



Effects of Gamification for the Enhancement of Mathematical Problem-Solving Skills at Primary Level

Misbah Irshad^{a*}, Farkhanda Jabeen^b, Farzana Naheed Salim^c, Safia Bibi^d, Amber Urooj^e

^{a,b,d}Department of Education Fatima Jinnah Women University Rawalpindi. ^cDepartment of Education, Abasyn University, Peshawar, Pakistan. ^eDepartment of Management Studies, Bahria University, Islamabad

*Email: misbahirshadict@gmail.com

Abstract: The purpose of the study was to investigate that how gamification techniques effect the mathematical problem solving at primary level. The major objectives of the study were to use gamification techniques to foster problem solving skills and to determine whether gamification can improve primary school pupils' ability to solve mathematical problems. Mathematics hold significant position in the curriculum. In school mathematics is taught mostly through traditional method which is the reason primary school students make it difficult. Students who study mathematics get knowledge and cognitive abilities that are valuable in today's world. The majority of our students were poor in mathematics at primary level because they found mathematics boring. This study is intended to evidence how gamification effect on enhancing mathematical problem-solving skills at primary level. It also investigates whether teaching mathematics through integrating game effect student learning in positive way or not. To use game in study it enhances self-confidence of students. For testing the hypothesis that the mathematical proficiency of pupils in the control and experimental groups is the same from private school. The population include 80 students, from school were selected as sample for the experiment. Different gamification technique was used in this study for teaching experimental group and other group was taught through traditional method. Pre-test Post-test control group research design was used in this study. By comparing the results of Pre-test Post-test scores, it has been found that student have achieved more scores in Post-test since it was administered after teaching by using gamification technique. Results showed that gamification technique largely effect students mathematical problem-solving skills at primary level. The findings of the study were to ascertain how gamification influences primary school children's ability to solve mathematical problems. Gamification may increase children's attention spans and enhance their capacity to work through difficult arithmetic problems. As a result, it is suggested that teaching mathematics to pupils through games could enhance their capacity to solve problems in mathematics at the primary school level. According to the study's findings, pupils who were taught using the gamification approach outperformed than students who were taught using the traditional way in terms of academic accomplishment. It was found that incorporating games into instruction increased students' engagement and interest. The results indicate that games have a big impact on arithmetic instruction and student learning. Students that took part paid close attention and comprehended the material well. The results of this study will influence changes in Pakistani mathematics education pedagogies. This technique can be applied to improve the performance of student at primary level. Therefore, the study recommends that teacher should teach mathematics by using games to students at primary level which encourage the student for better understanding of mathematical concepts.

Key words: Mathematical problem-solving skills, Gamification, Performance

1.Introduction

Education has emancipated humanity and served as a driving force for advancement. It enjoys great respect all around the world. Through education, man has progressed from ignorance to knowledge and enjoyment. People are now valuable to themselves and to their society. A person's growth on the physical, mental, moral, spiritual, and emotional levels depends on their education. Through education, one can acquire new knowledge, attitudes, and abilities that make them important members of society (Lazar, 2015). Primary education is commonly recognized as the foundation of education. Primary education is the foundation for all other educational levels. Because it provides the foundation for education, it has an immediate effect on the other educational levels. The teacher is the reason learning is joyful (Popescu, 2022). Without teachers, the majority of educational aims and objectives could not be met. For students to succeed, the teacher is essential. Aristotle described mathematics as the science of quantity, and this definition remained valid until the 18th century. Mathematics is the queen of the sciences. Mathematics is a game that is played using basic rules and meaningless marks on paper. The field of mathematics was developed as a result of the study of geometrical figures and numbers as well as computation. Mathematics serves as the cornerstone for both human intelligence and logic. It is essential that we comprehend both our surroundings and ourselves. Since mathematics improves logical cognitive and analytical skills, it is still a great instrument for promoting intellectual discipline.

