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Research paper

Effectiveness of Game-Based Learning on Academic Achievement of Students in Mathematics

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Abstract

In our everyday life, mathematics is an essential ability. The study of mathematics may be beneficial for all professions, including those of a chef, tailor, shop owner, farmer, fashion designer, vegetable seller, worker, and scientist. Thus, mathematics should be taught to produce effective outcomes rather than just as a topic to be learned. It has been noted that choosing the right teaching strategy improves student performance and logically fosters a favorable outcome. The objective of the study is to examine the effect of game-based teaching and the traditional method of teaching on students' achievement in Mathematics at the elementary stage. The study was experimental, based on a pre-test, post-test control group design. One unit of mensuration was selected from the sixth-grade JKBOSE textbook. 80 students of the sixth grade from Government Girls High School, Bhagwati Nagar, Jammu, were taken randomly. A pre-test was administered. Students were randomly divided into two groups (experimental and control). Both groups were taught for one month. Games were used for the experimental group, and the other group was taught traditionally. The games were non-digital. The time for teaching mathematics was 40 minutes daily for each group. A t-test was applied to the pretest and post-test scores to check whether there was a difference in the performance of the two groups. The findings of the study revealed that Mathematics should be taught with games at the elementary level.

Keywords: *Mathematics; Traditional Method of Teaching; Game-Based Teaching; Achievement.*

1. Introduction

Mathematics is a fundamental skill in our daily lives. Humans have been applying mathematical knowledge for over 5,000 years. Mathematics is the subject that empowers the individual to confront and resolve problematic situations in life. National Education Policy, 2020 (NEP 2020) emphasized building a strong foundation in mathematics through interactive, practical, and activity-based learning. It encourages critical thinking, problem solving, and connecting mathematics concepts to real-life situations to make learning meaningful and engaging. Mathematics is a core science subject; however, commonly, mathematics is also considered a language and an instrument for the development of a discipline based on science (Fajemidagba, Salman & Ayinla, 2012). The power of critical and logical thinking, the process of induction, generalization, and the establishment of the relationship between different components can be developed through mathematics education.

Mathematics is thought to be difficult to master, even though it contains original concepts and is known as the study of logical thinking. It helps an individual give a clear explanation of their ideas and choices. The country needs people who can manage challenging situations and are competent in handling a variety of difficulties. They should be able to effectively communicate their views to others. Math education equips students with the skills and behaviors necessary for a successful life in a civilization. Understanding mathematics fosters creativity and opens students' minds.

Mensuration is crucial in daily life for tasks such as calculating areas for painting walls, determining the amount of material needed for construction, or estimating the volume of liquids in containers. It helps with interior design, gardening, and land measurement. It aids in budgeting for home renovations or landscaping projects by accurately measuring spaces. In cooking, mensuration helps with measurements for ingredients, particularly when adjusting recipes. Overall, it simplifies various tasks requiring precise measurements, making them more efficient and accurate. So, the researcher selected this branch of Mathematics for study.

2. Game-Based Learning

Regarding games, Rousseau (1910) asserts that you should love kids and allow them to go wild with their games so they may find their inner love. Games encourage students to collaborate as a team in addition to offering a fun, engaging, and stress-free learning atmosphere. Students may also learn social ethics via games, which is crucial in modern society when individuals are abandoning their morals and manners to succeed. The concept of Rousseau is further developed by Pestalozzi, who remarks that some games should pique a child's

attention and motivate them to meet their learning objectives. Froebel is known as the "Father of Kindergarten" and is renowned for his playway approach. The game-based strategy is distinctive and successful in drawing in school children. It is a useful tool for encouraging innovative teaching methods. The foundation of mathematics is critical, logical, and diverse thinking. Games-based learning has the potential to improve students' opinions of the courses. Additionally, students may benefit from game-based exercises that allow them to apply and transfer their knowledge to real-world scenarios. Piaget's cognitive development theory served as the foundation for this game-based learning approach. Piaget thought that assimilation-adaptation was the process by which children developed. Piaget refers to children's psychology (or intellect) as arising from the subject's activity rather than from intrinsic maturity or learned experience. The adaptation of the subject to the object is the fundamental element of this activity. Through absorption and adaptation, individual adaptation brings the organism and environment into equilibrium. When a youngster applies the schema or skill he has acquired to participate in and finish tasks, it is referred to as assimilation. Children adapt when they attempt new schemas or abilities to accomplish certain objectives. Knowledge adaptation and the core of human wisdom are the result of the balancing act or coordination between assimilation and adaptation. According to Piaget, games are an essential part of a child's intellectual development because they help kids learn new things, build and extend their knowledge and abilities, and integrate thinking and action.

