

# Online Gamified Flipped Classroom as a Strategy for Performance Improvement in Solving Equations in One Variable

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## ABSTRACT

*The current study is a one group pre-test & post-test experimental design to examine the effect of the flipped classroom strategy on students' performance. On the basis of various studies conducted, the researchers found no investigation based on an online Gamified Flipped classroom as a strategy to increase performance in solving Mathematical equations in one variable. Hence, this study was conducted to investigate the effect of online Gamified Flipped classrooms on the students' performance. The study shows the regular completion of students' assignments which resulted in extra time for discussing, clearing doubts and solving higher order thinking problems as an in-class activity and students' improved performance.*

**Keywords:** *Gamified Flipped classroom, Gamification, Performance, Equations in one variable, online education*

## I. INTRODUCTION

The Covid-19 Pandemic made us realize the importance of using technology. It encouraged us to use the online platform to continue education, thereby helping us to maintain social distancing. It paved the way for teachers and students to attend classes anytime and from anywhere. Education could take the form of flipped learning where the student's learning could be supplemented through the use of technology.

Although the flipped classroom has recently received much research attention and provides numerous positive impacts on students' learning, such as students' learning achievement, motivation, engagement, and interaction (Zainuddin & Halili, 2016), some challenges are still reported from several studies (Çakıroğlu & Öztürk, 2017). Many studies reported that the unpreparedness of students during in-class activities proves to be a great challenge in flipping the class as students are not motivated to complete by themselves the out-class activities (Chun et al., 2014; Akçayir & Murat, 2018).

This engagement crisis can be mitigated by supplementing flipped classes with games as suggested by Amornrit (2020) as 'Gamification' can reduce the limitations of learning caused due to the distance between learners and teachers. Gamification also increases collaboration in the learning process. According to Prensky (2001), digital natives are from the Games Generation. Games motivate because of their impact on the cognitive, emotional and social areas. The success of gamification lies in engaging people on an emotional level and motivating them to achieve their goals to create positive learning outcomes (Youssef, 2015). Hence the researchers tried to investigate the effect of using games in flipped classrooms on the performance students.

For gamifying the content using the flipped strategy, the researchers used the Edpuzzle app and Quizizz.com for providing practice and for formative assessment which provided the teacher with feedback on the success of the teaching method and the students' understanding of a particular topic. Both the platforms provided task-level feedback via awarding points for right answers. This had a high potential to scaffold the learning process performance in gamified quizzes which results in better outcome (Sailer & Sailer, 2021).

This study is significant because of the limited reporting of Gamified Flipped classrooms as a strategy for increasing performance in Linear equations in Mathematics (Chun & Lo, 2022). Besides, no well-defined research has been documented on the use of Edpuzzle as a tool for Gamified Flipped classroom supplementing with Quizizz as a formative assessment tool in teaching Mathematics at an upper primary level. To address the aforementioned gaps, the following research question was developed:

**RQ.** What is the effect of online gamified flipped classroom strategy on students' performance for solving Equation in One Variable using gamified flipped classroom as strategy?

**H0** There is no significant difference in mean scores of Pre and post-test Achievement of students in Equation in One Variable using gamified flipped classroom as strategy.

## **II. CONCEPTUAL FRAMEWORK**

### **2.1 Gamification as a strategy to enhance teaching learning process**

According to Santos & Castro (2021) 'Learning is dynamic'. The way a teacher learned the lesson before is not the same way that lessons are learnt now. Nowadays, the students are digital natives and they learn and process information differently (Prensky, 2001; Santos, & Castro, 2021, Wepee, 2015) and the educational system does not fit their needs (Wepee, 2015).

The NCF (2005) suggested creating situations and opportunities for students to provide them with challenges, creativity and active participation. Gamification assists teachers in engaging students and creating their interest for meaningful learning. Areed et al. (2021) suggested that it is very important for instructors to apply games as a modern and innovation-oriented tool through which students can be engaged in an attractive, competitive experience which increases competency and the mastery of new skills in and out of the classroom. According to Sahin & Namli (2018) 'Games increase enjoyment for students by providing rewards and feedback, which can improve students' attitudes toward learning traditionally challenging subjects like mathematics or science.' Gamification can motivate students to engage in the classroom (Ozer et al. 2018). For this study the researchers used Edpuzzle and Quizizz as gamification tools.

