The Effects of Gamification Teaching Method in Enhancing Numeracy Learning Among Primary School Students in Tamil Nadu

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ABSTRACT

Background: Attaining universal basic numeracy in primary schools by 2025 is emphasized in the Indian National Education Policy (NEP) 2020. By setting a deadline, all students in the primary school system have demonstrated a commitment to acquiring a fundamental level of numeracy skills. **Aim:** This study aims to determine the impact of gamification on enhancing numeracy learning in primary school students. **Method:** A quasi-experimental design was used to achieve the aim of the study. The experimental group was taught by the gamified teaching method and the control group by the traditional method. Pretest and posttest were executed to collect data. A total of twelve weeks of time was taken to collect the data. **Sample**: A total of 30 children aged 6-7 years old from a private school in Tamil Nadu participated in this study, with fifteen students as the experimental group and fifteen students as the control group. **Results:** The results of the pretest and posttest values through the independent sample T-test show significant effects of gamification in enhancing numeracy learning and increasing motivation and engagement among primary school students in Tamil Nadu. **Conclusion:** The study shows that gamification has significant impacts on numeracy learning and increases motivation and engagement in students.

Keywords: Gamification; Teaching Method; Effects; Motivation; Engagement

Background

India has made significant progress on many goals, but it is off track when it comes to achieving the targets set for ensuring that every child in the country attains foundational numeracy by the end of grade 3 by 2026-27, as outlined in the NIPUN Bharat initiative in 2020. In other words, India is facing challenges or difficulties in meeting the specific educational target of ensuring that all children achieve basic numeracy skills by a certain deadline. This highlights a need for further efforts and interventions to address this issue and bring the country back on track toward achieving this educational goal.

The National Education Policy (NEP) 2020 of India indeed emphasizes achieving universal foundational numeracy in primary schools by the year 2025. The goal signifies a commitment to ensuring that all children in the primary education system attain a basic level of numeracy skills by the specific deadline. It is a critical objective aimed at improving the quality of education and ensuring that students have the fundamental skills needed for further learning and development. Achieving a universal foundation in numeracy is a key component of India's education policy, and it reflects the country's aspirations for inclusive and quality education for all. In addition, the 2009 Assessment Survey Evaluation Research (Aser) conducted by the non-profit Pratham labeled Tamil Nadu as a weakly performing red state. The 2020 annual survey in Tamil Nadu shows that only 17.4% of children in class 3 were able to do simple math. Lack of foundational skills, inadequate teacher training, and limited access to learning resources. These challenges can arise from a combination of factors, including design, teaching methodologies, infrastructure, and socio-economic disparities. Children learning mathematics through traditional lecture method can face challenges in understanding, engagement, and overall math performance.

Traditional methods of learning may not always engage students' curiosity or foster a love for math, leading to reduced motivation to learn the subject. Therefore, this study focuses on primary school students, specifically those who gamify math to enhance numeracy learning and increase motivation and engagement. The traditional approach may not provide students with valuable skills (Tularam 2018). In the traditional method, the teacher does all the speaking, and children inactively listen and talk just when approached and do what they are told. Because of this constrained intellectual capability, children lose interest in learning (Noreen & Rana, 2019).