Mathematical understanding was necessary in order to comprehend courses such as physics, social studies, music, and the arts. The 21st century has seen a revolution in educational games as a result of technological advancements, shifting paradigms in education, and growing awareness of the potential of games to improve learning. With the introduction of smartphones and laptops, educational games have become more accessible, which is one of the major trends and developments in the field of games for education in the twenty-first century. Gamification is one of these games and game-like approaches that focus on personal motivations in order to increase participant involvement in their work. Gamification aims to improve the personal qualities of participants, such as consistency, inventiveness, and flexibility (Araya, 2019). The application of game design concepts outside of games is known as gamification. To create gamification and scenarios, three types of game design features are utilized: dynamics, mechanics, and components. In the upcoming years, gamification might be applied to classroom instruction. Gamification possesses the capability to effectively direct students' incentives towards educational endeavors, thereby assisting them in attaining achievement in their scholastic and social lives. Gamification is a useful tool for motivating pupils to engage in particular tasks. Owing to their degree of technological comfort and their expectation of participation that goes beyond conventional lecture methods, students today essentially expect something like gamification. The ability of students to solve problems more effectively is becoming one of the primary goals of education. Some children found it particularly challenging to solve arithmetic problems in mathematics classes. A common goal of gamification is to increase student involvement in the curriculum. Point-based systems have the potential to enhance student engagement by making learning enjoyable and engaging (Davis et al., 2018). This, in turn, encourages students to participate more in their studies across many disciplines. Finland used the Mathematics Syllabus of Singapore 2013 as a guidance when classifying and updating the Keys for educational purposes (Kaitera, 2021). Although gamified assessment and learning are very successful, they can be challenging for educators to create and implement (Issayeva, 2023). All things considered, there is a great deal of promise for gamification to improve the way mathematics is taught and learned, which could increase students' mathematical proficiency and understanding (Farangiz, 2023).

1.1 Components of Mathematical Problem-Solving Skills

Mathematical problem solving involves multiple important elements.

1.1.1 Determine the Issue

To correctly solve a question or problem statement in mathematics, one must first accurately identify it. The question in a mathematical problem can be found using the methods listed below:

1.1.2 Create a Strategy

Naturally, of course! Formulating a mathematical problem-solving approach involves breaking the problem down into smaller, more manageable parts and using the appropriate problem-solving techniques. This is a rigorous approach to plan drafting.

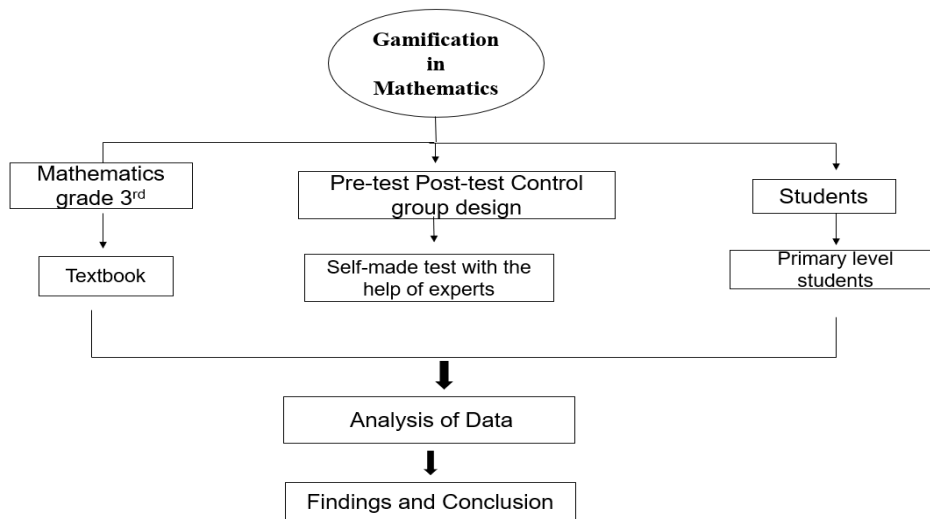
1.1.3 Evaluate Assessing a Query

A mathematical question needs to be assessed from several perspectives to ensure its clarity, relevance, and appropriateness within the context of the situation. Consider the following while evaluating a math question.

1.1.4 View your Response

Consider the following while evaluating or deriving a mathematical solution: Accuracy: Check the methods by which the solution was obtained. Verify that each step is precise and follows the applicable mathematical rules.

