Arab Humanities Journal

Vol. (6) Issue (2)

Edition 20th

2025 (1 - 20)

Impact of gamification on learning Math in elementary classes (Cycle-1) Lebanon

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A requirement for Doctorate in education (Mathematics)
Published on: 15 April 2025.

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Abstract

The use of technology in education is growing, leading to new teaching methods that help students stay engaged and improve their learning. One of these methods is gamification, which means adding game-like features to non-game activities. This approach has become popular for empowering students' performance in subjects like math (Dichev & Dicheva, 2017)[1]. Gamification can make learning more fun and interactive.

Math is an essential subject that helps students develop problem-solving and critical thinking skills. However, many children develop math anxiety and negative feelings about the subject at an early age (Boaler, 2016)[2]. Traditional teaching methods often depend on memorization and repetitive exercises, which may not engage students effectively. Gamification provides an alternative by adding rewards, levels, challenges, and feedback, making math more interesting and enjoyable (Hamari, Koivisto, & Sarsa, 2014)[3].

This study aims to explore whether gamification can truly help elementary students become more

1. Dichev, C., & Dicheva, D. (2017). Gamification in education: Where are we in 2015? International Journal of Educational Technology in Higher Education, 14(1), p.1-36.
2. Boaler, J. (2016). Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages, and innovative teaching. Jossey-Bass.
3. Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work?—A literature review of empirical studies on gamification. Proceedings of the 47th Hawaii International Conference on System Sciences (HICSS), 3025–3034.

engaged, motivated, and successful in math. Previous research suggests that gamification encourages students to participate more actively and view mistakes as a natural part of learning (Su & Cheng, 2015)[4]. However, even though gamification is widely used in digital learning, more studies are needed to understand how it directly affects math education at the elementary level (especially cycle 1 in Lebanese curriculum).

By examining how gamification impacts students' attitudes and achievements in math, this study hopes to provide teachers and curriculum designers with useful insights. Understanding both the benefits and challenges of gamification can help create engaging, student-focused learning environments that improve long-term math skills.

*** Introduction**

In today's digital world, teachers are looking for creative ways to help students learn better. One popular approach is gamification or GBL game based learning, where game-like features are added to subjects like math (Deterding et al., 2011)[5]. Since many elementary students see math as difficult or even scary, gamification can make learning more enjoyable and interactive. Research suggests that adding rewards, challenges, and problem-solving activities can boost motivation, improve memory, and create a more positive attitude toward math (Hamari, Koivisto, & Sarsa, 2014)[6].

Gamification—the use of game elements in non-game settings—offers a new way to teach math (GBL). By focusing on the learning process, providing quick

4. Su, C. H., & Cheng, C. H. (2015). A mobile gamification learning system for improving the learning motivation and achievements. Journal of Educational Technology & Society, 18(2), p.4-16.

1. Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification." Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, 9–15.

2. Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? —A literature review of empirical studies on gamification. Proceedings of the 47th Hawaii International Conference on System Sciences (HICSS), 3025–3034.

feedback, and encouraging students to learn from mistakes, gamification can make math classes more engaging and effective.

This research will explore how gamification affects elementary students' math learning, focusing on its impact on engagement, understanding, and academic success.

*** Review of Literature**

Gamification means using game-like elements in non-game settings, and it has become popular in education to help students stay interested and learn better. Since many elementary students find math difficult, adding game mechanics can make it more fun and engaging. Researchers have studied how gamification affects motivation, understanding, and overall academic performance. This section looks at key findings on gamification in elementary math education.

*** Math Games**

A math game is an interactive activity or structured play that incorporates mathematical concepts to enhance learning and problem-solving skills. These games can be digital, physical, or board-based and are designed to make math engaging, fun, and educational. Math games often include challenges, puzzles, or competitions that encourage students to practice arithmetic, logic, geometry, and other mathematical skills in an enjoyable way.

Key Features of Math Games:-

1- Engagement: They make learning math fun and interactive.

2- Skill Development: They reinforce mathematical concepts such as addition, subtraction, multiplication, division, and problem-solving.

