PREFACE

The SIG CS@e-Learning committee sincerely appreciates the dedication and contributions of the educators from Jabatan Sains Komputer & Matematik (JSKM), UiTM Penang Branch, in bringing the 9th edition to fruition. This edition received 30 scholarly articles, all of which met the required criteria and were accepted. Authors are encouraged to further refine their research with additional insights and discussions for potential publication in high-impact journals indexed by SCOPUS, WOS, or ERA.

The theme for the ninth volume, "Beyond Boundaries: The Multidimensional Horizons of E-Learning," reflects the continuous evolution of digital learning. Over the past few decades, e-learning has proven to be a transformative force in education, demonstrating exceptional adaptability and effectiveness. The widespread use of mobile technology has expanded its reach, making e-learning an essential component not only in higher education and vocational training but also in primary and secondary education. Emerging trends such as artificial intelligence (AI), micro-credentials, big data, virtual and augmented reality, blended learning, cloud-based platforms, gamification, mobile learning, the Internet of Things (IoT), and online video are reshaping the digital learning landscape.

SIG CS@e-Learning remains dedicated to fostering academic excellence through impactful publications. With continuous commitment and innovation, we aspire for JSKM to attain recognition in esteemed academic journals, further advancing the frontiers of e-learning.

Ts. Jamal Othman
Chief Editor
SIG CS@e-LEARNING
Beyond Boundaries : The Multidimensional Horizons of E-Learning
Vol. 9, 24 March 2025

TABLE OF CONTENTS

e-ISBN : 978-629-98755-5-0
SIG : e-Learning@CS
https://appspenang.uitm.edu.my/sigcs/
Publication Date : 24 – Mac- 2024

GAMIFICATION AND INTERACTIVE LEARNING: A STRATEGY FOR REDUCING MATHEMATICS' ANXIETY

*Fuziatul Norsyiha[1], Mawardi Omar[2], Norshuhada Samsudin[3] and Wan Nur Shaziayani[4]
**fuziatul@uitm.edu.my[1], mawardio@uitm.edu.my[2], norsh111@uitm.edu.my[3], shaziayani@uitm.edu.my[4]*

[1,2,3,4]Jabatan Sains Komputer & Matematik (JSKM),
Universiti Teknologi MARA Cawangan Pulau Pinang, Malaysia

**Corresponding author*

ABSTRACT

Innovations like gamification and interactive learning have revolutionized digital education by altering the way standard online teaching approaches are used. This is due to the fact that gamification in e-learning is redefining conventional educational methods and offering a creative way to increase student motivation, engagement, and retention of the material. Mathematics is often perceived as one of the most challenging subjects, with many students experiencing anxiety with a feeling of tension, fear, or apprehension that interferes with mathematical performance. This anxiety can lead to avoidance of math-related tasks, lower confidence, and poor academic outcomes. With the rise of online education, new teaching strategies are needed to create engaging and stress-free learning environments. One promising approach is gamification and interactive learning, which integrate game-based elements such as points, badges, challenges, and adaptive feedback to make learning mathematics more enjoyable and less intimidating. By shifting the focus from memorization to an interactive, problem-solving experience, gamification can help students develop a positive mindset toward mathematics while improving motivation and retention. This paper explores the types and roles of gamification in reducing mathematics anxiety and the impact on student engagement and confidence in learning mathematics.

Keywords: gamification, interactive learning, education tool, anxiety, mathematic

Introduction

Mathematics, often regarded as one of the most difficult subjects, poses significant challenges for many students. According to (Dowker et al., 2016), many studies over the years have indicated that many people have extremely negative attitudes to mathematics, sometimes amounting to severe anxiety. A considerable number of learners experience mathematics anxiety, a psychological phenomenon characterized by feelings of fear, tension, or apprehension that negatively impact their mathematical performance. This anxiety can lead to avoidance behaviours, reduced self-confidence, and ultimately, poor academic outcomes. While (Luttenberger et al., 2018) studied and showed that math anxiety takes immediate effect in math-related situations such as examinations or in the classroom. With the increasing shift towards online education, there is a growing need for teaching strategies that make mathematics more engaging and less intimidating. Additionally, (Mutodi & Ngirande, 2014) also found that mathematics anxiety is one psychological factor that affects students' achievement and their general

practices. Therefore, facilitators/teachers should strive to understand mathematics anxiety and implement teaching and learning strategies and study habits that can help them overcome anxiety.