In this study, third-grade students were taught to broad heuristics, which are believed to serve as building blocks in the solution of non-routine mathematical problems. When the school year first started, it looked like a lot of mathematics assignments were proving to be difficult for students, especially when it comes to documenting their solutions. The Problem-solving Keys, which were adapted from Strategy Keys based on research by Herold-Blasius (2021), were presented to students as tangible tools. The goal of the study was to compare the third graders' abilities and approaches before and after the intervention, which provided a broad range of mathematics problems and solutions. The goal was to determine whether problem-oriented learning had an impact on students' problem-solving techniques and how gamification affected elementary school kids' ability to solve problems in mathematics.



1.2 Research Objectives

- Use the gamification technique to foster the mathematical problem-solving skills.
- Determine whether gamification is a useful tool for improving primary school student's ability to solve problems in mathematics.

1.3 Hypothesis

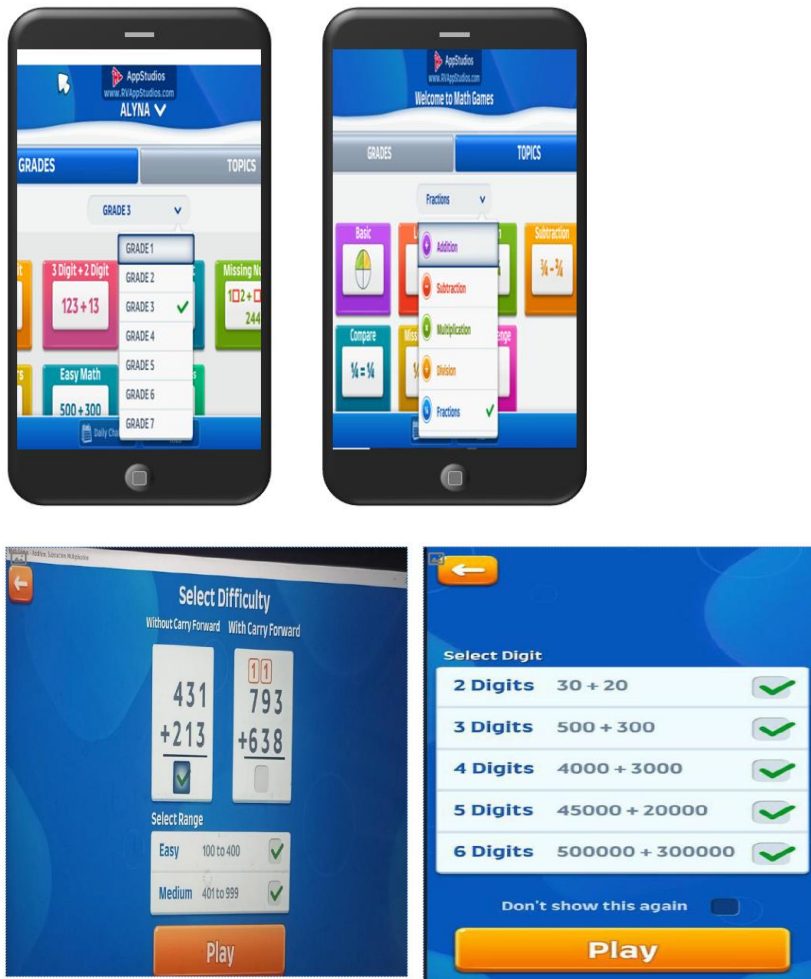
There is no significant effect of gamification in enhancement of Mathematical problem-solving skills.

2. Methodology

The quantitative research employee the Pre-test Post-test Control group design. The sample were chosen on the basis of convenience sampling. For this study experimental research design was chosen. The study was conducted in private school of Khanpur Haripur. The brainstorming and Socratic technique was used during lesson. Math game was used as intervention during study. The content that was selected from 3rd grade were Number operations, Fraction and Geometry. Post -test was taken before intervention and Post-test was taken after intervention.