3- Variety: They can be digital (apps, online games), physical (board games, card games), or classroom activities.

4- Gamification Elements: Many include rewards, levels, or challenges to motivate learners.

*** Gamification and Student Engagement in Math**

Many studies show that gamification helps students stay engaged in math. Traditional teaching methods can be boring, but adding points, leaderboards, challenges, and progress tracking makes learning more interactive and fun (Dichev & Dicheva, 2017). These features keep students motivated.

For example, Buckley and Doyle (2016)[7] found that students using gamified math platforms participated more than those in regular classrooms. Kapp (2012)[8] explained that gamification works because it activates the brain's reward system, encouraging positive learning habits. Barata et al. (2017)[9] also noted that gamification helps students develop a growth mindset, meaning they see challenges as chances to improve.

However, some researchers warn that focusing too much on rewards like points and badges may reduce students' natural motivation to learn (Deci, Koestner, & Ryan, 2001)[10]. To be effective, gamification should balance rewards with meaningful learning experiences.

*** Gamification and Academic Performance in Math**

Studies show that gamification can improve students' math skills and academic performance. By providing instant feedback, adjusting difficulty levels, and using interactive content, gamification makes learning more effective (Hamari, Koivisto, & Sarsa, 2014).

Su and Cheng (2015)[11] found that elementary students who used a gamified math app performed better

1. Buckley, P., & Doyle, E. (2016). Gamification and student motivation. Interactive Learning Environments, 24(6), 1162-1175.
2. Kapp, K. M. (2012). The gamification of learning and instruction: Game-based methods and strategies for training and education. Pfeiffer.
3. Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2017). Gamification for smarter learning: Tales from the trenches. Smart Learning Environments, 4(1), 1-23. https://doi.org/10.1186/s40561-017-0041-6
4. Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. Review of Educational Research, 71(1), 1-27. https://doi.org/10.3102/00346543071001001
1. Su, C. H., & Cheng, C. H. (2015). A mobile gamification learning system for improving the learning motivation and achievements. Journal of Educational Technology & Society, 18(2), 4-16.
2. Wouters, P., Van Nimwegen, C., Van Oostendorp, H., & Van Der Spek, E. D. (2013). "A meta-analysis of the cognitive and motivational effects of serious games." Journal of Educational Psychology, 105(2), 249-265.
3. Kebritchi, M., Hirumi, A., & Bai, H. (2010). "The effects of modern math computer games on mathematics achievement and class motivation." Computers & Education, 55(2), p. 427-443.

in problem-solving and understanding concepts than those who learned through traditional methods. A study by Wouters et al. (2013)[12] also confirmed that gamified learning improves memory and comprehension.

Kebritchi, Hirumi, and Bai (2010)[13] discovered that students using digital math games scored higher on tests because games help them visualize abstract concepts. However, Clark et al. (2016)[14] pointed out that poorly designed gamification, which focuses too much on fun rather than learning, may not lead to better academic results.

*** Gamification and Motivation in Math**

A big benefit of gamification is its ability to motivate students. According to Self-Determination Theory (Deci & Ryan, 2000)[15], motivation depends on three things: feeling in control (autonomy), feeling capable (competence), and feeling connected to others (relatedness). Gamification supports these by allowing students to make choices, take on challenges, and work together.

Nah et al. (2014)[16] found that gamified learning increases both internal motivation (students enjoy learning) and external motivation

4. Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. Review of Educational Research, 86(1), p.79–122. https://doi.org/10.3102/0034654315582065
5. Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry, 11(4), p. 227–268

1. Nah, F. F.-H., Zeng, Q., Telaprolu, V. R., Ayyappa, A. P., & Eschenbrenner, B. (2014). Gamification of education: A review of literature. International Conference on HCI in Business, p. 401-409.
2. Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. Computers & Education, 80, p.152-161.
3. Domínguez, A., et al. (2013). "Gamifying learning experiences: Practical

(students are encouraged by rewards). Similarly, Hanus and Fox (2015)[17] showed that students in gamified math classrooms were more motivated than those in regular classes.

