

Impact of Gamification on Achievement in Mathematics

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Abstract: *This study aims to demonstrate how gamification affects mathematics achievement. Because mathematics is such a vast area, the generally traditional educational approaches employed to teach it do a poor job of describing the creativity that is inherent in mathematical studies. The government and its stakeholders in the public and private sectors are both concerned about the kids' substandard math performance in the Indian educational system. With STEM fields like science, technology, engineering, and medicine (STEM) increasingly important for entering new job sectors, this is a serious issue that needs to be addressed immediately. To comprehend how gamification functions, one must grasp the various components and game mechanics. Gamification in education is the process of incorporating game mechanics and game-like experiences into the creation of instructional materials. It has been adopted to support learning across a range of contexts and subject areas, as well as to address related attitudes, activities, and behaviours like participatory approaches, collaboration, self-guided study, completion of assignments, facilitation of assessments, incorporation of exploratory learning approaches, and bolstering of student creativity and retention (Caponetto et al., 2014). This article makes the assumption that game elements can be incorporated into the design of a learning process in order to engage students in a fruitful learning experience and, more broadly, to improve academic accomplishment in mathematics and foster a good attitude toward learning mathematics.*

Keywords: Gamification, Gaming Mechanics and Elements, Student Motivation and Engagement, Achievement and Achievement in Mathematics

1. Introduction

Without mathematics, nothing would exist and the world would stand still. Everyone requires mathematics in their daily lives, whether they are a farmer or a cook, a carpenter or a mechanic, a shopkeeper or a doctor, an engineer or a scientist, a musician or a magician. Even insects need mathematics to survive in their daily lives (Tulloch, R, 2014). Since the study of mathematics serves as the foundation for the study of science and engineering fields, mathematics is crucial for the scientific and technological advancement of a country. Additionally, learning mathematics helps to build a person's personality, reasoning skills, and mental sharpness. It makes a significant contribution to the world's population's general and fundamental education. (Asiedu-Addo & Yidana, 2004).

Teachers are working hard to develop new teaching methods and better approaches in order to change students' attitudes toward this discipline. The study of mathematics is an incredibly diverse field, and traditional educational approaches do a terrible job of communicating the underlying inventiveness of the subject. The conventional method of teaching math at the college level is tedious and monotonous. The students are uninterested in this strategy. Students frequently grow to dislike math and frequently look forward to the games they would play during breaks rather than paying attention to the subject.

The field of mathematics lends itself well to simulation and inventive game-like discovery instead of this technique, which does not intend to undermine the repetitious drilling style of mathematics teaching but rather to add nuance to it. As a result, by gamifying assignments or other tasks, mathematics instruction can take on some of the engaging features of the games that students plan to play during their breaks.

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Gamification in education is the practise of incorporating game mechanics and game-like experiences into the creation of instructional materials. It has been adopted to support learning across a range of contexts and subject areas, as well as to address related attitudes, activities, and behaviours like participatory approaches, collaboration, self-guided study, completion of assignments, facilitation of assessments, incorporation of exploratory learning approaches, and bolstering of student creativity and retention. This article makes the assumption that game elements can be incorporated into the design of a learning process in order to engage students in a fruitful learning experience and, more broadly, to improve academic accomplishment in mathematics and foster a good attitude toward learning mathematics.

2. Gamification

Nick Pelling first used the term "gamification" in 2002. (Marczewski, 2013). However, the phrase was first used in a public setting in 2008, and since then, it has been employed quite a bit (Scepanvic, Zaric & Matijevic, 2015). The term "gamification" refers to a creative strategy that imbues a non-gaming setting with a playful atmosphere by using game mechanics. According to Wang (2011), gamification is "a set of design concepts, techniques, and systems used to encourage, engage, and influence people,

organisations, and communities to drive desired behaviours." Gamification is sometimes conflated with phrases like "game layer," "applied gaming," "productivity games," "funware," "playful design," and "behavioural games," according to Landers and Callan (2011).

The idea is that a designer takes the motivating aspects of games and layers them on top of other learning activities, fusing goal-setting with the human impulse to share accomplishments and interact with others to focus learners' attention and inspire them. Gamification, according to Yukai Chou (2012), is the art of taking all the entertaining and addictive features found in games and applying them to real-world or productive activities. According to Tulloch (2014, p.13), gamification is not simply a straightforward collection of methods and mechanisms but also "an alternative framework for instructing and modifying participant behaviour that includes the concepts of enjoyment and engagement at its centre."

Gamification has the potential to change how we learn and how we communicate.

According to Matera (2015), there are several parallels between study and gaming that make gamification compatible with teaching. Making a game is not required for gamification. Without compromising education's legitimacy, it means making it more entertaining and engaging. Gamification encourages pupils to study, and as a result of the encouraging feedback, they are propelled forward and are piqued to learn more.