Literature Review

Basic numeracy skills are the ability to understand and use math in daily life at home, work, or school. Many studies have been carried out to highlight the effects of gamification on Education (Ratna *et al.,* 2023; Rahim *et al.,* 2024) and on math learning at different levels of students, like early childhood learners, elementary, and secondary. However, the above-reviewed studies show that none of the studies proved that using gamification effectively in learning basic numeracy was effective for grade one students in Tamil Nadu, India. Gamification is more effective in attaining optimum learning outcomes compared to the traditional method of curriculum teaching and learning. Research has been carried out to emphasize the importance of gamification in enhancing numeracy and the effects of gamifying math to increase motivation and engagement in numeracy learning. (Papp & Theresa, 2017) said that gamification provides unique insights into student ability, and the effect of gamification shows increased motivation and engagement at the primary level. (Jagušt *et al.*, 2017), students used tablet computers and digital learning lessons for learning mathematics, and through the results, they suggested that gamification improved students's performance, but success depends on the carefully balancing combination of game elements. (Sakai & Shiota, 2016) Japan investigated a classroom (where teachers find it difficult to set appropriate questions) using gamification and proved that gamification is effective in teaching math. (Jagušt, Botički, & So, 2018) In Japan, they suggested that the use of gamification allows students to sustain more interest compared to the non-gamified approach to learning with digital resources. (Kimble, 2020) Georgia said that students using gamification were only able to master two out of ten skills at grade level. The evidence does not support the claim that students master more grade-level math skills with the use of gamification. (Dikmen, 2021) In Turkey, they suggested that gamification helps to make learning fun and motivate students by attracting their attention. Hui & Mahmud (2023) state that game-based learning has positively impacted students when they are learning mathematics.
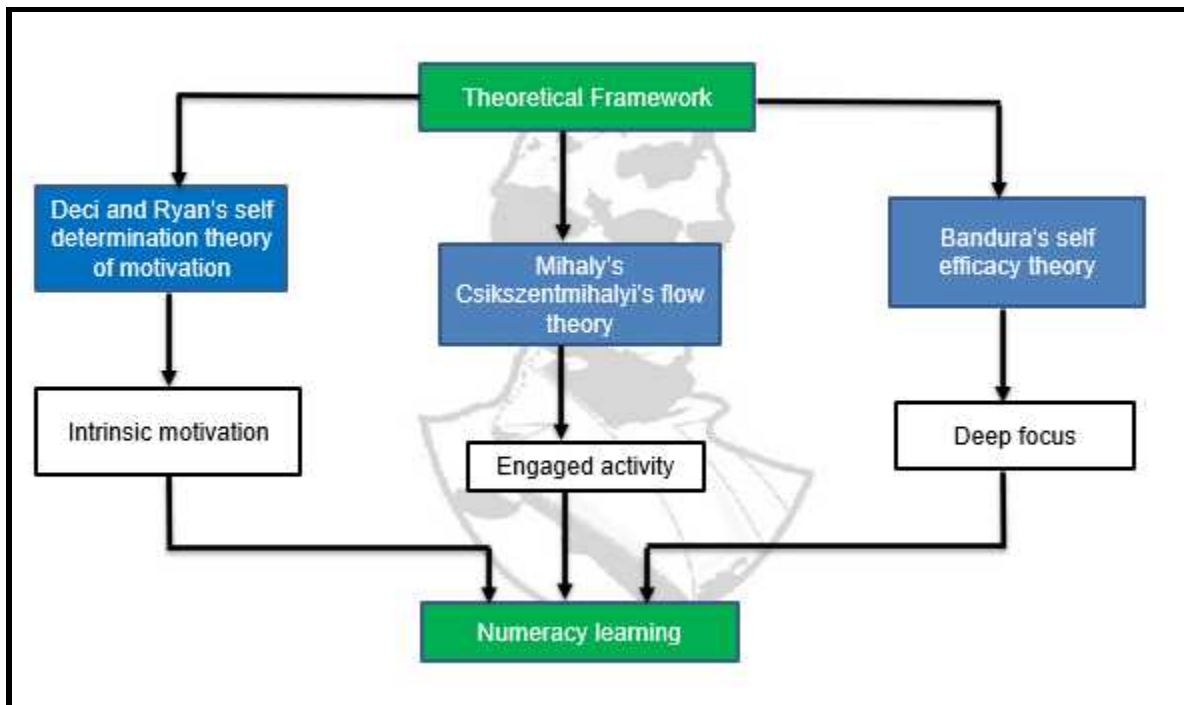
Theoretical Framework

Figure 1: Theoretical Framework

(Deci & Ryan, 2015) Deci and Ryan's determination theory of motivation Self-determination theory focuses primarily on internal sources of motivation, such as a need to gain knowledge or independence, which is known as intrinsic motivation. Research shows that when students have intrinsic motivation for learning, they are more likely to attach meaning to their work, explore new topics, and persist in the face of learning challenges. They enjoy exploring the material and mastering it. Intrinsic motivation enhances numeracy learning.