However, gamification is not efficient for all learners. Domínguez et al. (2013)[18] found that some students feel uninterested in competitive game environments. This means teachers should adapt gamification to fit different learning styles and abilities.

*** Cognitive and Behavioral Benefits of Gamification in Math**

Gamification also helps students develop thinking and problem-solving skills. Shute et al. (2009)[19] stated that game-based learning (GBL) improves higher-level thinking, such as critical reasoning and logical problem-solving.

Kiili (2005)[20] found that gamified learning allows students to learn from mistakes in a low-pressure setting. This aligns with Vygotsky's (1978)[21] idea that students learn best through interaction and hands-on experiences.

implications and outcomes." Computers & Education, 63, p.380-392.

1. Shute, V. J., Ventura, M., Bauer, M., & Zapata-Rivera, D. (2009). "Melding the power of serious games and learning assessment to create a more engaging, effective, and efficient form of learning." International Journal of Artificial Intelligence in Education, 19(2), p.309-339.
2. Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. Internet and Higher Education, 8(1), 13–24. https://doi.org/10.1016/j.iheduc.2004.12.001
3. Vygotsky, L. S. (1978). Mind in Society: The Development of Higher Psychological Processes. Harvard University Press.
4. Sweller, J., Ayres, P., & Kalyuga, S. (2011). Cognitive load theory. Springer. https://doi.org/10.1007/978-1-4419-8126-4

Cognitive Load Theory (Sweller, Ayres, & Kalyuga, 2011)[22] suggests that gamification reduces mental overload by breaking math concepts into smaller, interactive steps. Visual aids and animations in games also help students understand complex ideas.

From a behavioral perspective, Lee and Hammer (2011)[23] found that gamification teaches perseverance. When students fail a level and try again, they learn determination, instead of feeling discouraged.

*** Challenges and Limitations of Gamification in Math**

Despite its benefits, gamification has some challenges. One issue is that students may lose interest over time if the game elements become repetitive (Hanus & Fox, 2015). To keep students engaged, educators need to refresh and improve game mechanics regularly.

Another problem is the digital divide—not all schools and students have access to gamified learning tools, creating inequality in education (Kebritchi et al., 2010). Also, some teachers may not have the training needed to use gamification effectively (Landers, 2014)[24].

Critics also argue that gamification can over-simplify math, making students too dependent on game mechanics instead of developing deep understanding (Sailer et al., 2017)[25]. To prevent this, gamification should support traditional teaching rather than replace it.

*** Types of Games**

As mentioned before, Math games are interactive learning tools, available in both physical and digital formats, that engage players in

1. Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother? Academic Exchange Quarterly, 15(2), 1–5
2. Landers, R. N. (2014). Developing a theory of gamified learning: Linking serious games and gamification of learning. Simulation & Gaming, 45(6), p. 752-768.
3. Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. Computers in Human Behavior, 69, 371–380. https://doi.org/10.1016/j.chb.2016.12.033

practicing and improving their mathematical skills. These games incorporate elements of fun, competition, and discovery to reinforce key math concepts such as arithmetic, geometry, algebra, and logical reasoning. They can take various forms, including board games, card games, mobile apps, online puzzles, or hands-on group activities in classrooms. By presenting math challenges in an entertaining and stimulating way, these games help learners develop problem-solving abilities, critical thinking, and a deeper understanding of mathematical principles while making the learning process more enjoyable and effective. We may classify them in two main categories: Digital and non-digital Math games.

*** Digital Math Games**

Digital math games are online or app-based interactive games that help players learn and practice math skills through engaging challenges. These games use technology, including animations, interactive problem-solving, and instant feedback, to make math topics like arithmetic, algebra, geometry, and logic more enjoyable. They can be played on devices such as computers, tablets, and smartphones, offering options like solo puzzles, multiplayer competitions, or adaptive learning experiences. The main purpose of digital math games is to improve mathematical understanding, enhance problem-solving skills, and boost motivation in a fun and interactive way. Hereafter, some examples of 10 digital Math games with a brief description: -

1- Nearpod – Nearpod offers interactive math lessons and gamified quizzes**,** where students can engage in time-based challenges, polls, and collaborative activities. Studies show that interactive tools like Nearpod increase student engagement and retention (Wang, 2015)[26].

