A Review of Gamification in Enhancing Mathematics Education

Che Ku Nuraini Che Ku Mohd[1]*, Farah Natasha Juhari[2], Fatin Aliah Yahya[3], Shafina Abd Karim Ishigaki[4], Nurul Hajar Mohd Yussoff[5], Mohd Syafiq Abd Aziz[6], Helmi Mohd Kasim[7]

[1,2,3,4]Pervasive Computing & Educational Technology, Department of Media Interactive, Fakulti Teknologi Maklumat dan Komunikasi, Universiti Teknikal Malaysia Melaka, 76100 Durian Tunggal Melaka, Malaysia

[5]Fakulti Teknologi dan Kejuruteraan Industri dan Pembuatan, Universiti Teknikal Malaysia Melaka, Malaysia

[6]Fakulti Teknologi dan Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka, Malaysia

[7]Operations & Project Director, Integrasi Pintar Sdn Bhd, Medan Perniagaan, 60, Jalan MSJ 3, Taman Senawang Jaya, 70450 Senawang, Negeri Sembilan, Malaysia

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.910000751

Received: 02 November 2025; Accepted: 07 November 2025; Published: 23 November 2025

ABSTRACT

This paper explores the intersection between gamification and mathematics education, aiming to assess its effectiveness in enhancing mathematics skills. Given the pervasive influence of digital technology in education, gamification emerges as a promising method to captivate young learners in mathematical concepts within a lively and interactive learning environment. Nonetheless, specific research on applying gamification across primary mathematics education. The study conducts a review of existing literature on gamification techniques and their impact on mathematics education, emphasizing both the potential advantages and obstacles associated with integrating gaming elements. By examining various gamification strategies, including game-based learning, rewards systems, and interactive platforms, this study aims to provide insights into the effectiveness and impact of gamified approaches on mathematical proficiency, student engagement, and overall learning outcomes. Moreover, this paper also explores the role of technology, design elements, and psychological factors in shaping the gamified learning environment and influencing student attitudes and behaviors towards mathematics. Additionally, it investigates the roles of intrinsic and extrinsic motivation in fostering engagement and positive learning outcomes among students. The research also explores the design of gamified learning experiences tailored to individual learning preferences, thereby promoting skill development in mathematics. By investigating the potential of gamification in education, this study contributes to ongoing discussions on innovative pedagogical approaches aimed at improving mathematics proficiency and nurturing a lifelong love for learning among students.

Keywords: Gamification, Mathematics, Computer, Technology, Education, Interactive Platforms

INTRODUCTION

The significance of mathematics education for students cannot be overstated as it forms a crucial foundation for academic achievement and cognitive growth. Given the challenging and essential nature of the subject, mathematics remains one of the most prominent topics in education. Over the years, there has been a prevailing belief among both educators and students that mathematical prowess is a trait reserved for a select few, often referred to as "math people," leaving others to grapple with understanding this subject. The contemporary students, who are immersed in daily technology usage, have evolved into digital natives, adept at engaging and playing with online games [1]. The incorporation of gamification has garnered significant attention from educators and researchers, aiming to integrate game elements into non-gaming environments

like classrooms and workplaces to enhance motivation and engagement in learning [2]. Various factors, including cultural diversity, social dynamics, and technological advancements, significantly influence the learning processes of learners [3]. Against this backdrop, it becomes evident that the digital era and the widespread use of smart devices have become integral aspects of learners' daily lives, with many utilizing them for diverse purposes [4].

However, engaging students with mathematical concepts can present challenges due to the abstract nature of the subject. In recent years, gamification has emerged as a promising strategy to enrich mathematics instruction by integrating game design elements to create interactive and enjoyable learning experiences. The primary school stage holds significant importance in childhood education, particularly concerning mathematics, which is pivotal for future development. Nevertheless, traditional mathematics classes often fail to accommodate individual differences, limiting students from reaching their full potential [5]. While some may attribute students' poor academic performance to their lack of attention, the thoughtful design of classroom teaching content proves to be more beneficial for efficient knowledge acquisition [6]. In many modern primary school classrooms, instruction remains predominantly traditional, overlooking individual differences and varying levels of student enthusiasm, particularly evident in mathematics courses [7]. Enhancing students' learning outcomes in Science, Technology, Engineering, And Mathematics (STEM) (fields can be achieved through the utilization of digital games [8]. Globally, there is a recognized urgency to advance STEM education [9], aiming to equip students with high levels of achievement, mastery, and innovation in STEM subjects from kindergarten through tertiary educational levels [10]. In this context, the adoption and implementation of gamification in STEM-related areas could serve as a pathway to motivate students to actively engage and excel in STEM subjects.