In order to reduce the anxiety of mathematics, gamification was approached to transform mathematics into an engaging and enjoyable experience. Gamification can be part of student's educational lives in the years to come(Karamert & Kuyumcu Vardar, 2021). For example, when the facilitators/teachers ask a math question, students do not think about it in relation to society. So, by playing games, students commonly experience mastery, competence, enjoyment, immersion, or flow, all characteristics of intrinsically motivated human behavior. (Udjaja et al., 2018) also stated that gamification is a creative way of learning that has a tremendous power of influence to improve the level of learning independence and improve someone mathematic skills, subsequently expert system is needed to create content from mathematical learning. So, students are more likely to feel the connection between the subject and society. It will also increase student motivation and interest (Sakai & Shiota, 2016). Other than that, gamification and interactive learning are two of these developments that have attracted a lot of attention due to their potential to enhance the learning process, especially in difficult topics like mathematics. (Yiğ & Sezgin, 2021) found that gamification does not intend to provide learning directly, but it has an impact on many other learning variables through motivation, and engagement. Therefore, we can consider the use of gamification to solve the problem. Next, gamification is a dynamic substitute for traditional teaching techniques that uses game-based components including leaderboards, badges, points, and level up challenges. These techniques promote more profound learning and active participation by developing a sense of accomplishment and engagement.

Examples of Gamification in Mathematics

1. Reward-Based Learning

   Students receive rewards, such as stars or badges, for solving math problems correctly. Extra points can be given for completing bonus challenges or assisting classmates. A leaderboard can add an element of friendly competition, motivating students to improve.

2. Level Up Challenges

   Mathematical concepts are structured into levels, allowing students to advance as they master each topic. Just like in video games, each stage presents more complex problems, and successfully completing them unlocks new challenges or special rewards.

3. Story-Driven Math Adventures

   Math exercises can be made into an exciting adventure where students take on the roles of heroes and solve puzzles to advance in their quest by using a story line. In a "Math Quest," for example, completing equations could enable players to overcome challenges, solve mysteries, or save a virtual environment.

4. Interactive Digital Math Games

   Online platforms and mobile apps incorporate gamified elements to make learning more engaging. Tools like “Kahoot!” use timed quizzes and instant feedback, while games like “Prodigy” and “Dragon Box” create immersive role-playing experiences where students solve math problems to progress.

5. Real World Simulations

   Learning becomes more meaningful when math is applied to real-world scenarios. For instance, students can take part in a classroom "Math Market," where they purchase and sell goods using virtual cash, or manage a virtual budget for trip planning.

6. Classroom Math Tournament

   By setting up friendly competitions in the classroom, students may work together to solve challenges, which promotes excitement and teamwork.

However, interactive digital math games have gained popularity as an engaging tool for teaching mathematics. Technology in the classroom and exam administration helps retain students, while technology and nontraditional assessments are supported by pedagogy to improve student learning. Furthermore, students have a positive inclination toward participating in learning activities that incorporate technology (Malabayabas et al., 2024). While digital gamification holds promise for enhancing mathematical prowess, addressing diverse learning styles, and ensuring equitable access to technology are essential components for inclusive and effective education (Cai et al., 2024). Additionally, (Rachmiazasi Masduki et al., 2020) studied showed an improvement in performance and this improvement was statistically significant since the students got better achievement in their mathematics understanding by using interactive digital learning. These are some examples of interactive digital games for Mathematics.

Example of Gamification Applications for Online Learning

1. GeoGebra

   Figure 1 shows the home screen of GeoGebra. GeoGebra is an interactive geometry, algebra, and calculus tool that enables students to experiment with mathematical concepts through visual representations. It is useful for all levels of mathematics which are from basic geometry to advanced calculus and statistic. It combines geometry, algebra, calculus, statistics, and graphing tools into a single platform, making it an essential resource for both classroom learning and self-study. Additionally, it also allows students to experiment with math concepts dynamically rather than relying on static textbook examples.

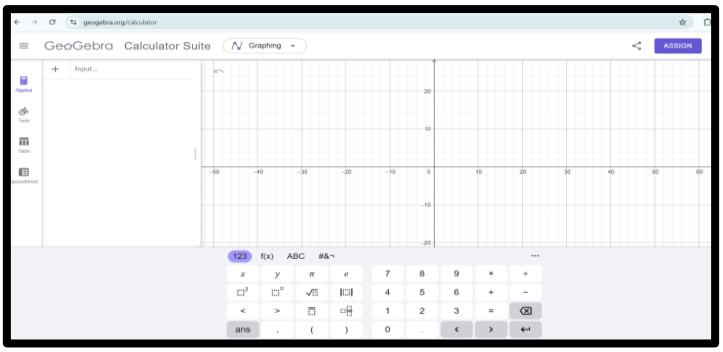

Figure 1: Home screen of Geogebra

2. Google Form & Kahoot!

   Figure 2 shows the home screen of Kahoot!. Kahoot! is a popular game-based learning platform that allows teachers, and students to create and play interactive quizzes, surveys, and discussions. Teachers can create quizzes and polls to check students' understanding in an interactive way and students have to compete by answering multiple- choice questions within a time limit in live mode. Points are awarded based on speed and accuracy, making it exciting and competitive. Indirectly, it may encourage collaboration, engagement, and friendly competition by turning learning into a social and interactive experience.

