts, and create a more dynamic and enjoyable learning experience. Moreover, research has consistently shown that gamification is an effective tool for teaching mathematical concepts. This is in line with Debón et al. (2023), the results showed that students feel that the game has greatly enhanced their understanding of the subject. Over 60% agree or strongly agree that the game has been beneficial for their knowledge acquisition, while only about 8% believe it has not been helpful. Flores et al. (2016) demonstrated that challenge-based gamification enhanced students' understanding and application of mathematical modeling. Salvatierra et al. (2021) further supported these findings, reporting that gamification was perceived as a dynamic tool for learning basic mathematics and mathematical complements by university students. These studies collectively suggest that gamification can be a valuable strategy for teaching mathematical concepts.

Students are more interested in using technology-based math applications or games rathen than conventional learning. This is in line with Ibrahim et al. (2018), which stated that approximately 80% of students exhibit a favorable attitude towards the games, with around 84% finding them enjoyable as a learning tool. Additionally, an average of 80% agreed that the games offer them learning opportunities. Moreover, nearly 85% of students expressed interest in utilizing educational games for their future learning endeavors. Litster & Moyer-Packenham (2019) emphasizing a balanced approach and establishing connections between gaming and mathematical affordances is crucial to effectively support student learning.

In the Role-Playing Games perspective, RPG learning is suitable for use in schools and can aid pupils in improving their problem-solving abilities (Andriyani et al., 2024). As stated by Lastuti (2018), the use of teaching materials can assist students in developing their problem-solving skills. Games in the RPG genre hold the top position in Indonesia, with a 46% share. These games have the advantage of allowing users to directly control or play a character within a pre-designed game story (Samudra & Djuniadi, 2017).

Pratama and Setyaningrum (2018) investigated the impact of game-based learning, developed using a problem-solving approach, on students' cognitive and affective aspects. The results indicated that students exposed to game-based learning through this method experienced positive effects in both areas. The improvement in cognitive aspects was evidenced by test results, where 87.88% of students met the minimum mastery criteria in learning three-dimensional geometry. Meanwhile, the positive impact on affective aspects was demonstrated through a questionnaire, which showed a significant increase in students' interest in learning mathematics. Initially, their interest had a score of 65.36, categorized as medium. After using the GeoGame Adventure media, the interest score rose to 98, placing it in the high category. Implementing game-based learning through a problem-solving approach (GeoGame Adventure) produced better learning outcomes compared to traditional textbook-oriented instruction. Additionally, the study confirmed the hypothesis that game-based learning could provide significant benefits for problem-solving in mathematics classes (Setyaningrum et al., 2018).

In addition to having positive impacts, the use of gamification also requires special attention from educators (Setyaningrum et al., 2023). Incorporating game elements into learning management systems can have negative effects. However, students may experience negative emotions, struggle to form positive relationships with peers, and become demotivated and anxious due to the integration of game elements in online learning (Alabbasi, 2018). Sánchez-Mena & Martí-Parreño (2017) stated that teachers perceive that gamification presents several challenges. A primary barrier for teachers using gamification in their courses is the perceived lack of resources, including the time needed to prepare gamified activities, insufficient knowledge about gamification, and an unsuitable classroom environment for implementing gamified activities. Another challenge of integrating technology into education is closely related to the available infrastructure and facilities. Therefore, it requires collaboration from various stakeholders, ranging from educators to policymakers, to ensure the successful integration of technology in education (Jhurree, 2005).

CONCLUSION

The integration of technology, particularly the use of gamification in mathematics education, has received a positive response from students and serves as an innovation in mathematics learning. Technology in education significantly aids teachers in developing engaging and interactive learning environments for students. RPG games have great potential to be used as an interactive learning tools in the classroom because they contain various interesting features that support the psychological and cognitive development of students. By utilizing RPG Maker, teachers can design stories and scenarios that align with the lesson material, allowing students to learn through enjoyable and challenging games.

Based on the findings above, there are several implications of this research. First, the use of technology in mathematics learning, including gamification, has been proven to increase students' interest, collaboration, and motivation. Therefore, schools and teachers should consider using technology such as educational applications, interactive software, and online platforms to teach mathematics. Second, students show a high interest in using games for learning and wish to continue using games in the future. Thus, educational developers and policymakers should invest in the development of educational game applications and platforms that students can access independently. This supports continuous learning outside the traditional classroom environment.

There are some limitations to this research. However, this research only integrates gamification technology in the genre of Role-Playing Games. Further research has great potential to integrate different game genres into learning, such as Real-Time Strategy (RTS), First-Person Shooter (FPS), Third-Person Shooter (TPS), Adventure, and simulation games. Additionally, researchers are recommended to design a didactic design that integrate technology, ensuring that educational practices are both engaging and effective in enhancing students' learning experiences.

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