Mihaly's Csikszentmihalyi introduced flow theory in the 1970s based on research examining people who did activities for pleasure, even when they were not rewarded with money. Students were motivated by the quality of the experience they had while they were engaged in the activity. In the activities, students were deeply involved and motivated because they were participating in an enjoyable experience that led to learning. (Lopez-Garrido, 2023) Bandura's self-efficacy theory. The term 'self-efficacy" was first coined by psychologist Albert Bandura (1977), a Canadian American psychologist and a professor at Stanford University. Bandura was responsible for bringing the term to light, but psychologists have studied self-efficacy from several perspectives. To give an example of another perspective, Kolbe, an educator and best-selling author, thinks that believing in one's own abilities can be vital in measuring cognitive strength (Kolbe, 2009). She believes that self-efficacy also involves determination and perseverance, seeing as how it helps one overcome obstacle that would interfere with utilizing those innate abilities to achieve goals. Helping students to believe in themselves and be in a positive mood can boost one's beliefs in self-efficacy, which brings deep focus to learning.
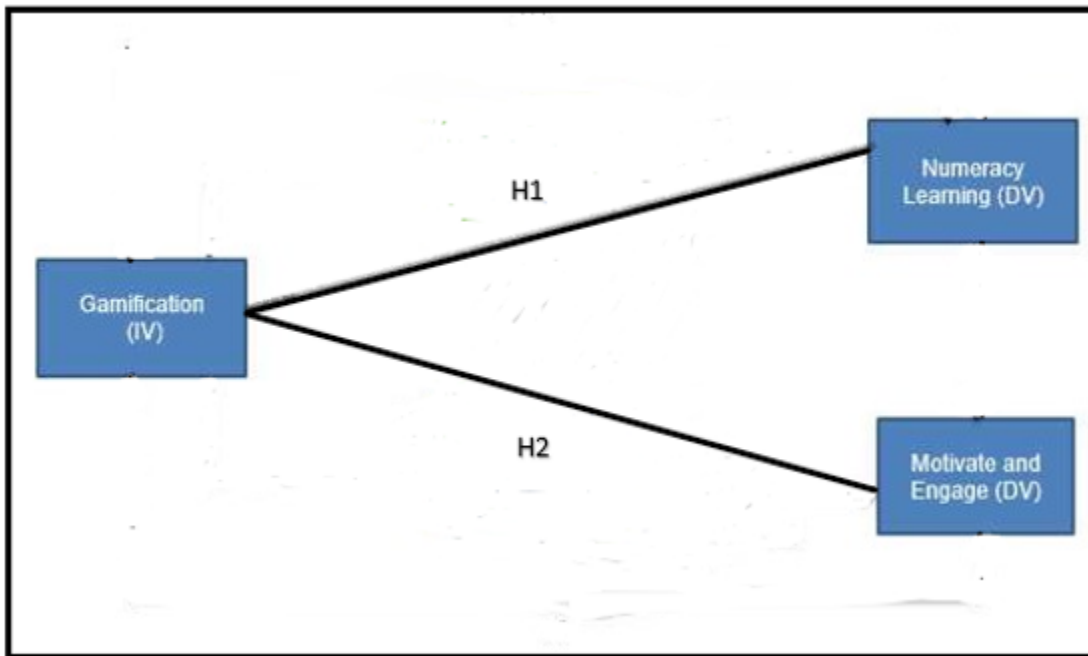
Conceptual Framework of the Study

Figure 2: Conceptual Framework

The independent variable, or the input of the study, is gamification. In this study, the researcher gamifies math to see the direct and indirect connection of the independent variable to the dependent variables. On the other hand, the study has two dependent variables: numeracy learning and motivation and engagement. The researcher intends to determine the direct effect of gamification on numeracy learning and whether it increases motivation and engagement. The connection of the hypothesis to the independent and dependent variables are clearly visible here in the conceptual framework.