Educators need to prioritize the design of teaching content to foster deeper student learning and enhance classroom efficiency. Traditional mathematics instruction typically relies on direct lectures delivered by teachers. Students respond, engage in continuous homework and exercises, and undergo final exams to assess their understanding and proficiency in the subject. However, this approach lacks mechanisms to gauge individual student comprehension of mathematical concepts [5]. Parents represent a cornerstone within the social institutions that greatly influence and are influenced by schools. Within the educational system, teachers, students, and parents constitute essential elements that ensure its continuity and contribute significant value to its functioning [11]. It's crucial to recognize that modern education facilitates the development of various skills, including utilizing contemporary technologies for information access, generating new insights from acquired information, and fostering creativity among learners [12].

The development of mathematics skills during childhood establishes the foundation for proficiency across various academic and practical domains. Core concepts such as numeracy, problem-solving, and spatial reasoning are integral for achieving mathematical fluency. However, numerous students encounter obstacles in mastering these skills, stemming from challenges such as abstract thinking, lack of motivation, and limited exposure to real-world applications. Overcoming these hurdles necessitates the implementation of innovative pedagogical methods that accommodate diverse learning styles and preferences. Mathematics skills are pivotal for students' academic success and cognitive growth. Ranging from basic numeracy to advanced problem-solving, mathematics significantly contributes to the development of students' analytical thinking, logical reasoning, and quantitative literacy. Establishing robust mathematics skills early in life not only prepares students for future academic endeavors but also furnishes them with indispensable tools for tackling real-world challenges.

During the elementary years, students embark on acquiring fundamental numeracy skills encompassing counting, addition, subtraction, multiplication, and division. These foundational principles serve as the cornerstone for mastering intricate mathematical operations and problem-solving techniques. Through hands-on experiences, visual aids, and interactive games, students cultivate a conceptual grasp of numbers and arithmetic, establishing a sturdy groundwork for future mathematical comprehension. As students' progress through their educational journey, they encounter progressively intricate mathematical concepts and proficiencies, which include geometry, algebra, fractions, decimals, and measurement. Mastery of these subjects necessitates the utilization of higher-order cognitive skills such as spatial reasoning, pattern recognition, and logical deduction. Engaging in activities involving spatial manipulation, geometric

visualization, and algebraic reasoning empowers students to analyze problems critically, formulate hypotheses, and apply mathematical principles to real-world contexts.

Additionally, mathematics education nurtures critical thinking abilities by prompting students to explore various problem-solving approaches, assess evidence, and articulate their reasoning proficiently. By means of collaborative endeavors, classroom dialogues, and investigative assignments, students cultivate creative thinking skills, demonstrate resilience in problem-solving, and substantiate their solutions with mathematical evidence. Furthermore, mathematics education encourages interdisciplinary linkages by illustrating the interconnectedness of mathematics with other disciplines such as science, technology, engineering, and economics. Through the integration of mathematical principles with practical contexts and real-world applications, students gain a deeper understanding of the applicability and adaptability of mathematics across diverse domains.

Gamification in Educational Context

The integration of gamification in education has garnered praise for instigating competition, fostering critical thinking, and promoting collaborative engagement, all of which contribute to the construction of new knowledge and the establishment of a positive learning environment [10]. Through gaming experiences in learning, learners acquire relevant skills and practical knowledge essential for the 21st century [13]. As a novel and innovative teaching approach, gamification has the potential to enhance students' motivation and interest in various subjects, including primary school mathematics. However, its utilization in primary school mathematics remains relatively limited. Mathematical problems encountered in primary education can range from basic to more complex, serving as exercises to reinforce understanding of concepts such as matching polygons with their corresponding names or solving elementary mathematical equations [5]. Numerous studies have demonstrated the efficacy of gamification in teaching mathematics at the elementary school level, underscoring its potential as an invaluable tool for primary education. Recognized as an emerging technology, gamification is believed to exert a significant impact on education, particularly in developed countries (Yan & Yusheng, 2023). It involves the integration of game design elements into non-gaming contexts, including workplaces and educational settings [14].

Nowadays, where high-tech devices are omnipresent, there is a growing need for more visual approaches to teaching mathematics in order to engage students, particularly those who are visual thinkers and may struggle with the subject [15]. Teachers' guidance and pedagogical support are essential during gamified educational activities to ensure effective learning processes [13]. Additionally, there should be a concerted effort to enhance teachers' proficiency in utilizing digital technology and invest in technological resources to address academic gaps and challenges in subjects such as reading and mathematics following the pandemic [16]. Gamification represents an innovative approach applied in various personalized applications, incorporating elements like scores, motivational values, and competitive opportunities among players [17]. Three functions within gamification: production, consumption, and exchange [18]. The execution of tasks by players using specific tools relates to the production function. Gamification aims to integrate certain game functions into teaching practices, facilitating expanded thinking, framework construction, aesthetics, and integration of game mechanics [19]. Its elements include reward mechanisms, rules and instructions, narratives, challenges, decision-making processes, and a sense of mastery, all designed to enhance students' motivation. With the passage of time, digital games are gaining increasing popularity.