2- Prodigy – A role-playing adventure game where students solve math problems to battle opponents and level up**.** Game-based learning enhances motivation and learning outcomes (Tuzun et al., 2009)[27].

1. Wang, A. I. (2015). "The wear-out effect of a game-based student response system." Computers & Education, 82, p. 217-227

2. Tuzun, H., Yilmaz-Soylu, M., Karakus, T., Inal, Y., & Kizilkaya, G. (2009). "The effects of computer games on primary school students' achievement and motivation in geography learning." Computers & Education, 52(1), p. 68-77.

3- Kahoot! – A quiz-based game where students answer math questions in a timed competition. Gamified quizzes improve recall and active participation (Wang, 2015).

4- Splash Learn – Offers engaging, curriculum-aligned math games with progress tracking**.** Adaptive learning platforms boost personalized learning (Hamari, Koivisto, & Sarsa, 2014).

5- Blooket – A classroom game where students answer math questions while competing in various mini-games**.** Competition and rewards increase motivation in math (Domínguez et al., 2013).

6- DreamBox – An adaptive math program that provides personalized learning experiences through gamified lessons. AI-driven gamification can improve problem-solving skills (Shute et al., 2009).

7- Mathletics – Allows students to compete globally in math challenges**.** Competitive learning environments encourage engagement and skill mastery (Kebritchi, Hirumi, & Bai, 2010).

7- Reflex Math – A fluency-based program that uses games to help students master basic math facts**.** Immediate feedback and rewards reinforce learning (Su & Cheng, 2015).

9- ABCya! Math Games – Offers a variety of fun, interactive math games for different grade levels**.** Engaging visual learning improves conceptual understanding (Booth & Koedinger, 2012)[28].

10- IXL Math – Provides gamified skill practice with instant feedback and progress tracking. Gamification with adaptive difficulty enhances learning retention (Hamari et al., 2014).

*** Classroom Math Games (Non-Digital)**

1- Math Bingo – Students solve problems to mark numbers on their bingo cards. Game-based reinforcement strategies improve retention (Wouters et al., 2013).

2- Around the World – A rapid-fire mental math game where students compete to answer problems quickly. Timed problem-solving games enhance math fluency (Shute et al., 2009).

3- Escape Room Math – A collaborative game where students solve math puzzles to "escape" a scenario. Team-based learning

1. Booth, J. L., & Koedinger, K. R. (2012). "Key mechanisms in mathematical cognition: The role of spatial visualization." Educational Psychology Review, 24(2), p. 143-161.

fosters critical thinking and engagement (Vygotsky, 1978).

4- Math Jeopardy – A classroom version of the popular quiz shows where students answer math questions in different categories. Active recall through games strengthens learning (Kebritchi et al., 2010).

5- Dice Roll & Solve – Students roll dice and apply math operations to get the correct answer. Hands-on learning activities enhance problem-solving skills (Bruner, 1966).

6- Math Board Races – Students race to solve problems on the board. Physical movement combined with learning increases retention (Jensen, 2005)[29].

7- Fraction War – A card game where students compare and order fractions. Gamified number comparisons improve conceptual understanding (Booth & Koedinger, 2012).

7- Domino Math – Students use dominoes to create and solve addition or multiplication problems. Visual and tactile learning reinforces mathematical concepts (Su & Cheng, 2015).

9- 24 Game – A card game where students use addition, subtraction, multiplication, or division to make 24. Strategic problem-solving enhances numerical reasoning (Boaler, 2016).

10- Estimate & Win – Students make estimates in math problems, and the closest estimate wins. Estimation skills are crucial for real-world math applications (Sowder, 1992)[30].

For what has been mentioned before, gamification has a positive impact on math learning by improving engagement, motivation, and problem-solving skills. However, to be effective, it must be carefully designed to match educational goals. Challenges such as long-term engagement, digital access, and content depth must be considered. When used correctly, gamification can transform math education into a fun and rewarding experience. Future research should explore how to make gamification work for different learning environments.