Hypothesis

H1 - Gamification has a significant impact on Numeracy learning in primary school.
H2 - Gamification has a significant impact to increase motivation and engagement in students.
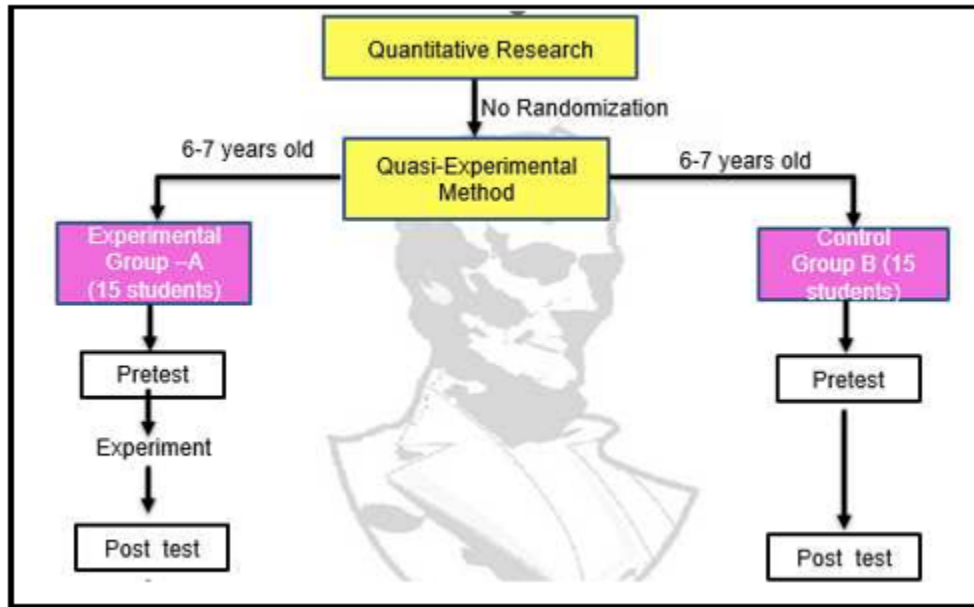
Methods

Figure 3: Research Method

Population & Sampling Technique
This research is a quantitative study. A quasi-experimental research design, as shown in ***Figure 3*** above. To conduct true experimental research, three fundamental components should be involved: randomized sampling, a control group, and intervention or experimentation. Population is the collective or totality of the things or people who are included in the study's intended scope. The total population of the study is 30 primary school students of age 6-7 in private schools in the city of Chennai, Tamil Nadu. As the research is based on gamification in numeracy learning, a sample of 30 children aged 6-7 has been chosen as participants in the research. Fifteen children participated in the experimental group, and fifteen children will participate in the control group. There was no random sampling, as the available number of students in Grade 1, Division C, is the sample number.

Data Collection
The study conducted from July to September compared an experimental group, receiving gamification-based instruction, to a control group taught traditionally. Both consisted of fifteen Grade 1 C division students with similar IQ levels. The researcher collaborated with the class teacher, ensuring consistency in teaching. Pretests and posttests were administered, with a questionnaire gathering student opinions on gamification at the study's end.

Results & Findings

The quasi-experimental research was done to examine the impact of gamification on enhancing numeracy learning among primary school students in Tamil Nadu. The results were analyzed using a paired sample T test**.** The control group consists of 15 primary school students aged between 6 and 7. The following table displays each student's scores in the pretest and posttest. The following table displays each student's scores in the pretest and posttest.

Table 1: Experimental Group (group B) Pretest & Posttest Scores

Roll No	Student Name	Group B- Test scores without Gamification (pretest) (20)	Group B-Test scores after using Gamification (posttest) (20)	Improvement in the result (d)
1	E1	8	13	5
2	E2	13	18	5
3	E3	18	19	1
4	E4	12	16.5	4.5
5	E5	14	18.5	4.5
6	E6	16	19	3
7	E7	14	16	2
8	E8	13	19	6
9	E9	12	18	6
10	E10	14	19	5
11	E11	16	19	3
12	E12	18	19.5	1.5
13	E13	13	17	4
14	E14	11	17.5	6.5
15	E15	15	19	4

Table 1 shows the pretest and post test scores of Experimental groups and shows the improvement result scores.