Currently, as defined by researchers, gamification has the potential to enhance students' motivation and promote self-directed learning [20]. Given the limited interest in mathematics and the lack of motivation for self-learning among students, gamification emerges as a promising application in this context. However, gamification remains primarily in the research phase and has not yet been extensively or systematically implemented in mathematics classrooms. Thus, the question of whether gamification can effectively be utilized in elementary school mathematics remains unanswered. Gamified instruction captivates the interest of elementary students, allowing them to experience both success and failure in a supportive environment. Through a reward system, students learn to engage in healthy competition and become more motivated to learn as they seek rewards. Additionally, Gamification not only facilitates the acquisition of mathematical knowledge but also enhances students' teamwork, management, and communication skills. Presently,

traditional mathematics teaching predominantly emphasizes theoretical instruction, often neglecting the development of students' diverse skill sets. However, these skills are essential for students' future success.

Gamification integrates principles and mechanics of game design into contexts beyond gaming to amplify engagement and motivation. Within mathematics education, gamification techniques encompass a range of strategies, including game-based learning platforms, educational apps, and interactive simulations. These tools employ elements like points, badges, leaderboards, and narrative storytelling to craft immersive and interactive learning environments. Through features like immediate feedback, scaffolded challenges, and avenues for exploration, gamified experiences foster active learning and intrinsic motivation among students. As potent instruments in enhancing mathematics education, gamification techniques amalgamate elements of game design into learning environments. The inherent motivation and engagement inherent in games, these techniques reinvigorate mathematics instruction, transforming it into dynamic, interactive experiences that capture the interest of young learners and deepen their comprehension of mathematical concepts [5]. In mathematics education, one prominent gamification technique involves integrating game-based learning platforms and educational apps. These platforms present interactive activities, puzzles, and challenges, providing students with opportunities to explore mathematical concepts in a lively and captivating manner. Through vibrant graphics, animated characters, and engaging narratives, game-based learning environments evoke a sense of adventure and enthusiasm, motivating students to actively engage and persevere through problem-solving tasks. Another gamification technique entails the implementation of rewards and incentives to reinforce desired behaviors and achievements. Through the acquisition of points, badges, and virtual rewards, students receive immediate acknowledgment and feedback for their efforts, fostering feelings of accomplishment and advancement. Additionally, leaderboards and competitive elements promote friendly rivalry and collaboration among peers, cultivating a positive learning community where students encourage and inspire one another to excel.

Moreover, gamification techniques often integrate aspects of challenge and progression to scaffold learning experiences and accommodate individual skill levels. Adaptive learning algorithms dynamically adjust task difficulty based on students' performance and mastery, ensuring they face appropriate challenges while avoiding frustration or boredom. By presenting a series of progressively complex challenges and opportunities for mastery, gamified learning experiences foster ongoing improvement and skill enhancement over time. Additionally, storytelling and narrative-driven approaches are frequently employed to contextualize mathematical concepts and immerse students in engaging learning experiences. By embedding mathematics problems within compelling narratives, students actively participate in solving real-world challenges and exploring mathematical concepts within meaningful contexts. Through role-playing, problem-solving quests, and interactive scenarios, students hone critical thinking skills and apply mathematical principles to authentic situations, promoting deeper understanding and content retention. Gamification techniques offer innovative and impactful strategies to enrich mathematics education among students by leveraging the motivational allure of games to encourage active learning, engagement, and skill refinement. By creating immersive and interactive learning environments that cater to various learning styles and preferences, gamification revolutionizes mathematics instruction into a dynamic and enjoyable endeavor, empowering students to become self-assured, proficient, and lifelong learners.

Review of Gamification in Mathematics

Implementing gamification in teaching begins with ensuring its alignment with the content and avoiding rigid integration. Not all content lends itself well to gamified instruction, and inappropriate use may yield adverse effects. Teachers assume a crucial role in the game design process, necessitating alignment with students' needs and relevant content. In mathematics education, gamification can effectively guide students in learning mathematical concepts by rendering mathematical models intriguing or embedding them within narratives. An inventive method for teaching "adjacency" in mathematics by constructing a friendly robot using lines and dots, assigning opposite corners of the robot's figure as neighbors. The four fundamental operations, encompassing addition, subtraction, multiplication, and division, hold significant importance in primary school mathematics [21]. For instance, when teaching basic addition and subtraction operations, teachers can introduce a shopping-themed game [22]. Students use varying amounts of money to purchase goods from the teacher, ensuring that all funds are spent precisely. Correctly calculating the total price of purchased items

earns students a prize, intertwining arithmetic knowledge with an enjoyable shopping activity [23].