3. Rationale of The Study

The traditional technique is typically used to accomplish most of the instruction in classrooms. While the teacher speaks and the students passively listen to the teacher, the children in the classrooms sit in rows and are silent. They just speak when asked to and follow instructions exactly. In a traditional classroom, most students' learning capacities are limited to copying what is written on the board; they are unable to process information properly through analysis, investigation, and cognitive processes. This limited intellectual capacity causes students to lose interest in learning. The games-based strategy is a novel and successful way to draw in schoolchildren. It serves as an effective tool for encouraging innovative teaching methods. The foundation of mathematics is the use of critical, divergent, and logical thinking. Philosophers such as Froebel, Lato, Dewey, Tagore, Montessori, and many others establish crucial points for the child-centered teaching-learning process, in which students learn by doing. These exercises may take the form of role-playing, games, demonstrations, etc. More success in mathematics teaching can be achieved using games. With this viewpoint in mind, the researcher has tried to "determine the effects of game-based learning and traditional mathematics teaching techniques on elementary school students."

4. Review of Literature

Rai and Shrivastava (2024) conducted a study on the Effectiveness of Game-Based Learning on the Academic Achievement of Middle School students. The findings revealed that there exists a significant difference in the academic achievement of the students when taught through game-based learning methods of teaching mathematics. The mean score of the experimental group was higher than the mean score of the control group.

Bhadawkar (2021) studied the Effectiveness of Game-based learning strategies for enhancing Achievement and interest in Mathematics among Middle school students. The main findings were that there was a significant difference in the post-test scores of standard middle school students in experimental and control groups. There was a significant difference in the pre-test and post-test achievement & interest score of the experimental group at the 0.01 level.

Metin Basalt and Ümit Kul (2021) studied the effects of a Game-Based app on Primary Students' Self-Efficacy and Achievements in Learning Fractions during Distance Education. The findings of the study saw that the success scores of the experimental group students who received a game-based mobile application-supported education in addition to distance education led to a higher increase in the subject of fractions than the control group students who only received distance education, and the students' level of comprehension of this subject increased.

Shukla (2020) conducted a quasi-experimental study to find the effectiveness of game-based learning in the teaching of mathematics at the elementary level." The major findings were that there was a significant effect on the attitude toward mathematics, achievement in mathematics, and mathematical creativity of the students taught through game-based instruction.

5. Objectives of The Study

1) To study the effectiveness of game-based learning on the academic achievement of students in mathematics.
2) To study the effectiveness of game-based learning on gender.

6. Hypothesis

1) There is a significant effect of game-based learning on the academic achievement between the control and experimental groups.
2) There is a significant effect of Game-Based Learning on the academic achievement of boys belonging to the experimental and control groups.
3) There is a significant effect of game-based learning on the academic achievement of girls belonging to experimental and control groups.

7. Games Used in The Experiment

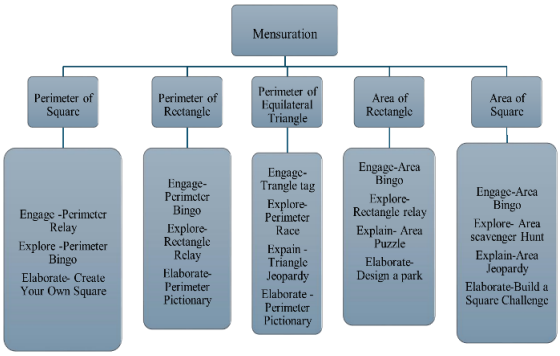

Fig. 1: Games Used in the Experiment.

8. Methodology and Procedure

Sample of the Study: The current study includes 80 students (40 boys & 40 girls) studying in the 6th grade at the Government Girls High School, Bhagwati Nagar, Jammu, affiliated with JKBOSE of district Jammu, Union Territory of Jammu & Kashmir, India.
Research Design: The research was experimental, based on a pre-test, post-test control group design.
Data Collection Methods: Data will be collected by pre-test and post-test
Statistical Technique Used: The t-test was used to find out the significant difference between the groups.

9. Analysis and Interpretation of Data

Table 1: Mean Comparison of the Academic Achievement of Students of the Experimental Group and the Control Group. (N=40 Each)

Variable	N	Mean	S. D	t-value	Level of Significance	Effect size
Experimental Group	40	8.35	0.69	14.4	Significant	3.06
Control Group	40	5.9	0.90			

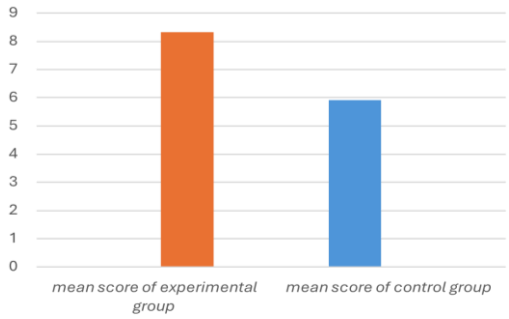

Fig. 2: Mean Comparison of the Academic Achievement of Students of the Experimental Group and the Control Group.

Table 1 (Figure 2) shows that the mean score of academic achievement of students of the experimental group is higher (M=8.35) than the mean score of the control group (M=5.9). The calculated t value came out to be 14.4, which shows a significant difference. It can be inferred that students of the experimental group and the control group differ in academic achievement. An effect size of 3.06 is considered very large, indicating a strong and meaningful impact of the game-based learning on academic achievement. Hence, hypothesis 1, that 'There is a significant effect of game-based learning on the academic achievement between the control and experimental groups' is accepted.