Gaming mechanics and elements

To comprehend how gamification functions, one must grasp the various components and game dynamics. Each game activity must have a clear end point, an internal purpose (such as learning to solve a problem), and extrinsic aspects (such as points and awards). These factors must be combined with a clear end point to produce the desired result (such as perform better on a specific skill). One of the most significant methods for boosting student engagement and learning is gamification (Elvira, Juanjo, and Mara-Soledad 2020). Gamification incorporates components of games for educational purposes, such as the completion of fun challenges. The frequency and strength of the feedback offered by games is one of the key components and characteristics of video games and other kinds of games. The player is frequently notified of his or her progress during the game while receiving this feedback in real-time. The majority of games also come with severe rules by default. Rules are an essential part of every game, according to Marczewski (2013). There will always be rules that must be followed, regardless of the game's mechanics. A leaderboard is another feature found in some games. Players can view their position in comparison to other players as well as how far they have come on a leader board. Kapp (2012). When you are intrinsically motivated, you want to achieve a specific goal or anything else that will make your life better Chou (2016).

Student motivation and engagement

When games are well-designed, they appeal to our deeply ingrained, biologically programmable love of learning and intrinsic motivation. Gee (2009). Gamification can encourage students to participate in class and give their all to the process of learning. In addition to motivating students and involving them in the learning process, it can help them practice behaviours and mental processes that are easily transferable from the classroom setting to real life Hammer & Lee and eventually lead to a career of lifelong learning (2011).

Students find it challenging to focus and become motivated to study about science as a result of traditional teaching techniques. The first step in learning a subject is to get interested in it, and this is accomplished by inspiring kids to be curious about it. In order for the intended learning to occur, motivation must be maintained through feedback, reflection, and active participation. Motivation is a crucial component of effective learning. Aylers, Driskell, and Garris (2002). According to Muntean (2011), gamification also encourages students to study and pushes them forward due to the positive feedback, which increases their interest and motivation to learn. Gamification can be a strong motivator for people to read or learn more.

Achievement

Achievement denotes a person's completion of a task, accomplishment, gain, or well executed performance. It refers to all the behavioural adjustments an individual makes as a result of diverse learning experiences. According to Good's Dictionary of Education (1973), achievement is the knowledge acquired or the abilities developed in a topic of study and are typically indicated by test results, marks given by teachers, or a combination of the two. The particular duties that educational institutions have to inspire pupils to pursue arithmetic are the subject of mathematician Stephens. Academic achievement is defined as "the performance by a student in a course based on formal study in an institution of learning" by the Webster Dictionary of Education (1989). Academic achievement, according to Craighhead and Nemeroff (2001), is "a measure of knowledge, comprehension, and skills in a given subject or range of disciplines."

Achievement in mathematics

The term "achievement" refers to a level of accomplishment or proficiency in a particular field of academic or scholastic activity. Academic achievement, as measured by exam marks, is the quantity and quality of learning in a topic or group of subjects, according to Pandey (1973).

It helps to understand where the student stands and is a little aspect of the larger concept of educational growth. Generally speaking, it refers to the results of the yearly test. The more one achieves, the more opportunities one has to pursue better careers and positions across all industries, which ultimately leads to success in one's life.

Here, Achievement in mathematics is measured by the pupils' mean gain scores on achievement test in mathematics.

Research aims

The government and its stakeholders in the public and private sectors are both concerned about the kids' substandard math performance in the Indian educational system. With STEM fields like science, technology, engineering, and medicine (STEM) increasingly important for entering new job sectors, this is a serious issue that needs to be addressed right now. In reality, the Indian government created the National Curriculum Framework Policy in 2005 with the intention of addressing the crisis of declining math scores while simultaneously boosting the levels of numeracy and attainment.

Despite this, math student performance in India appears to be poor, both at the primary and secondary education levels. In 2018, the MHRD, Government of India, evaluated 15L students across all states and union territories for the National Achievement Survey (NAS), which produced some troubling results: Particularly in Mathematics, where the average score was under 40%, class 10 pupils were performing far worse than even class 3 students. Additionally, analysis revealed that as the course went on, math proficiency also suffered. Based on the findings, this research will be adopting a Gamification Framework as an intervention that can facilitate teaching and learning of at the basic level and see if gamification can be used to improve student scores in mathematics and their motivation towards learning mathematics. This research also aims to provide recommendations on how to reconstruct the math curriculum in the future to increase students' interest and scores in math using technology in teaching.

3. Methods

In order to address the research question, "Do groups taught through gamification and traditional teaching produce significantly different math outcomes?" this report included a pilot project of experimental study. Through the use of the gamification programme, Minecraft, in the classroom, the design sought to enhance the teaching and learning of fundamental mathematics. Through the use of the gamification programme, Minecraft, in the classroom, the design sought to enhance the teaching and learning of fundamental mathematics. The "One Group Pre-test Post-test Approach," which is employed in classroom experiments where experimental groups are organically assembled as entire classes and may be comparable to Best & Kahn's design, was chosen for the current study (2010).

Accepting this design was justified by the practical impossibility of interfering with school schedules to exclude pupils in order to generate sufficiently big sample relationships. (Gay, 1992). The approach involves gathering data in accordance with the scientific process, developing hypotheses, and then testing them.