2.1 Math Game by Rv App Studios

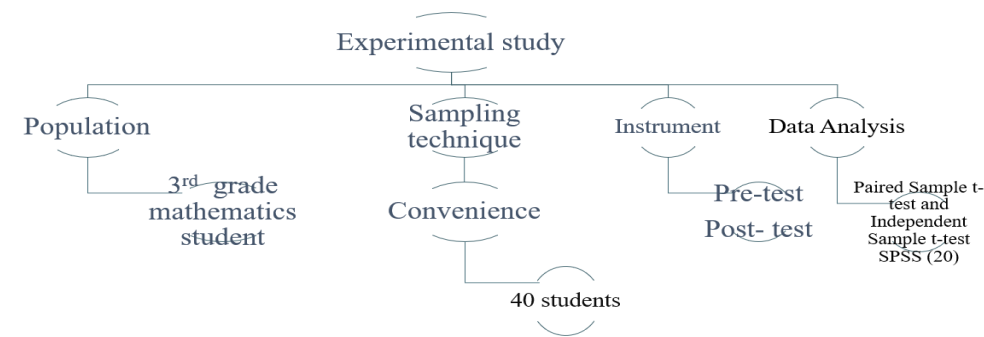
Math game was used as intervention for experimental group. The researcher utilizes the offline math game which was available on Microsoft store so the researcher downloads the game in laptop and Pc and then utilize that game in teaching mathematics for connecting mathematical concepts with gamification.



In order to assess students' prior knowledge, the researcher began the topic with a brainstorming session. Next, the researcher collected pre-test results from the control and experimental groups. Using Math activities i.e. Learn Add, Subtract, Multiply & Divide by RV AppStudios, a free app that provides a range of math activities for youngsters, includes addition and subtraction. The researcher instructed only the experimental group. Students in the experimental group were then given a post-test by the researcher following a month-long intervention. In the post-test, the item sequence was altered. Students take a pre-test administered by the researcher to gauge their prior understanding of number operations, fractions, and geometry. Subsequently, the researcher employed activities and online games to teach pupils about those subjects. Pre- and post-tests were administered in order to strengthen one's capacity for solving mathematical problems and gauge the impact of gamification on these abilities. SPSS software was used to generate the results. To analyze the data, the pre-test and post-test scores' means and standard deviations were computed.

The test was administered on the chapters that were chosen from the section on arithmetic, algebra, and geometry. Three topics served as the foundation for the test: high level, majority level (average questions), and low level. The test consisted of five true or false questions, five multiple-choice questions, five fill-in-the-blank questions, and five brief question answers. It assessed four important aspects of the mathematical problem-solving abilities of elementary school students. The pretest and posttest had a total of thirty marks each.

Research Methodology



3. Data Analysis

A pre-test and post-test control design was employed in the experiment. Convenience sampling was employed in the selection of participants, who were part of an experiment. For quantitative data, a pre-test and post-test were employed. Experts from the IT and mathematics departments validated the study's instrument. Using SPSS (20), quantitative data was analyzed using the t-test. The difference between the groups was ascertained using the paired sample t-test. An independent sample t-test was employed to ascertain the difference between the means of the control and experimental groups.

4.1 Paired Sample t-test

Table 1: Paired Sample t-test

Group	Mean	SD	N	Standard Error
Experimental group (score on the pre-test)	12.30	3.123	40	.494
Group under experimentation (post-test score)	27.03	2.370	40	.375

The pre- and post-test mean and standard deviation were calculated using a paired sample t-test. The results show that there is a difference in the mean and standard deviation of the individuals' pre-test (M=12.30, SD= 3.123) and post-test (M=27.03, SD= 2.370) scores. There was a 15-point rise in answer scores from the pre-test mean scores of 12.30 to the post-test mean scores of 27.03.

4.2 Differences between Pairs

Table 2: Differences between pairs

Groups	Mean	SD	t-value	Df	Sig(2-tailed)
Experimental group pre-test scores					
Experimental group post-test scores	-14.725	3.922	-23.744	39	.000

The results indicate a considerable difference in performance. The post-test results (M=27.03, SD=2.370) showed a

statistically significant increase over the pre-test values ($M=12.30$, $SD= 27.03$). Pre- and post-test results for the participants revealed a significant difference with a p-value of .000.