Another gamified application involves teaching mixed arithmetic using a game called 24 points. Students are grouped and provided with a set of cards containing different numbers. The game's rules dictate drawing four cards per turn, wherein students utilize the four operations to manipulate the numbers, aiming for a final result of 24 to earn game coins. The group with the most game coins emerges victorious, combining mixed operations knowledge with competitive gameplay to reinforce arithmetic methods [22]. However, a significant challenge in gamification lies in game design. Educators must familiarize themselves with essential elements of gamification, including users, challenges/tasks, points, levels, badges, and user rankings.

Gamification holds equal significance in teaching geometry content, a pivotal component of primary school mathematics which encompasses recognition of shapes such as triangles, rectangles, squares, and circles, along with calculations of their perimeter and area. Mastery of geometry aids in the development of spatial thinking and multidirectional cognition. Research indicates that gamification can offer numerous benefits to geometry learning, although challenges persist that require resolution [23]. In contrast to traditional teaching methods, modern education leverages multimedia formats to present content. Teachers can utilize such technology to dynamically dissect geometric shapes into various forms [24]. Engaging with geometric shapes fosters spatial awareness and stimulates imagination, prompting teachers to encourage students to explore geometric shapes from diverse perspectives during instruction. With the continuous advancement of technology, an increasing number of applications merge gaming and geometry, offering educators additional tools to enhance learning experiences [23]. Dividing geometric shapes into various forms and dynamically integrating them aids students in mentally constructing different figures and enhances spatial imagination. Moreover, teachers can employ flash-based games to elucidate the characteristics of geometric shapes, ensuring student engagement remains paramount when utilizing games or multimedia technology.

In a study that conducted by [25], the impact of gamification on students' success in scientific lessons in Turkey was examined quantitatively. The findings indicate that gamifying scientific classes holds the potential to significantly enhance students' problem-solving abilities [25]. Additionally, [26] explored the effects of gamification activities on academic achievement and attitudes toward the course and cooperative learning among students in social studies in Turkey. Employing a quantitative approach, the study utilized a semi-experimental research methodology involving 60 students. The results reveal that gamification in social studies education makes substantial contributions to students' attitudes toward the course, cooperative learning abilities, and academic achievement compared to conventional methods [26]. An exploratory holistic investigation into digital gamification in mathematics education, employing a blend of social network analysis, computerized lexical analysis, and content analyses to delineate the challenges, objectives, and emerging trends through a comprehensive literature review [27]. In addition to motivation and engagement, their study highlights that gamification also bolsters mathematical problem-solving, attainment, and performance. Furthermore, [28] scrutinized the impact of gamification on the academic achievement and perceptions of 46 mathematics students regarding the course. Utilizing a quasi-experimental methodology, the study identifies significant statistical disparities favoring the experimental group in achievement test scores, although no notable changes were observed in the attitude scale [28]. Additionally, [29] investigated the effects of gamification in education through a meta-analysis encompassing 21 studies published between 2012 and 2018. Their findings indicate an overall enhancement in learner performance by 50% in gamified courses [29]. Assessing the impact of gamification on the academic performance and mathematical skills of high school students, focusing on the perspectives of teachers. The study adopted a quantitative approach, gathering data via a questionnaire administered to 169 randomly selected mathematics instructors. According to the study's results, teachers express a positive inclination toward the integration of electronic gaming applications for teaching mathematics, highlighting their perceived benefits in enhancing students' abilities in retention, comprehension, analysis, problem-solving, and decision-making [30].

Factors Contributing to Effective Mathematics Through Gamification

Several critical factors contribute to the efficacy of gamified mathematics instruction. Intrinsic motivation, rooted in feelings of autonomy, competence, and relatedness, serves as a fundamental driver for sustaining engagement and nurturing a growth mindset. While extrinsic motivators, like rewards and recognition, can also