Table 2: Comparison of Pretest & Posttest Experimental Group (Paired samples statistics)

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1- Pretest Scores	13.8000	15	2.62406	0.67753
Pair 1- Posttest Scores	17.8667	15	1.70573	0.44042

Hypothesis 1

H1: Gamification has a significant impact on numeracy learning in primary school.

Table 2 shows the pretest and posttest scores of the experimental group, whereas the scores differ significantly: Pretest scores: mean=13.8, SD=2.6, and posttest scores: mean=17.8, SD= 1.7. Posttest scores are relatively higher than pretest scores. A control and experimental group of thirty primary school students took the pretest at the same time. Then the control group started learning through the normal lecture method, and the experimental group started learning through the gamification method. Then the posttest was carried out after a period of twelve weeks for both groups. So, it shows that after the intervention, the students showed improvement in numeracy learning. The findings show improvement in the student's scores by an average of 4.0 points. H1: Gamification has a significant impact on numeracy learning in primary school; hence, the results support this hypothesis.

Table 3: Control Group (group A) Pretest Scores & Posttest Scores

Roll No	Student Name	Group A-Test Scores (pretest) (20)	Group A- Test after using worksheet traditional manner (posttest) (20)	Improvement in Result (d)
1	A1	10	14	4
2	A2	14	16	2
3	A3	18	18.5	0.5
4	A4	15	17	2
5	A5	12	13.5	1.5
6	A6	17	18.5	1.5
7	A7	18	20	2
8	A8	15	17	2
9	A9	13	15.5	2.5

10	A10	16	18	2
11	A11	13	14.5	1.5
12	A12	14	16	2
13	A13	9	13	4
14	A14	12	15	3
15	A15	11	12.5	1.5

Table 3 shows the pretest and posttest scores of the control group and shows the improvement in the result scores.

Table 4: Control Group Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1- Pretest Scores	13.8000	15	2.75681	0.71181
Pair 1- Posttest Scores	15.9333	15	2.22700	0.57501

Table 4 shows the first hypothesis of the study. Control group pretest and posttest scores were analyzed. The control group of fifteen students from Grade 1 took the pre-test at the same time as the experimental group, and the post-test was carried out after a period of twelve weeks for both groups. The scores differ significantly, the mean of the control pretest= Mean scores= 13.8 and SD =2.7post-test scores Mean scores=15.9 and SD=2.2. The findings show improvement in the student's scores by an average of 2.1 points.

Table 5: Comparison of Pretest Scores of Control and Experimental Group (Independent Sample Test)

	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
Pretest scores- Equal variances assumed	0.206	0.653	0.000	28	1.000	0.00000	0.98271	-2.01299	2.01299	
Equal variances not assumed			0.000	27.93	1.000	0.00000	0.98271	-201321	2.01321	

Table 5 shows that the comparison of pretest scores of the control and experimental groups in an independent sample test doesn't show much difference. Almost both the group pretests remain the same, as the 95% confidence interval of the difference clearly shows that in the control group and the experimental group, the students have the same IQ level.

Table 6: Control & Experimental Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Pretest Scores	Control	15	13.8000	2.75681	0.71181
Pretest Scores1	Experimental	15	13.8000	2.62406	0.67753

Table 6 shows the control group pretest scores (Mean=13.8, SD=2.7) and experimental group pretest scores (Mean=13.8, SD=2.6). The findings of the comparison of the pretest of the control and experimental groups almost show the same scores, with a SD difference of (0.1).