*** Purpose of the Study**

This study aims to understand how gamification affects elementary students' learning in math,

1. Jensen, E. (2005). Teaching with the Brain in Mind. ASCD.
2. Sowder, J. T. (1992). Estimation and Number Sense: Chapter in Handbook of Research on Mathematics Teaching and Learning. Macmillan

particularly their engagement, motivation, and academic performance. With technology becoming more common in education, gamification has emerged as a useful way to make learning math more interesting and effective. This research will explore how game-like elements such as rewards, challenges, progress tracking, and interactive activities impact students' experiences and success in Math.

Specifically, this study will: -

1- Examine Gamification's Effect on Student Engagement – Research suggests that gamified learning keeps students more involved and attentive in their studies (Zichermann & Cunningham, 2011)[31]. This study will investigate whether gamification makes elementary students more engaged in math compared to traditional teaching methods.

2- Explore Gamification's Role in Motivation – Motivation is key to academic success, especially in subjects like math that many students find challenging (Deci & Ryan, 2000). This study will analyze whether gamification increases curiosity, persistence, and a positive mindset toward Math.

3- Evaluate Its Impact on Academic Performance – Studies show that students using gamified learning often score higher on tests than those in regular classrooms (Hamari, Koivisto, & Sarsa, 2014). This study will assess whether gamification improves problem-solving skills, logical thinking, and overall math achievement.

4- Identify Challenges and Limitations – While gamification has many benefits, some researchers warn that relying too much on game elements may reduce students' natural motivation over time (Hanus & Fox, 2015). This study will explore possible drawbacks and suggest ways to use gamification effectively.

By addressing these points, this research will provide valuable insights into how gamification can improve math education, helping teachers create more engaging and effective learning experiences for students.

*** Significance of study**

This study will contribute to the expanding research on gamification in education by examining its use in elementary math. By presenting real-world evidence on its advantages and challenges, this

1. Zichermann, G., & Cunningham, C. (2011). Gamification by design: Implementing game mechanics in web and mobile apps. O'Reilly Media, Inc

research can serve as a basis for future studies on modern teaching approaches. An experimental part will be held in GLS (Genius Leaders School-Lebanon), the students of this school study Mathematics through the York-e math curriculum[32], as no practical experiments were held on Lebanese learners who study through this curriculum.

Overall, this study is important for both theoretical and practical insights into how gamification impacts elementary math education. Its findings could help shape teaching methods, curriculum development, and future research, ultimately enhancing students' learning experiences and academic success.

*** Priror theorems**

Gamification in education is based on several well-established learning theories that explain how game-like elements can improve student motivation, engagement, and knowledge retention. These theories provide a framework for incorporating gamification into elementary math instruction.

1- Self-Determination Theory (SDT)

Self-Determination Theory (SDT) states that motivation is influenced by three key psychological needs: autonomy (having control over learning), competence (gaining skills and confidence), and relatedness (feeling connected to others) (Deci & Ryan, 2000). Gamification supports these needs by allowing students to choose activities (autonomy), offering challenges and rewards to build skills (competence), and including social features like leaderboards or teamwork (relatedness) (Deci & Ryan, 2000).

2- Flow Theory

Flow Theory describes how people become deeply focused and engaged when tasks match their abilities and provide clear goals and feedback (Csikszentmihalyi, 1990)[33]. Gamified learning environments encourage this state by using

1. York-E offers the York Global Maths program, a comprehensive K-12 mathematics curriculum grounded in the York Global Curriculum Framework. This framework integrates standards from various educational systems, including the US Common Core, Canada's Ontario standards, the UK curriculum, Singapore's Mastery Approach in Mathematics, and curricula from the Arab world

1. Csikszentmihalyi, M. (1990). Flow: The psychology of optimal experience. Harper & Row.

progressive challenges, instant feedback, and engaging narratives, helping students stay motivated while solving math problems.

3- Operant Conditioning Theory

B.F. Skinner's Operant Conditioning Theory highlights how learning is reinforced through rewards and feedback. In gamification, students earn points, badges, or prizes for completing tasks, reinforcing positive learning behaviors and encouraging practice (Skinner, 1953)[34]. However, research suggests that relying too much on external rewards may reduce internal motivation over time (Deci, Koestner, & Ryan, 2001).