### **2.2 Flipped Classroom**

A flipped classroom refers to flipping the traditional classroom where the role of teacher changes from sage on stage to guide on side and the schoolwork changes with homework and vice versa, thus changing a teacher centered classroom to a student-centered classroom for the better learning outcomes. According to Bell (2015), instructors who flip their classrooms reverse the roles of schoolwork and homework by recording video lectures for students to watch before coming to class. Students then work on their homework in the classroom where the instructor is present to help them.

### **2.3 Gamified Flipped classroom**

A teaching strategy where gamification is supplemented to curb the disadvantage of flipped classrooms by motivating and engaging the learners in order to achieve better outcomes. The NEP (2020) also suggested incorporating games into the curriculum.

The Flipped classroom approach supported by gamification includes creating a

competitive environment where students are entertained and their interests and motivation levels are elevated. Hei (2019) stated that Gamified Flipped classroom helps in self-directed learning and it promotes more in-depth learning resulting in better achievement of students. Zainuddin (2018) claimed that a gamified flipped-class setting fostered better motivation and engagement.

#### **2.4 Edpuzzle**

Edpuzzle is an easy-to-use platform where teachers can find already created videos or teachers can make a video based on content of their choice or redesign the video by embedding their own questions or audio. Teachers can assign the video link to the students in self-pace mode or during the class as live mode as an assignment. According to Silverajah & Govindaraj (2018), the use of Edpuzzle permits a flexible environment to students which supports the development of self-regulated learning skills.

#### **2.5 Quizizz**

Quizizz is an educational app that enables students to participate in fun multiplayer class activities (Zaho, F. 2019). Quizizz, is a game-based online test which can be used as a formative assessment tool that enables teachers to get the information about understanding, learning needs and progress of students in a subject. Teachers can design the quiz, and share the link to the students to play on self-paced mode, single handed or in a team.

#### **2.6 Related work in equations in one variable**

The transition from arithmetic to algebra at Upper Primary Stage in Mathematics is both challenging and rewarding. However, teachers should be able to create and sustain an interest and engage the students in problem solving. Introduction of variables, and linear equations gives students fluency in using the new language and lays the base for a mode of thinking that can be called algebraic (NCERT, 2006).

Based on research, following are some of the difficulties faced by students while solving the problems on linear equations -

According to Tiwari & Fatima (2019) cognitive difficulties and conceptual misunderstandings acquired at this stage hamper the learning and interest in Mathematics. As stated by Olivier (1988) students believed the letters of the alphabet represent numbers and thought that the expression  $ab$  represented a two-digit number instead of the multiplication of two numbers  $a$  and  $b$ .

Saraswati (2016) states linear equations with one variable are necessary to support learning of other topics in Mathematics. As the concept of variable is introduced in Arithmetic, students find it difficult to transit from arithmetic to Algebra. Some of the misconceptions found by this study were:

To find the value of  $y$  in equation

1.  $4y = 12$ , 12 should be divided by 4, but students make the mistakes of subtracting 4 from 12. So, instead of getting the answer  $12/4=3$ , they get  $12-4=8$
2.  $5 + y = 7$ , here 5 should be subtracted from 7 but student write  $6y = 7$

The common misconceptions as stated by Mulungye et al. (2016) are

1.  $3x + 3x = 6x^2$
2.  $3x - (x - 5) = 2x - 5$
3.  $(x + y) = 3xy$
4.  $3x + 5 = 8x$

That is, the student perceived that the answer should not contain an operator symbol. The student perceived that the “+” sign “as an invitation to do something” and the student went ahead to do it.

Egodawatte (2011) observed the misuse of the “change- side, change-sign” rule in the last steps of the equation solving process as.....  $-7n = 0$ , therefore  $n = 7$ .

One of the researchers, as a mentor, observed the difficulties in understanding the concept of variables in her students. To mitigate the fear of handling alphabets and to give more practice in a fun oriented way, she supplemented gamification with flipped classrooms.

### **III. RESEARCH METHODOLOGY**

#### **3.1 Method**

This study was conducted with a one group pre-test & post-test experimental design to examine the effect of the flipped classroom strategy on students’ achievement. According to Allen (2017), a one-group pre-test & post-test design is a type of research design that is used to determine the effect of a treatment or intervention on a given sample in which all participants are given the same treatments and assessments and the effect of a treatment is determined by calculating the difference between pre and post test scores.