Figure 2: Home screen of Kahoot!

3. Prodigy Math Game

Figure 3 shows the home screen of Prodigy Math Game. It is a gamified learning platform where students solve math problems to progress in an adventure-based game. Students may explore a fantasy world, battle opponents, and complete quests by solving math problems. It also combines role-playing game (RPG) elements with curriculum-aligned math practice, making it enjoyable for students while reinforcing key mathematical concepts. Besides that, Prodigy Math Game is designed for both classroom learning and home practice, making it a versatile tool for students, teachers, and parents.

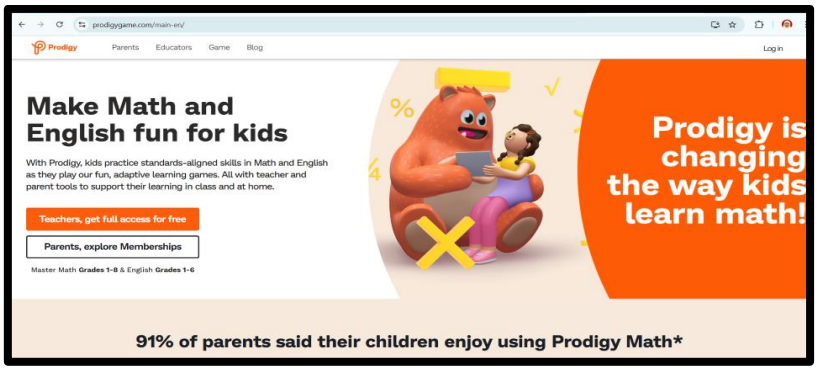

Figure 3: Home screen of Prodigy Math Game

4. Dream Box Learning

Figure 4 shows the home screen of Dream Box Learning. Dream Box Learning is an adaptive math platform that personalizes instruction based on students' responses and progress. The benefits of Dream Box Learning are encouraging independent learning by allowing students to progress at their own pace through interactive, personalized lessons. Other than that, Dream Box Learning provides instant feedback which allowing students to learn from their mistakes in real time.

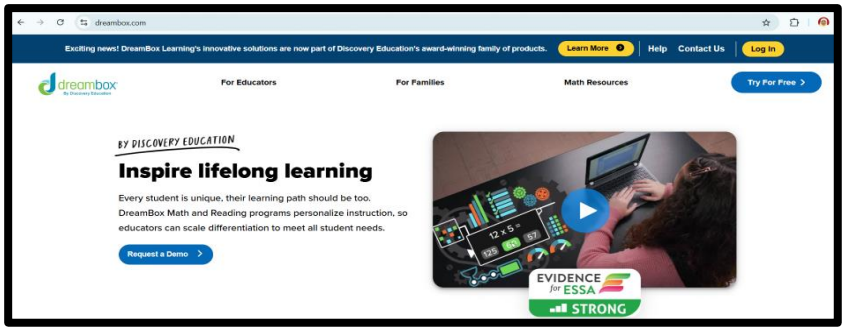

Figure 4: Home screen of Dream Box Learning

5. Quizizz

Figure 5 shows the home screen of Quizizz. Quizizz is an online learning platform that allows teachers and students to create and play interactive quizzes, polls, and lessons in an interesting way. It is a gamified quiz platform where students can answer multiple-choice, fill in the blank, and open-ended math questions at their own pace. The advantages of Quizizz for teachers is its auto-grading and detailed reporting features, which significantly reduce the time and effort required for assessments. When students complete a quiz, Quizizz automatically grades their responses in real time, eliminating the need for manual marking.