bolster motivation, they must be carefully managed to prevent undermining intrinsic interest. Moreover, the design of gamified experiences should integrate elements of challenge, mastery, and progression to optimize learning outcomes. Personalization and adaptability further enhance the effectiveness of gamified instruction by tailoring experiences to individual learning preferences and abilities. Games closely mirror real-life situations, enabling students to build confidence in their learning process, thereby enhancing learning efficiency. Furthermore, games can ignite students' interest in learning, fostering a positive emotional effect on their learning experiences. Through gameplay, students actively engage in participation and strategic thinking, which contributes to the improvement of learning quality [23]. Gamification promotes user engagement, particularly in educational settings where teaching and learning activities are expected to be enjoyable and captivating [31]. Indeed, numerous studies underscore the significance of gamification in evaluating its impact on student learning [32]. Cooperative teaching represents a significant aspect of gamification. In mathematics instruction, cooperative learning yields substantial benefits [33]. Cooperative group learning enhances students' creative thinking abilities, fostering a collaborative environment where students articulate their perspectives and engage in multi-level communication. This learning environment empowers students to harness their creative thinking skills, enabling diverse interpretations of mathematical concepts. Hence, gamification emerges as a highly effective pedagogical approach worthy of promotion in education [23].

Impact on Mathematics Education

Engaging in gamification activities is likely to enhance students' enjoyment of the learning process and increase their motivation and engagement in studying [34]. A majority of students exhibit positive attitudes toward playing mathematics video games [35]. Hence, incorporating gamified activities in the classroom can prove beneficial, particularly when students perceive the lesson as dull or encounter challenges in achieving the learning objectives. It is imperative for teachers to discern how to motivate students to complete tasks [36]. In essence, teachers' comprehension of the diverse student profiles in the classroom equips them to effectively employ gamified activities to inspire and involve students [37]. Research into the impact of gamification in mathematics education yields promising findings. Studies demonstrate enhancements in student engagement, motivation, and performance when exposed to gamified learning environments. By transforming mathematics instruction into dynamic and interactive experiences, gamification fosters a deeper comprehension of mathematical concepts and encourages lifelong learning habits. However, challenges such as balancing entertainment with educational content, ensuring accessibility and inclusivity, and addressing potential equity issues necessitate careful consideration. The profound impact of gamification techniques on mathematics education is evident, revolutionizing traditional teaching approaches and reshaping students' interaction with mathematical concepts. Through the integration of game elements into educational contexts, gamification holds the potential to elevate motivation, engagement, and learning outcomes across diverse student populations.

One of the most impacts of gamification on mathematics education lies in its capacity to enhance student engagement and motivation. Conventional methods of teaching mathematics often struggle to pique students' interest or instill genuine enthusiasm for the subject. However, gamification techniques harness the inherent enjoyment and thrill associated with games to craft interactive and absorbing learning encounters. By integrating components such as challenges, rewards, and competition, gamified mathematics instruction captures students' focus and promotes active involvement in problem-solving endeavors. Additionally, gamification techniques foster a growth mindset and resilience amidst challenges. Through continuous feedback loops, scaffolded challenges, and avenues for exploration, students cultivate perseverance and determination in tackling mathematical problems. Errors are redefined as opportunities for learning and growth rather than setbacks, fostering a supportive learning atmosphere where students feel emboldened to embrace risks and confront challenges.

Furthermore, gamification amplifies the relevance and practicality of mathematics in real-world contexts. By integrating mathematical principles into meaningful narratives and scenarios, students develop a deeper comprehension of how mathematics is utilized in everyday life and across diverse disciplines. Gamified learning endeavors prompt students to establish connections between abstract mathematical concepts and tangible applications, fostering a richer understanding of mathematics' significance and applicability in their surroundings. Additionally, gamification techniques cultivate collaborative learning and peer interaction.

Through multiplayer games, cooperative challenges, and group competitions, students collaborate with peers to resolve issues and attain shared objectives. Collaboration nurtures a sense of community and camaraderie among students, fostering teamwork, communication and social skills. Moreover, gamification serves as a valuable tool for collecting data and insights into students' learning progress and performance. By monitoring students' interactions, behaviors, and accomplishments within gamified learning environments, educators gain valuable perspectives into students' strengths, areas for improvement, and weaknesses. This data-driven approach enables educators to tailor instruction, offer targeted assistance, and customize learning experiences to meet students' diverse needs. The impact of gamification on mathematics education is multi-faceted and extensive. By nurturing engagement, motivation, relevance, collaboration, and personalized learning experiences, gamification techniques have the potential to transform mathematics instruction and empower students to become self-assured, capable, and lifelong learners. As educators delve into and implement gamification strategies in classrooms, the future of mathematics education holds promise for innovative, interactive, and transformative learning encounters.

While technology advances rapidly and numerous multimedia techniques prove beneficial for teaching and learning, their adoption remains limited in many schools. Instead of embracing these innovative pedagogies, numerous schools persist in traditional teaching methods, causing them to fall significantly behind. The absence of adequate financial support contributes to educational stagnation [23]. Additionally, sufficient space is necessary for gaming activities. Many school classrooms accommodate nearly 60 students, occupying nearly all available space and leaving minimal room for gaming activities. The abundance of students also makes it challenging to ensure the participation of every student in the game, as it consumes excessive classroom time. These are objective environmental constraints that hinder the proper functioning of gamification. Moreover, teachers must possess effective coordination skills. They need to adeptly guide students through the game and manage its duration to prevent interference with content learning.