Table 7: Comparison of Posttest Scores of Control & Experimental Group (Independent Sample Test)

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Posttest scores-Equal variances assumed	1.729	0.199	-2.669	28	0.013	-1.9333	0.72429	-3.41698	-0.44968
Posttest scores-Equal variances not assumed			-2.669	26.220	0.013	-1.9333	0.72429	-34215	-0.44513

An independent sample test is an important test for differences between groups. Table 7 shows two rows; the first row provides statistics for the tests under the assumption of equal variances. The second row provides statistics for the tests under the condition that equal variances are not assumed. The p value (<0.05) means a significant difference. There is a 95% CI presented, which is a 95% confidence interval of the difference. This CI has a lower limit at -3.41698 and an upper limit at -0.44968. Because the CI does not include 0, we can infer that the difference between the two groups does exist here.

Table 8: Control & Experimental Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Posttest Scores	Control	15	15.9333	2.22700	0.57501
Posttest Scores	Experimental	15	17.8667	1.70573	0.44042

Table 8 shows the comparison of the pretest and posttest of the control and experimental groups, were analyzed to test the hypothesis (H1). The findings are Pretest scores: control group (Mean=13.8, SD= 2.7) and experiment group (Mean= 13.8, SD=2.6). The findings show almost the same scores for both groups, with an SD difference of 0.1. There is not much difference in the pretest of both the control and the experimental group. The posttest of the control group shows improvement with student scores on average of 2.1, and the experimental group shows improvement in the students' scores on average of 4.0. The results of the control group do not show as much improvement as those of the experimental group. This shows that students learning through gamified math like point scoring show good improvement when compared with the control group. So, it is proven that gamification has a significant impact on numeracy learning in primary school. According to the findings above, the hypothesis was accepted. Hence H1 proved that gamification has a significant impact on numeracy learning in primary school students in Tamil Nadu.
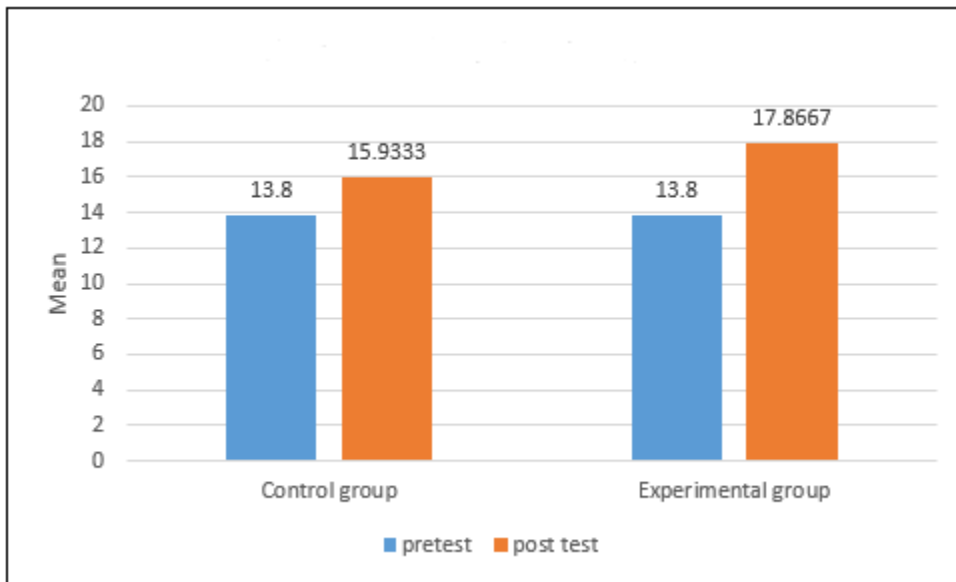
Figure 4: Comparison of Pretest and Posttest Analysis of Control Group & Experimental Group

Figure 4 shows the comparison of pretest and posttest analyses of the control group and the experimental group, which shows a positive impact on the experimental group. The effects of adding gamification elements to math learning revealed that students exposed their high level of interaction, which leads to high academic achievement. Traditional instructional methods have made it difficult for students, when compared with experimental groups, to concentrate and develop a desire to learn. There is improvement in the control group, but when compared with the experimental group, it is not sufficient. Finally, gamification has improved student performance on average, although student outcomes vary. The left-skewed distribution and outliers emphasize the necessity of understanding gamification's impact. Exploring outliers and subgroups will illuminate the mechanisms at play and inform future pedagogical initiatives to maximize the benefits of gamification in education. So, H1-gamification has a significant impact on numeracy learning.