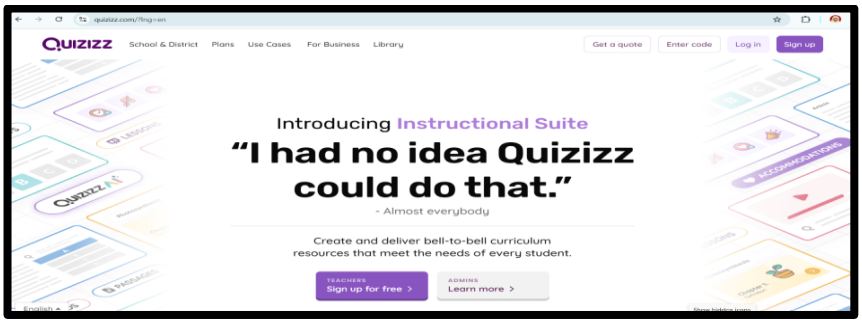

Figure 5: Home screen of Quizizz

6. Dragon Box

Figure 6 shows the home screen of dragon box game. Dragon Box is a series of educational games designed to teach mathematics, particularly algebra, in a fun and engaging way. This gamified with mathematical concepts through engaging, puzzle-like gameplay without initially using numbers or symbols. As players progress, the game slowly introduces numbers and traditional algebra notation, transitioning them to formal algebra seamlessly. The goal is to help students develop a deep understanding of algebraic principles in a way that feels like playing a game rather than studying math.

Figure 6: Home screen of Dragon Box

Conclusion

In conclusion, mathematics anxiety remains a significant barrier to students' academic success, often leading to avoidance behaviors and reduced confidence. Thus, the use of the developed gamified instructional materials and activities marked a highly significant difference in the level of academic performance in mathematics. More than that, incorporating gamification and interactive learning can transform mathematics into an engaging and less intimidating subject. Research has shown that gamified learning strategies such as reward-based learning, level-up challenges, and story-driven math adventures enhance motivation, engagement, and overall mathematical proficiency. Interactive digital tools further support these efforts by providing immediate feedback, fostering collaboration, and making learning more dynamic. While digital gamification has a lot of potential which allows students to sustain more interest compared to the non-gamified approach to learning with digital resources but it must be inclusive and accessible to all students. By implementing these innovative strategies, facilitators/teachers can create a more positive and effective learning environment that fosters Mathematical competence and reduces anxiety, ultimately improving student outcomes in Mathematics.

References:

Cai, S. J., Yu, J., Li, C., Journal, /, & Derasin, L. M. (2024). The Impact of Digital Gamification And Traditional Based Learning On Students' Mathematics Achievement: Evidence From The Philippines. https://doi.org/10.5281/zenodo.778108

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? In *Frontiers in Psychology* (Vol. 7, Issue APR). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2016.00508

Karamert, Ö., & Kuyumcu Vardar, A. (2021). The effect of gamification on young mathematics learners' achievements and attitudes. *Journal of Educational Technology and Online Learning*, *4*(2), 96–114. https://doi.org/10.31681/jetol.904704

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. In *Psychology Research and Behavior Management* (Vol. 11, pp. 311–322). Dove Medical Press Ltd. https://doi.org/10.2147/PRBM.S141421

Malabayabas, M. E., Yazon, A. D., Tessoro, J. F. B., Manaig, K. A., & Sapin, S. B. (2024). Effectiveness of Mathematics-Gammified Applications for Learners Interactive Numeracy Growth (Math-Galing) in Enhancing the Academic Performance of Grade 11 Learners. *Advanced Journal of STEM Education*, *2*(1), 31–42. https://doi.org/10.31098/ajosed.v2i1.2324

Mutodi, P., & Ngirande, H. (2014). Exploring mathematics anxiety: Mathematics students' experiences. *Mediterranean Journal of Social Sciences*, *5*(1), 283–294. https://doi.org/10.5901/mjss.2014.v5n1p283

Rachmiazasi Masduki, L., Prayitno, E., & Yustina Rensi Dartani, M. (2020). The Implementation Of Interactive Multimedia In Improving Mathematics Learning Outcomes. *11*(2). http://journal.upgris.ac.id/index.php/eternal/index

Sakai, K., & Shiota, S. (2016). A Practical Study of Mathematics Education Using Gamification, 353-354.

Udjaja, Y., Guizot, V. S., & Chandra, N. (2018). Gamification for elementary mathematics learning in Indonesia. *International Journal of Electrical and Computer Engineering*, *8*(5), 3860–3865. https://doi.org/10.11591/ijece.v8i5.pp3860-3865

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), 115–136. https://doi.org/10.31681/jetol.888096

SIG CS@e-Learning
Unit Penerbitan
Jabatan Sains Komputer & Matematik
Kolej Pengajian Pengkomputeran, Informatik & Matematik
Universiti Teknologi MARA Cawangan Pulau Pinang

e-ISBN : 978-629-98755-5-0

Design of the cover powered by FPPT.com