#### **3.2 Sample**

Twenty-three students from the age group 12-14 years were taken as a purposive sample. They attended all the online classes, watched all the gamified flipped classroom videos (Edpuzzle), solved all the assignment on 99 math, Nearpod, and Mathplayground, and attempted pre and post tests on Quizizz.

### **IV. PROCESS**

#### **4.1 Gamified platforms**

The researchers used Edpuzzle to send the content for flipped classrooms as an assessment. These were embedded with the content related questions based on the objective of the study. Using Edpuzzle, the students were required to watch the video and solve the questions. For every right answer they were awarded 100 points. Quizizz was used to gamify their online classroom participation encouraging individual self-paced mode. The daily assignment and the full length pre and post tests were assigned using Quizzes. According to Metwally et al. (2021) students can take on a persona, earn points, and experience a deeper sense of achievement doing the gamified homework. Also, there are many gamification elements which attract the user viz.; leaderboard, badges and points Sulong et al. (2021).

#### **4.2 Participants and intervention design**

##### **4.2.1 Pre Intervention**

The researchers selected videos from Edpuzzle and designed and edited them according to the objectives. They added students to the Edpuzzle classroom. The Edpuzzle videos were 4-9 minutes in length followed by 5-7 questions for assessment. Similarly, on the quizzes in Quizizz.com contained 15-20 questions as a part of their assignments while the pre and post-tests contained 30 questions of 1 mark each. All the concepts of Linear Equation in one Variable were tested in the pre and post-tests.

##### **4.2.2 Process of Intervention**

The researchers designed the intervention programme of three weeks duration in which ten online sessions were conducted on the Zoom platform. Online sessions were conducted thrice a week, each for an hour. In the introductory session, the researchers gave instructions for downloading the Edpuzzle app, explained in detail about it and provided the students with the class code and requested them to join the class using that code. They gave the students hands-on training on Edpuzzle and Quizizz also introduced them with the process which they would

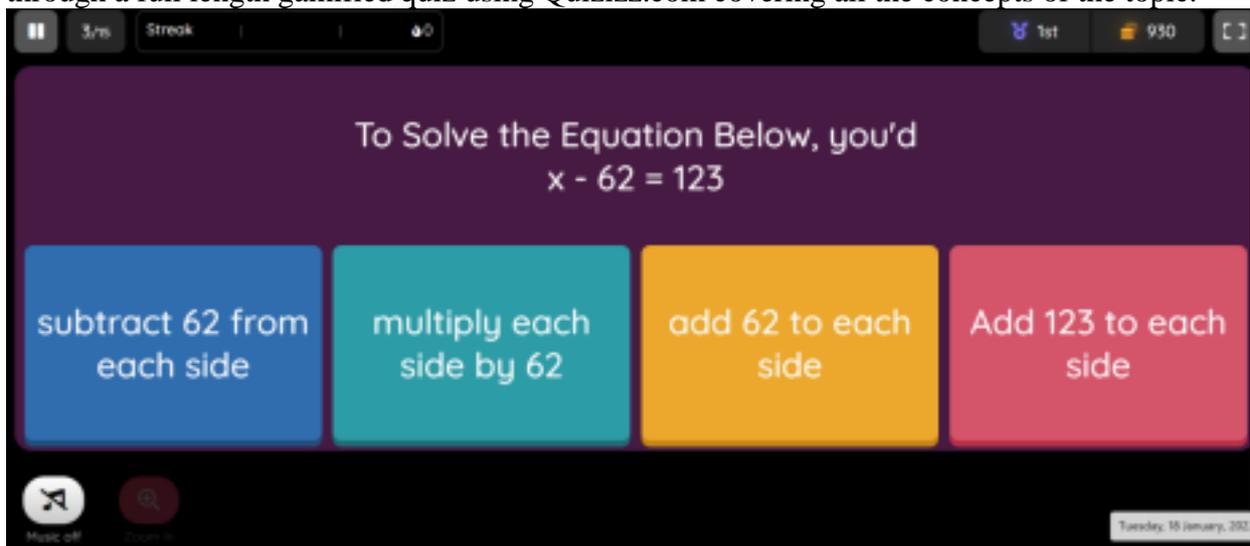
have to follow for 10 online sessions.

In the first session one of the researchers conducted a full-length gamified quiz using Quizizz.com. This was used as a pre-test and had 30 questions for evaluating the concept of Linear Equation. Twenty three participants took the quiz.