Hypothesis 2

H2: Gamification has a significant impact to increase motivation and engagement in students.

Table 9: Gamifications have the most Positive Effects on Motivation and Engagement of Experimental Group (Question wise Analysis)

S.NO	Name of the student	Q1.	Q2.	Q3.	Q4.	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10
1	E1	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
2	E2	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
3	E3	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
4	E4	S A	S A	S A	S A	S A	S A	Agree	S A	S A	S A
5	E5	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
6	E6	S A	S A	S A	S A	S A	S A	Agree	S A	S A	S A
7	E7	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
8	E8	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
9	E9	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
10	E10	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
11	E11	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
12	E12	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
13	E13	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
14	E14	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A
15	E15	S A	S A	S A	S A	S A	S A	S A	S A	S A	S A

Table 9 shows the most positive effects of gamification, which increases motivation and engagement among students. A questionnaire was used to analyze hypothesis 2. All the students strongly agree that gamification helps them learn math through fun learning, which increases motivation and engagement. The findings of the study show that among the 15 experimental students, most strongly agree that gamification enhances numeracy learning and that their interaction increases their motivation and engagement.
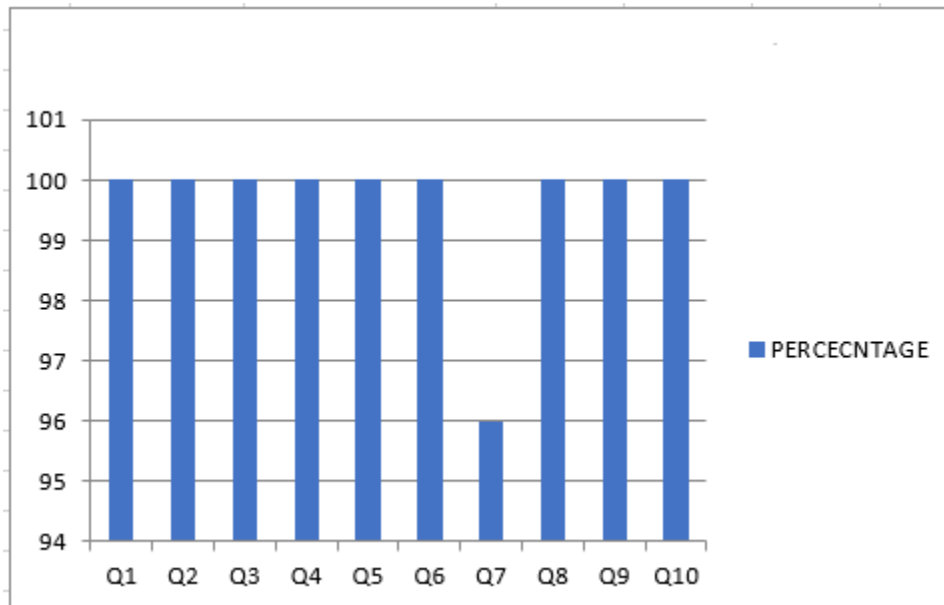

Figure 5: Question wise Analysis

Figure 5 shows the bar graph of the findings of the research that gamification shows positive effects that gamify math and interaction help them to increase their motivation and engagement, which also shows that students want to learn math in the gamified version in future classes too. Students were interested in learning math in the gamify version. These findings clearly show that gamification enhances numeracy learning and has a significant impact on increasing motivation and engagement among primary school students in Tamil Nadu. This was proved by analyzing the questionnaire and pretest and posttest scores using the T- test. So, it was proven that H2 Gamification has a significant impact on increasing motivation and engagement in students.