CONCLUSION

The manipulation of game mechanisms can lead to the development of sustainable and motivating gamified applications [32]. Poorly managed mechanics or game features may hinder the achievement of educational goals through gamification, whereas effective mechanics like tokens, points, and badges have the potential to engage students and enhance their performance ([38]. Successful and impactful gamification activities require careful consideration of the curriculum, subject context, organizational aspects, and learner performance in game design [38]. It is common for students to feel confused and hesitant when playing a game for the first time, especially if they are unfamiliar with the rules, but active participation can dispel negative attitudes toward the game [39]. Furthermore, some students may improve and learn from their experiences if they replay the game despite initial failures. Despite the challenges and the need for specific skills, players should be guided through tasks with enjoyable tutorials, level management based on goal difficulties, and narratives to encourage continued play [40]. Offering various types of games can be highly beneficial in maintaining students' positive attitudes toward gamification in mathematics [35]. To sustain engagement and incentivize desired behaviors, gamification can be enhanced with modifications such as tracking systems, feedback mechanisms, and goal setting [17].

Gamification provides students with opportunities to develop various skills, including teamwork, communication, and critical thinking. It serves as a powerful tool for improving mathematics proficiency among students by creating immersive, engaging, and tailored learning environments. By integrating principles of game design and technology, educators can cultivate a positive atmosphere for learning mathematics, motivating and empowering students to explore, experiment, and succeed in the subject. Continued research and innovation in gamified mathematics instruction are crucial to fully realize the potential of this transformative approach and ensure equitable access to high-quality education for all students. The integration of gamification techniques holds significant promise for enhancing mathematics skills within educational settings. By incorporating elements like challenges, rewards, and interactive narratives, gamification revolutionizes traditional mathematics teaching into dynamic and captivating learning experiences. The effective collaboration and reciprocal interaction between families and schools during the educational journey greatly contribute to students' achievements in mathematics. As children receive their initial education within

the family, parents serve as their first teachers [11].

The effectiveness of gamification in bolstering mathematics skills among students stems from its capacity to cultivate intrinsic motivation, active engagement, and profound interaction with mathematical principles. By leveraging students' inherent penchant for exploration and play, gamified learning environments seize their attention and instill a sense of intrigue and inquisitiveness about mathematics. Additionally, gamification nurtures a growth mindset by recontextualizing errors as opportunities for learning and growth. Through continuous feedback and structured challenges, students cultivate resilience, persistence, and problem-solving abilities crucial for excelling in mathematics and beyond. Moreover, gamification enriches the relevance and practicality of mathematics by illustrating its applications in real-world scenarios, fostering a deeper comprehension of how mathematical concepts manifest in everyday life and various fields of study. By integrating mathematics into meaningful narratives and contexts, students develop a heightened appreciation for the practicality and adaptability of mathematics in diverse contexts.

Moreover, gamification fosters collaboration, communication, and teamwork among students, fostering a supportive learning community where peers encourage and assist each other in achieving shared objectives. Through multiplayer games, collaborative tasks, and group competitions, students learn the value of cooperation while honing their social and interpersonal skills. As we envision the future landscape of mathematics education, the integration of gamification techniques presents promising opportunities to transform teaching and learning methodologies, equip students with confidence and proficiency in mathematics, and instill a lifelong passion for learning. By embracing innovation and creativity in education, we can fully harness the potential of gamification to inspire the next generation of problem-solvers, critical thinkers, and mathematics enthusiasts. Gamified instruction also helps students learn to embrace failure, fostering emotional development and self-regulation. Critical thinking, an essential social skill, is actively nurtured through gamified learning experiences as students engage in problem-solving and reflection. Prompt and opinion-based feedback from teachers is essential to facilitate this process [5].

However, it is crucial to recognize that many students encounter difficulties when learning mathematics. Challenges such as limited access to quality education, insufficient instructional materials, and negative perceptions about mathematics can impede students' mathematical progress. Overcoming these obstacles requires a comprehensive approach that prioritizes inclusive teaching methods, customized instruction, and personalized learning opportunities tailored to individual preferences and learning modalities. Proficiency in mathematics is a fundamental skill set that equips students to think critically, tackle challenges, and make well-informed decisions in an increasingly intricate world. By cultivating a nurturing learning atmosphere that fosters curiosity, experimentation, and resilience, educators can cultivate students' mathematical abilities and instill a lifelong passion for learning. Gamification significantly influences every aspect of elementary mathematics education to varying degrees. Therefore, as gamification gains more prominence, future research can delve deeper into or expand upon the mentioned variables to facilitate comprehensive exploration of the subject matter.