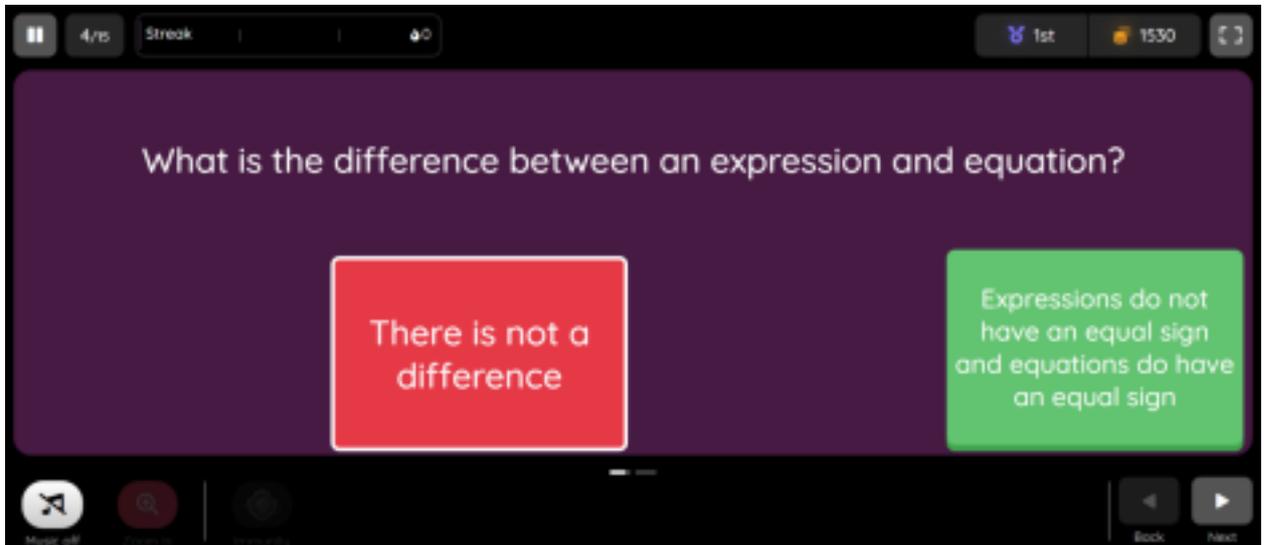
A day before every session, the teacher shared the link of a video on the Edpuzzle classroom. Students had to watch the assigned video and solve embedded questions, and be ready with their doubts and notes before the next class. After every class, the teacher shares the link of an online quiz as an assignment. Using the report feature of Edpuzzle and Quizizz, the researchers get an idea about the performance of the student. The reports helped the teacher to plan which topic, concept, and question need more discussions on, so as to strengthen students' understanding.

Students were asked to share the screenshot of their doubts and wrong answers related to the quizizz in the WhatsApp group so that it can be discussed among the students in the group and in the class. Leaderboards and points helped learners to motivate themselves to play more. According to Sulong et al. (2021) gamification drives people to take voluntary actions predictably through the use of game elements such as experience points, rewards, badges and many others of identified game elements.