Discussion

This research aimed to identify the impact of gamification on enhancing numeracy learning among primary school students in Tamil Nadu. Further, the study focused on gamification in numeracy learning for academic achievement and to increase motivation and engagement.

The findings of the research proved that H1 gamification has a significant impact on numeracy learning. The study findings of posttest scores show more improvement in the experiment group when compared with the control group. Finally, gamification has improved student performance on average, although student outcomes vary. (Sakai & Shiota, 2016) Japan, also proves that gamification is effective in teaching math. Jagušt *et al.* (2017) also prove that gamification gives positive results when compared with a non-gamified approach to mathematics learning. These two previous students align with this research, and hence it is proven that gamification has a significant impact on numeracy learning. Gamification is an effective tool to enhance students' basic numeracy skills. In alignment with Ding, Er, & Orey, (2018), also stated that games are an effective tool in education for quickening learning and encouraging

systematic thinking. Here, it is proved by comparing the control and experimental pretest and posttest analyses. Traditional instructional methods have made it difficult for students, when compared with experimental groups, to concentrate and develop a desire to learn. This study also aligns with Hui & Mahmud 2023, also proves that game-based learning has positively impacted students when they are learning mathematics. Jagušt *et al*., (2017) also prove that gamification allows students to sustain more interest compared to a non-gamified approach to learning. So, H1 proved that gamification has a significant impact on numeracy learning in primary school.

The findings of the H2 stated that gamification has a significant impact on increasing motivation and engagement. It is also aligned with the previous study done by Papp & Theresa (2017), and Jagušt *et al*., (2017) also state that gamification provides unique insights into student ability, and the effect of gamification shows increased motivation and engagement at the primary level. Both studies focused on how to improve young learners' motivation and engagement in math learning. Here, it proves that gamification influences the level of student interest in learning and allows students to sustain more interest compared to traditional methods of learning. When math education is gamified, it transforms the learning experience into an engaging and enjoyable process, which can lead to improved understanding, motivation, and retention of numerical concepts. Beyhan & Tural, (2007 also stated that using games in the math teaching process can assist students to learn math with enjoyment, which helps to increase engagement. In Dikmen, 2021, they suggested that gamification helps to make learning fun and motivate students by attracting their attention. This study, which aligns with Hui & Mahmud 2023, also proves that game-based learning has positively impacted students when they are learning mathematics. It is comprised of knowledge and mathematical skills and five types of affective domains like achievement, attitude, motivation, interest, and engagement. Hence, it proves and aligns with both hypotheses. Overall, gamification can create a positive and supportive learning environment, make math learning more accessible, and increases motivation. It's important for educators and parents to leverage gamification effectively by selecting math games and activities that align with educational goals and provide appropriate challenges for students at their grade levels.

Limitations of the Study

The study was limited to private matriculation school students in Tamil Nadu. The sample was limited to 30 primary school students in Tamil Nadu. The investigator has limited the study to a few students. The study was not done in different schools in Tamil Nadu.

Conclusion

The present study will help primary teachers make the learning process more enjoyable and interactive, which can help improve retention and understanding of course material. This study may help other primary school teachers make learning more effective and interactive in their schools. This research will benefit parents, teachers, and private and government education institutes that want to enhance the numeracy skills of their children. Based on the results, this study clearly shows the impact of gamification in enhancing numeracy learning among primary school students, which is a testament to the transformative power of innovative and engaging teaching methods. It also proves that gamification brings interest in math with enjoyment and success; students are more likely to develop a positive attitude toward the subject, setting the stage for continued exploration and achievement in numeracy.

The present study was conducted on students in grade 1 with a total of 30 number of students. A similar study can be conducted on many samples, where the results may be more reliable. It may be conducted at other levels, like elementary and secondary, in different districts of Tamil Nadu. The effects of gamification research should be conducted in different core subjects like English and science. Teachers

from different schools, like government and private schools, can be taken as samples for future research on the effects of gamification in different subjects.

Declarations

Ethics Approval & Consent to Participate: The present study was done with proper approval from the institution to collect data.

Conflict of Interest: Not applicable.

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