Hence, gamification emerges as a valuable tool in primary school mathematics instruction, albeit with several uncertainties that necessitate complementation with other pedagogical approaches like experiential learning. It requires proactive efforts from teachers to maintain the classroom dynamics. Consequently, while it can enrich the teaching approach, it should be integrated with other methodologies and not relied upon exclusively [5]. Moreover, this study's insights extend beyond mathematics education, as the pros and cons of gamification are largely applicable across various subject classrooms. Future research endeavors could explore how gamification synergizes with other pedagogical methods and effectively integrates into existing teaching models.

ACKNOWLEDGEMENT

Authors would like to express deepest gratitude towards Universiti Teknikal Malaysia Melaka (UTeM), Center for Research and Innovation Management (CRIM), Department of Media Interactive, Faculty of Information & Communication Technology (FTMK), Pervasive Computing & Educational Technology (PET) and everyone who have helped and participated in this study. This study is funded by PJP/2024/FTMK/PERINTIS/S01897,

Universiti TeknikalMalaysia Melaka (UTeM).

REFERENCES

1. Machajewski, S. T., (2017). Application of Gamification in a College STEM Introductory Course: A Case Study, Online Submission.
2. Ortiz Rojas, M. E., Chiluiza, K., & Valcke, M., (2016). Gamification in Higher Education and STEM: A Systematic Review of Literature, International Conference on Education and New Learning Technologies (EDULEARN), pp. 6548-6558.
3. Marín-Díaz, V., Sampedro-Requena, B. E., Muñoz-Gonzalez, J. M., & Jiménez-Fanjul, N., (2020).The Possibilities of Gamifying the Mathematical Curriculum in Early Childhood Education Stage, Mathematics MPDI, 8(12),pp. 1-15.
4. Ortiz-Colon, A., Jordan, A., & Agredal, M., (2018). Gamification in Education: An Overview of the State of the Art, Educação e Pesquisa, 44, pp. 1-17.
5. Liu, Q., (2023). Gamification in Primary School Mathematics Teaching, Journal of Education, Humanities and Social Sciences, 22, pp. 428-433.
6. Zhang, M., (2021). Optimizing Teaching Design to Build an Efficient Mathematics Classroom, Maths Teaching Newsletter, 34, pp. 40-42.
7. Paniagua, A., & Istance, D., (2018). Building the C's Framework: Insights and Reflections, OECD Publishing, Paris, pp. 51-74.
8. Wang, L.-H., Chen, B., Hwang, G.-J., Guan, J.-Q., & Wang, Y.-Q., (2022). Effects of Digital Game-Based STEM Education on Students' Learning Achievement: A Meta-Analysis, International Journal of STEM Education, 9(26).
9. Lynch, T., Playfoot, J., De Nicola, C., Guarino, G., Di Salvadore, F., & Ghergulescu, I., (2018). Gamification Elements in STEM Subjects – Lessons Learned from NEWTON Project, Ireland International Conference on Education, IPeTEL Workshop.
10. Kanagwa, B., Kahiigi, E., Semwanga, A., Siminyu, S., & Lubowa, P., (2023). Towards Gamification of Science and Mathematics in Upper Primary Schools in Uganda, International Journal of Science and Technology
11. Deringol, Y., (2019). Parents' Expectation of Mathematics Education and Their Engagement in Education and Homework Habits of Students, Acta Educationis Generalis, pp. 16-40.
12. Turan-Özpolat, E., Karakoç, B., & Kara, K., (2017). Evaluation of the Teachers and Parents' Views About the Homework Given in Primary School, International Journal of Eurasia Social Sciences, 8(30), pp. 1849-1890.
13. Moseikina, M., Toktamysov, S., & Danshina, S., (2022). Modern Technologies and Gamification in Historical Education, Simulation & Gaming, 53(2), pp. 135-156.
14. Nikolaou, I., Georgiou, K., & Kotsasarlidou, V., (2019). Exploring the Relationship of a Gamified Assessment with Performance, The Spanish Journal of Psychology, 22(6), pp. 1-10.
15. Boaler, J., Chen, L., Williams, C., & Cordero, M., (2016). Seeing as Understanding: The Importance of Visual Mathematics for Our Brain and Learning, Journal of Applied and Computational Mathematics, 5, pp. 325.
16. Panagouli, E., Stavridou, A., Savvidi, C., Kourti, A., Psaltopoulou, T., Sergentanis, T. N., & Tsitsika, (2021). A., School Performance Among Students and Adolescents During COVID-19 Pandemic: A Systematic Review, Students, 8(12) , pp. 1134.
17. Deterding, S., (2019). Gamification in Management: Between Choice Architecture and Humanistic Design, Journal of Management Inquiry, 28(2), pp. 131-136.
18. Ciuchita, R., Heller, J., Köcher, S., Leclercq, T., Sidaoui, K., & Stead, S., (2022). It is Really Not a Game: An Integrative Review of Gamification for Service Research, Journal of Service Research, pp. 1-18.
19. Faiella, F., & Ricciardi, M., (2015). Gamification and Learning: A Review of Issues and Research, Journal of e-Learning and Knowledge Society, 11(3), pp. 13-21.
20. Kapp, K. M., (2012). The Gamification of Learning and Instruction, San Francisco, Pfeiffer,.
21. Wang, X., (2022). The Use of Guided Pedagogy in the Four Operations of Primary School Mathematics, Basic Education Forum, 29, pp. 88-89.