Table 2: Mean Comparison of the Academic Achievement of Boys of the Experimental Group and the Control Group. (N=20 Each)

Variable	N	Mean	S. D	t-value	Level of Significance	Effect size
Experimental Group	20	8.3	0.57	14	Significant	3.9
Control Group	20	5.55	0.82			

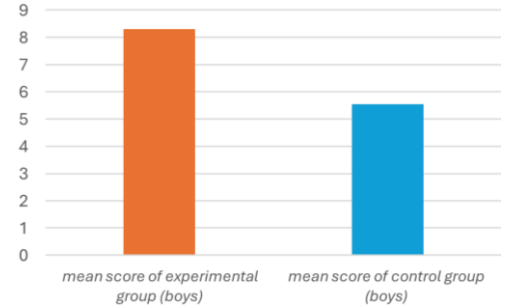

Fig. 3: Mean Comparison of the Academic Achievement of Boys of the Experimental Group and the Control Group.

Table 2. (Figure 3) shows that the mean score of academic achievement of boys of the experimental group is higher (M= 8.3) than the mean score of the control group (M= 5.55). The calculated t value came out to be 14, which shows a significant difference. It can be inferred that boys of both the experimental group and the control group differ in academic achievement. An effect size of 3.9 is considered very large, indicating a strong and meaningful impact of the game-based learning on academic achievement. Hence, hypothesis 2, that 'There is a significant effect of Game-Based Learning on the academic achievement of boys belonging to the experimental and control groups is accepted.

Table 3: Mean Comparison of the Academic Achievement of Girls of the Experimental Group and the Control Group. (N=20 Each)

Variable	N	Mean	S. D	t-value	Level of Significance	Effect size
Experimental Group	20	8.35	0.81	8.75	Significant	2.53
Control Group	20	6.25	0.85			

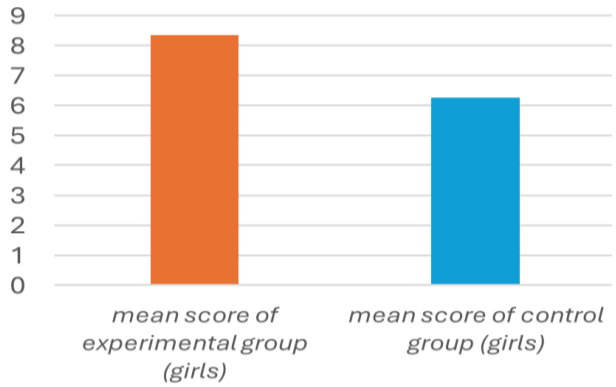

Fig. 4: Mean Comparison of the Academic Achievement of Girls of the Experimental Group and the Control Group.

Table 3 (Figure 4) shows that the mean score of academic achievement of girls of the experimental group is higher (M= 8.35) than the mean score of the control group (M= 6.25). The calculated t value came out to be 8.75, which shows a significant difference. It can be inferred that girls of both the experimental group and the control group differ in academic achievement. An effect size of 2.53 is considered very large, indicating a strong and meaningful impact of the game-based learning on academic achievement. Hence, hypothesis 3, that 'There is a significant effect of Game-Based Learning on the academic achievement of girls belonging to the experimental and control groups is accepted.

Findings

1) There exists a significant difference in the academic achievement of students when mathematics is taught using game-based learning techniques. The mean score of the control group was lower than the experimental group.
2) There exists a significant difference in the academic achievement of the boys of the experimental group and the control group. The mean score of the boys of the experimental group was higher than the boys of the control group.
3) There exists a significant difference in the academic achievement of the girls of the experimental group and the control group. The mean score of the boys of the experimental group was higher than the girls of the control group.

Conclusion

Teaching methods have changed a lot over the last few years. It is obvious that learning by heart, memorizing, and exposing or reciting should be abandoned. According to Sonia Jackson (2012), "The traditional chalk and speech teaching method, which has lasted for hundreds of years, now achieves inferior results compared to the modern and revolutionary teaching methods available for use in today's schools. It encourages more intense student interaction; authority limits are broken down and emphasis is placed on students' joy to learn." The mathematics teacher will use both traditional methods and modern teaching methods to meet the requirements of the school syllabus and to facilitate the development of logical reasoning. The success of a mathematics lesson depends on how the teacher manages to choose the most suitable methods and didactic instruments, to combine them, and to organize them in a harmonious assembly to achieve the proposed objectives. The study demonstrates the positive impact of game-based learning on students' academic performance and provides several opportunities for future exploration. Further research could examine the long-term retention of knowledge acquired through game-based learning methods or investigate its effectiveness across different subject areas such as mathematics, science, or language arts. A deeper analysis of how game-based learning influences different learners' profiles, including students with special educational needs or varying levels of prior knowledge, would also be valuable. The study also helps to solidify the role of game-based learning in mainstream education and guides the development of more personalized and curriculum-aligned learning tools.

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