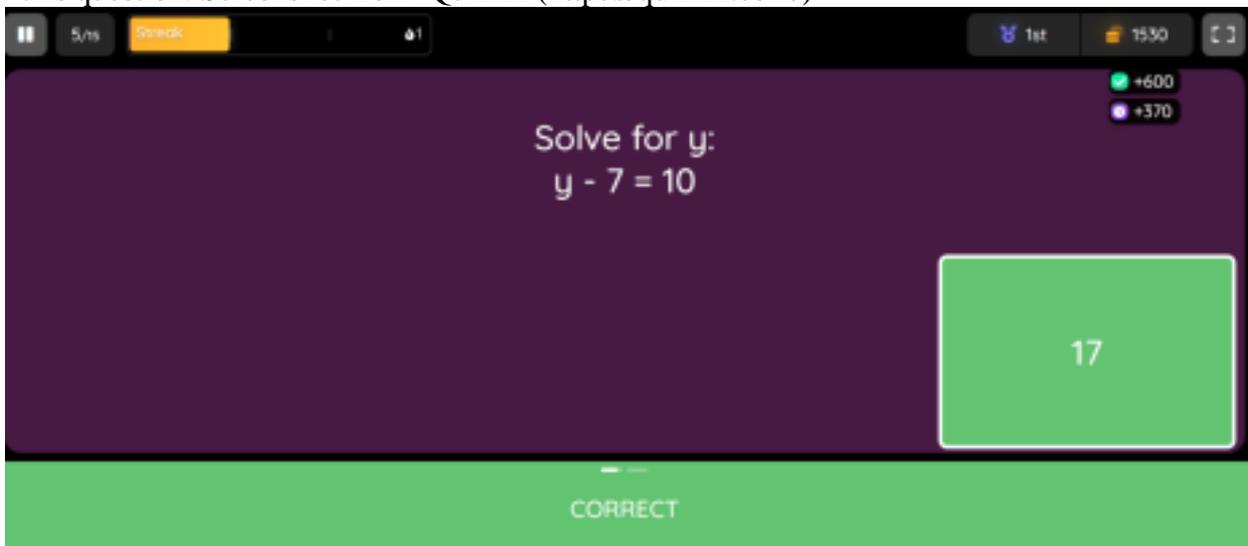
After the introductory session, 9 online sessions were conducted for teaching the concept. Online class was conducted using a mobile camera, a laptop and a physical whiteboard so that each step could be understood clearly. At the beginning of every session, a classroom discussion was conducted in order to solve doubts and misconceptions. After completing every sub-concept, an online quiz was conducted using Quizizz. The report generated was shared in the classroom in order to aid classroom discussion. Students' reflection on such discussions helped them to improve their learning strategies. In the 9th session, the post-test was carried out through a full length gamified quiz using Quizizz.com covering all the concepts of the topic.



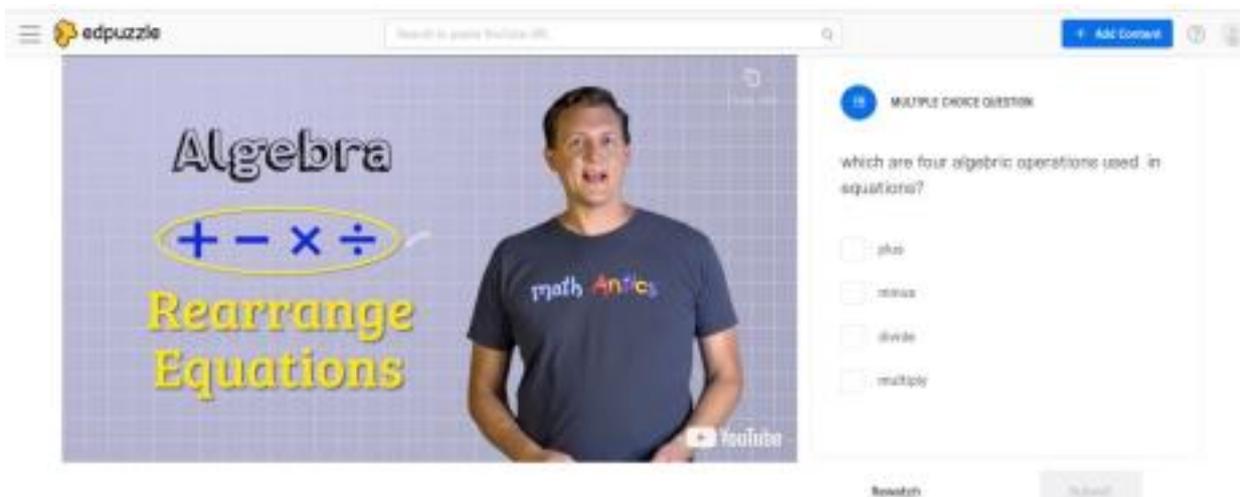
**Figure 1: Question shown on the students' devices. Screenshot from Quizizz (<https://quizizz.com/>)**



**Figure 2:** Feedback shown on the students' devices after each question. Feedback of a student *who selected the wrong answer* for this question. On the R.H.S. corner are points earned for this question. Screenshot from Quizizz (<https://quizizz.com/>)



**Figure 3:** Feedback shown on the students' devices after each question. Feedback of a student *who selected the right answer* for this question. On the R.H.S. corners are points earned for this question. Screenshot from Quizizz (<https://quizizz.com/>)



**Figure 4:** Questions shown on the students' devices on the R.H.S. Screenshot from Edpuzzle (<https://Edpuzzle.com/>)



**Figure 5:** Edpuzzle video quiz shown on the students' devices on the R.H.S. no. of multiple choice questions and its relevant time shown. Screenshot from Edpuzzle (<https://Edpuzzle.com/>)

## V. DATA ANALYSIS

A single group pre-test post-test experimental study was conducted to study the effect of online gamified flipped classroom on a sample of twenty-three students to assess achievement in solving problems on Linear Equations. A full-length gamified quiz using Quizizz.com as a pre-test and post-test as formative assessment was implemented in synchronous online mode. According to Areed et al. (2021) Gamification tools are better for assessing the learning performance of the students in question, specifically in terms of formative assessment.