4- Constructivist Learning Theory

According to Vygotsky's Constructivist Learning Theory, students learn best through hands-on experiences, exploration, and social interaction (Vygotsky, 1978). Gamification aligns with this approach by including interactive activities, peer collaboration, and problem-solving tasks that enhance understanding of mathematical concepts.

5- Cognitive Load Theory (CLT)

Cognitive Load Theory (CLT) suggests that too much information at once can overwhelm learners, making it harder to absorb new concepts (Sweller, Ayres, & Kalyuga, 2011). Gamification can help by breaking down complex math problems into smaller steps, using visuals to simplify explanations, and offering immediate feedback to support learning.

6- Goal-Setting Theory

Goal-Setting Theory states that setting clear and achievable goals improves motivation and performance (Locke & Latham, 1990)[35]. Gamified learning often includes progress tracking, challenges, and levels to keep students motivated and focused on their learning objectives.

7- learning through playing

John Dewey is one of the most prominent educational philosophers of the 20th century. His theories emphasized the importance of learning through experience and interaction. Dewey believed that education should not be limited to rote memorization but should be an active process in which students

1. Skinner, B. F. (1953). Science and human behavior. Macmillan

1. Locke, E. A., & Latham, G. P. (1990). A theory of goal setting & task performance. Prentice Hall.

engage through hands-on and experiential activities, including play as an effective learning tool (Dewey, 1938)[36]. He argued that meaningful learning occurs when students interact with their environment, actively constructing knowledge rather than passively receiving information (Dewey, 1916)[37].

As a conclusion, several learning theories support the use of gamification in elementary math education, emphasizing motivation, engagement, reinforcement, cognitive processing, and social interaction. By applying these principles, educators can design more effective and enjoyable learning experiences that enhance students' understanding and performance in mathematics.

*** Research part (Methodology)**

1- Problem: Although various initiatives have been implemented to enhance mathematics education in the elementary cycle, many students still face challenges with staying engaged, motivated, and grasping essential mathematical concepts. Conventional teaching approaches often do not effectively stimulate young learners' interest, which can result in poor academic achievement and unfavorable perceptions of mathematics. Recently, gamification—the integration of game-like elements into educational settings—has gained attention as a potential method to boost student motivation and improve learning outcomes.

*** Questions**

The study will try to answer the following questions: -

1- Is there a significant difference between the grades of Experimental group (EG) and those of Control group in pre-test?

2- Is there a significant difference between the scores of students in experimental group and control group in the post-test?

*** Hypotheses**

In the study, hypotheses are stated in null form at significance α level of 0.05

1- There is no significant difference between the grades of Experimental

2. Dewey, J. (1938). Experience and Education. New York: Macmillan.
3. Dewey, J. (1916). Democracy and Education: An Introduction to the Philosophy of Education. New York: Macmillan.

group (EG) and those of Control group (CG) in pre-test.

2- There is a significant difference between the scores of students in experimental group and control group in the post-test.

*** Research design**

The research was held on two sections of grade 2 in GLS (Genius Leaders School), each section contains 12 students, one of the sections is set as a control group and taught in traditional curriculum way and the second is set as experimental group and taught through Kahoot and Nearpod applications.

*** Instruments**

1- Pre-test (made for both sections related to some prerequisites as addition and comparison) – Appendix.

2- Post-test (made for both sections related to fractions)-Appendix 2

3- Interview (opinions and attitudes) -Appendix 3

*** Procedure**

First a pre-test was held, to make sure that the groups have close levels, then over a week, the students of the control group were learning traditionally through the activities of the book, whereas those of the experimental group were taught through game activities by Kahoot and Nearpod.

At the end of the week, a post test was held to check the competencies achieved by both groups. Finally an interview was done to investigate the opinions and attitudes of students towards learning through games.