22. Wu, J., (2023). A Study on the Game-Based Teaching of Mathematics Number and Algebra in Primary Schools, Jiangxi Education, 27, pp. 70-71.
23. Yan, Y., (2023). Gamification in Primary School Mathematics Education, Journal of Education, Humanities and Social Sciences, 22,pp. 370-376.
24. Ma, J., (2022). Teaching Fun in Primary Mathematics Geometry, China Society for Intelligent Engineering Research, pp. 669-671.
25. Şahin, M., & Namlı, R. A., (2016). Gamification and Effects on Students' Science Lesson Achievement, International Journal on New Trends in Education and Their Implications, 7(1), pp. 41-47.
26. Öztürk, Ç., & Korkmaz, Ö., (2020). The Effect of Gamification Activities on Students' Academic Achievements in Social Studies Course, Participatory Educational Research, 7(1), pp. 1-15.
27. Yiğ, K. G., & Sezgin, S., (2021). An Exploratory Holistic Analysis of Digital Gamification in Mathematics Education, Journal of Educational Technology and Online Learning, 4(2), pp. 115-136.
28. Karamert, Ö., & Vardar, A. K., (2021). The Effect of Gamification on Young Mathematics Learners' Achievements and Attitudes, Journal of Educational Technology and Online Learning, 4(2), pp. 96-114.
29. Briffa, M., Jaftha, N., Loreto, G., Pinto, F. C. M., & Chircop, T., (2020). Improved Students' Performance Within Gamified Learning Environment: A Meta-Analysis Study, International Journal of Education and Research, 8(1), pp. 223-244.
30. Babeer, M. A., (2021). The Impact of Using Gamification on the Performance and Mathematical Skills of Princess Nourah Bint Abdulrahman University High School Students from Teachers' Perspectives, International Journal of Science and Technology, 7(6), pp. 270-287.
31. Kusuma, G. P., Wigati, E. K., Utomo, Y., & Suryapranata, L. K. P., (2018). Analysis of Gamification Models in Education Using MDA Framework, Procedia Computer Science, 135, pp. 385-392.
32. Welbers, K., Konijn, E. A., Burgers, C., & de Vaate, A. B., (2019). Gamification as a Tool for Engaging Student Learning: A Field Experiment with a Gamified App, E-Learning and Digital Media, 16(2), pp. 92-109.
33. Slavin, R. E., Lake, C., & Groff, C., (2009). Effective Programs in Middle and High School Mathematics: A Best-Evidence Synthesis, Review of Educational Research, 79(2), pp. 839-911.
34. Hossein-Mohand, H., Trujillo-Torres, J.-M., Gómez-García, M., & Campos-Soto, A., (2021). Analysis of the Use and Integration of the Flipped Learning Model, Project-Based Learning, and Gamification Methodologies by Secondary School Mathematics Teachers, Sustainability,13.
35. Beserra, V., Nussbaum, M., & Oteo, M., (2019). On-Task and Off-Task Behavior in the Classroom: A Study on Mathematics Learning with Educational Video Games, Journal of Educational Computing Research, 56(8), pp. 1361-1383.
36. Çakıroğlu, Ü., & Güler, M., (2021). Enhancing Statistical Literacy Skills Through Real-Life Activities Enriched with Gamification Elements: An Experimental Study, E-Learning and Digital Media, 18(5), pp. 441-459.
37. Ofosu-Ampong, K., (2020). The Shift to Gamification in Education: A Review on Dominant Issues, Journal of Educational Technology Systems, 49(1), pp. 113-137.
38. Morschheuser, B., & Hamari, J., (2019). The Gamification of Work: Lessons from Crowdsourcing, Journal of Management Inquiry, 28(2), pp. 145-148.