The study answers the research question, “What is the effect of online gamified flipped classroom strategy on students' performance for solving Equation in One Variable using gamified flipped classroom as strategy?”

**Table 1:**  
**Comparison between gamified e-quizzes as Pre and Post-test for Equation in one Variable**

Group	M	SD	Df	t	p
Pre-test	0.82	0.66	22	15.55	0
Post-test	21.9	6.11			

The t value is 15.55 which is significant at  $p < 0.05$  level with  $DF = 22$ . It indicates that the mean scores of pre-test and post-test achievement differ significantly. In this context the null hypothesis that there is no significant difference in mean scores of Pre and post-test Achievement of students in Equation in One Variable using gamified flipped classroom as strategy is rejected. Further the mean scores of achievement of post-tests is 21.9 which is significantly higher than that of Pre-test whose mean scores of achievement is 0.82.

These results were in line with the results of previous studies Areed et al. (2021) that shows gamified e-quizzes help students to evaluate academic performance in formative

assessment, provide feedback to students, improve their knowledge, and support enjoyable and competition-based learning.

## **VI. RESULTS and DISCUSSION**

The aim of this research was to explore the effect of using a gamified flipped classroom strategy on students' Mathematics learning performance in solving Equations. The results of this investigation are limited to a study with 23 upper primary school students' in Gamified Flipped Classroom settings covering 10 online sessions as an intervention programme. These limitations should be considered when interpreting the results.

The result shows an increase in Performance of mean Post-Test scores as compared to mean Pre-test scores. It can be interpreted that a Flipped Classroom strategy when linked with gamification resulted in a positive effect on the performance and engagement of students. This shows that the performance of the students is dependent upon the instructional strategy, time & space given to learners and the practice of solving problems of various difficulty levels. This is supported by the study of Segumpan et al. (2018) which claimed that Mathematics performance is the result of the interlinking processes done in a mathematics classroom instruction.

The researchers found that the students were regular in completing their assignments. The increase in performance may be due to an increase of the classroom time as the students were already prepared for in-class activity. Hence, teachers should judiciously try to increase classroom time by distributing it as in-class and out class activity where students are engaged in both in and out of the class.

Increase in performance can be interpreted to be influenced by students watching video content as a gamified activity where they easily understand the content. By forwarding and rewinding as many times as required, they didn't need much explanation as self-learning took place. This gave the students more time for in-class activity and in solving problems requiring higher order thinking skills and also for their doubts clarification.

As various studies show, the game elements help to increase motivation leading to an increase in the performance across various levels, to compete with peers for points and to secure the highest position in leaderboards. This is supported by Azmi et al. (2015) as the gamification element is inserted to engage users with the system in addition the leaderboard and sounds engage the player.

Gamification offers personalized learning and encourages students to accept failure as part of the learning process and reattempt learning tasks without embarrassment. It facilitates learning in a fun & engaging environment with both challenges, and rewards. Lee & Hammer (2011) shared the same sentiments as games promising immediate rewards instead of vague long-term benefits and students learning to see failure as an opportunity, instead of becoming helpless, fearful or overwhelmed.

## **VII. CONCLUSIONS AND RECOMMENDATIONS**

This study examined the effect of Gamified flipped classroom strategy during online education. The findings of the pre-tests and post-tests reveal that the scores in the post tests were higher as compared to those in the pre-tests which can be subjected to the intervention programme and students' submission of their assignment on a regular basis which resulted in extra time for discussing, clearing doubts and solving higher order thinking problems as an in-class activity. It enhanced students' performances, kept students engaged and improved their confidence. (Metwally et al. 2021; Hei 2019; Zainuddin 2018). Gamified flipped classroom strategy can be

used in various disciplines and at various levels.

Technology can greatly aid the process of mathematical exploration, and clever use of such aids can help engage students, moreover innovations in the design and use of material must be encouraged so that their use makes school mathematics enjoyable and meaningful (NCERT 2006).

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