*** Results**

*** Descriptive Statistics**

Pre-test over 15	Number	Mean	Standard deviation
Control group	12	11.5	1.85
Experimental group	12	11.25	2.01

Post-test	Number	Mean	Standard deviation
Control group	12	11.9	1.76
Experimental group	12	13.42	1.11

The above descriptive statistics show that the means of the scores are very close in the pre-test which reflects that the choice of groups was right. Moreover, the mean of the scores is higher for the students in the experimental group.

*** Test of hypothesis**

*** For the first hypothesis**

t = 0.3040 and p-value equals 0.7640, hence there is no significant difference between the scores of the control and experimental groups

*** for the second hypothesis**

t = 3.6537 and p-value equals 0.0014, this difference is considered to be very statistically significant, and the impact of teaching through games is high.

*** Interview summary of responses**

Second-grade students typically view learning math through games in a very positive light. They often describe it as enjoyable and stimulating, which keeps them focused and eager to participate. For many, games transform math from a chore into a playful activity, boosting their self-assurance and inspiring them to tackle more challenging tasks. They also like collaborating with peers, engaging in friendly competition, and tracking their improvement as they play. In general, incorporating games into math lessons makes students more excited and interested in learning.

*** Discussion, Conclusions, and Implications**

*** Discussion**

Gamification has been shown to effectively boost elementary students' engagement, motivation, and academic performance in mathematics. By incorporating game elements like points, badges, leaderboards, and challenges, students are more likely to develop a positive attitude toward learning math . Psychological theories such as Self-Determination Theory and Flow Theory suggest that when students feel a sense of autonomy, competence, and enjoyment in learning, they are more likely to stay motivated and achieve better academic results.

Beyond making math more enjoyable, gamification also helps students build important cognitive skills like problem-solving, logical reasoning, and critical thinking. It encourages a growth mindset by allowing students to learn through trial and error, reinforcing the idea that mistakes are part of the learning process. However, the success of gamification depends on its design and implementation. If not structured properly, it can lead to over-reliance on rewards, where students focus more on external incentives rather than truly understanding mathematical concepts.

Another challenge is ensuring equal access to gamified learning. Not all students have access to the necessary digital tools, which can widen the digital divide. Additionally, teachers may need extra training to effectively incorporate gamification into their math lessons, ensuring that game elements enhance learning rather than distract from it.

*** Conclusion**

Gamification is a promising way to improve student engagement and learning in elementary math. By making math more interactive and enjoyable, it helps students build a

stronger understanding of mathematical concepts while reducing anxiety. However, for gamification to be truly effective, it needs to balance intrinsic and extrinsic motivation, align with curriculum goals, and be accessible to all students.

The success of gamification depends not just on its design but also on how well teachers integrate it into their lessons. While it can greatly enhance motivation and learning, it should be used alongside traditional teaching methods rather than replace them. Future research should focus on the long-term impact of gamification, how different game elements affect various learners, and ways to ensure equal access to gamified learning tools.

*** Implications**

The research on gamification has important takeaways for teachers, curriculum designers, policymakers, and researchers: -

*** For Teachers**

1- Gamification should be used to support learning objectives, not just for fun.

2- A balance between internal motivation (love for learning) and external rewards should be maintained.

3- Teachers need proper training to apply gamification effectively in their classrooms.

*** For Curriculum Designers**

1- Gamified math programs should be based on proven learning strategies and avoid overwhelming students.

2- Including different difficulty levels can help meet the needs of all learners.

*** For Policymakers & School Leaders**

1- Schools need better access to technology so all students can benefit from gamified learning.

2- Teacher training programs should include strategies for implementing gamification effectively.

*** For Researchers**

1- More studies should explore how gamification affects long-term math learning.

2- Research should analyze which game elements work best for different student groups.

3- The impact of competition versus teamwork in gamification should be further investigated.

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Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2017). Gamification for smarter learning: Tales from the trenches. Smart Learning Environments, 4(1), 1-23.

https://doi.org/10.1186/s40561-017-0041-6

Boaler, J. (2016). Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages, and innovative teaching. Jossey-Bass.

Booth, J. L., & Koedinger, K. R. (2012). Key mechanisms in mathematical cognition: The role of spatial visualization. Educational Psychology Review, 24(2), 143-161.

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