4.3 Independent Sample t-test

Table 3: Independent sample t-test

Groups	Mean	SD	t-value	Df	Significant p
Control group (Post-test Score)	12.10	3.233			
Experimental group (Post-test Score)	27.03	2.370	-23.550	71.519	.000

An independent sample t-test was used to investigate how gamification affected students' ability to solve problems in elementary mathematics.

Group under control: $M = 12.10$, $SD = 3.233$

Group under experimentation: $M = 27.03$, $SD = 2.370$

A highly significant difference ($p < .001$, $t = -23.550$) was found in the data, suggesting that gamification greatly improves problem-solving abilities. As a result, the null hypothesis that "gamification has no discernible effect on the improvement of problem-solving abilities in mathematics at the primary level" was rejected.

4.4 Findings and Discussions

- The current study's main objective is to ascertain how gamification influences primary school children's ability to solve mathematical problems.
- Gamification may increase children's attention spans and enhance their capacity to work through difficult arithmetic problems.
- As a result, it is suggested that teaching mathematics to pupils through games could enhance their capacity to solve problems in mathematics at the primary school level.
- According to the study's findings, pupils who were taught using the gamification approach outperformed students who were taught using the traditional way in terms of academic accomplishment.
- It was found that incorporating games into instruction increased students' engagement and interest.
- The results indicate that games have a big impact on arithmetic instruction and student learning. Pupils that took part paid close attention and comprehended the material well.
- The results of this study will influence changes in Pakistani mathematics education pedagogies.

5. Conclusion

The current investigation led to the following conclusions.

- Although implementing novel teaching techniques is viewed as extremely difficult in our educational system, our study has demonstrated that doing so increases students' interest in mathematics.
- It was found that incorporating games into lessons increased students' engagement and interest.
- It is established through experiments that students on the post-test, the experimental and control groups received different scores.
- The experimental group outperforms the group that received traditional mathematics instruction.
- It has been determined that gamification does not significantly improve students' ability to solve mathematical problems at the elementary school level.
- Gamification may increase pupils' attention spans and enhance their capacity to work through difficult arithmetic problems.

5.1 Recommendations

- Gamification can help in increasing the motivation and achievement of students.

- b) Teacher can easily use this strategy for conceptual understanding of student and make lesson more engaging.
- c) Mathematical problem-solving skills can be increased by using this strategy.
- d) The current study set out to determine whether gamification improves students' mathematics problem-solving skills, future investigations should focus on how gamification enhances students' conceptual knowledge in other areas, such science and social studies.
- e) Pre-service teacher training programs that emphasize gamification as a means of assisting students in conceptually grasping challenging concepts are available to both in-service and classroom teachers.
- f) Studies can be conducted to determine how gamification impacts secondary school students' conceptual knowledge.
- g) The results of this study will influence changes in Pakistani mathematics education pedagogies. Therefore, it can be said that gamification will help students' learning more than rote memorizing. Understanding of topics and increase their enjoyment of learning within our educational system.

“Mathematics is similar to taking mental exercise at the gym. It honed your mental faculties”.

Danica McKellar

References

- Araya, R., Ortiz, E. A., Bottan, N., & Cristia, J. (2019). Does Gamification in Education Work?: Experimental Evidence from Chile. Department of Research and Chief Economist. Chile: Inter-American Development Bank.
- Davis, K., Sridharan, H., Koepke, L., Singh, S., & Boiko, R. (2018). Learning and engagement in a gamified course: Investigating the effects of student characteristics. *Journal of Computer Assisted Learning*, 34(5), 492–503.
- Farangiz, S. (2023, July). The study of effectiveness of gamification in teaching mathematics. in interdisciplinary innovation and scientific research conference (Vol. 1, No. 11, pp. 1-4).
- Issayeva, L. (2023, February 13). Gamification in Learning & Assessment. *Assessment Systems | Online Testing & Psychometrics*.
- Kaitera, S., & Harmoinen, S. (2022a). Developing mathematical problem-solving skills in primary school by using visual representations on heuristics. *LUMAT*, 10(2).
- Popescu, C. N., Attie, E., & CHADOUTEAU, L. (2022). Gamified Learning: Favoring Engagement and Learning Outcomes. In *Next-Generation Applications and Implementations of Gamification Systems* (pp. 97-131). IGI Global.