Participants

Because all of the teachers and students of Sat Paul Mittal School in the Ludhiana District had registered personal Office 365 IDs, the school was chosen for the study. The location was perfect for the study because all kids at the school have access to MinecraftEdu Education Edition, a gamification programme that is a component of the Microsoft 365 suite. The school regularly incorporates technology into their curriculum and the teaching and learning process. Due to the special characteristics of the school, the researcher has the chance to investigate whether or not the intervention utilising the Minecraft Edu programme improved math test scores and, ultimately, student motivation to learn math.

A third-standard intact class and a fourth-standard intact class with English as the primary language of teaching were chosen. The final sample was made up of 30 third-standard pupils from a population of 120 and 30 fourth-standard students from a population of 120.

Table 1.1 provides the sample breakdown for the experimental group.

Table 1.1: Breakup of Sample in the Experimental Group

| Grade | Boys | Girls | No. of students |
|----------|------|-------|-----------------|
| Grade 3D | 18 | 12 | 30 |
| Grade 4C | 14 | 16 | 30 |

Data analysis

The tools and materials used for the study are as follows:

- Achievement test for assessing the students of third standard on the topic, Symmetry and Patterns, after being taught by Traditional Method.
- Achievement test for assessing the students of Fourth standard on the topic, Gamification Software: Minecraft.
- Achievement Test in Mathematics for third grade students after the Intervention using Microsoft Forms
- Achievement Test in Mathematics for fourth grade students after the Intervention prompts within the game, Minecraft.

The present study was undertaken with the purpose of studying the impact of gamification on the achievement in mathematics. In order to screen the data for meaningful purpose and to test the impact, the data was analyzed with the help of various statistical techniques. An attempt has been made to relate the outcome of the analysis to the aim of this research so as to arrive at meaningful conclusions.

4. Results

For the sake of convenience and keeping in view the nature and objectives of the study, the results have been presented into two sections:

- Section I deals with the frequency distribution, mean, median, S. D. of data.
- Section II deals with the significance of Difference

between the variables.

Section I

Distribution of Scores

Before persisting the actual analysis of data and discussion of results pertaining to the hypotheses, it was deemed desirable to describe the nature of distribution of scores so as to ensure whether the condition of basic assumptions implicit in some of the statistical techniques employed here was fulfilled.

The description of scores are presented in measures of mean, median, standard deviation in the tables 2.1 to 2.2

Table 2.1: Mean, Median Standard Deviation, Skewness of Use of Gamification on Achievement in Mathematics Grade 3 (n=30)

| Content | Pretest Scores | Post Test Scores | Difference in Performance |
|--------------------|----------------------|----------------------|---------------------------|
| Mean | 16.7 | 19.17 | 2.27 |
| Median | 18 | 20 | 1.5 |
| Mode | 19 | 20 | 0 |
| Standard Deviation | 3.4655944 41 | 1.32916013 6 | 2.325767702 |
| Skewness | - 1.5471125 99 | - 1.20660674 5 | 1.095957295 |

The variable of gamification was tested for normalcy. Table 2.1 shows that: The values of mean and median of the scores of the variable of gamification on achievement in mathematics are as 19.17 and 20 respectively which are quite proximate to each other. The value of skewness is -1.20660666745 showing the distribution as negatively skewed. But the distortions are quite small. Therefore the distributions can be taken as normal.

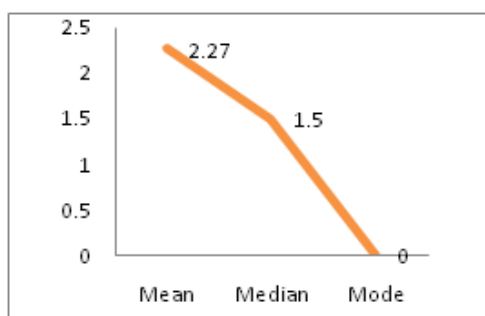
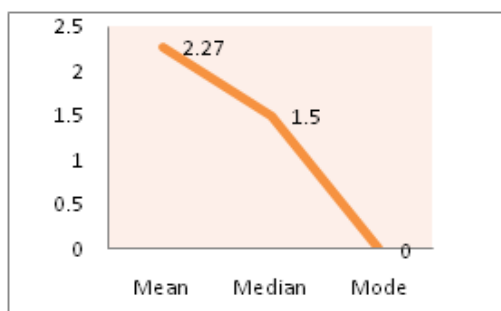


Figure 2.1: Graph showing the scores of Use of Gamification on Achievement in Mathematics Grade 3

Table 2.2: Mean, Median Standard deviation, Skewness of Use Of Gamification on Achievement in Mathematics Grade 4 (n=30)

| Contents | Pretest Scores | Post test Scores | Difference in Performance |
|--------------------|----------------------|------------------|---------------------------|
| Mean | 17.4166666 7 | 18.86666667 | 1.45 |
| Median | 18 | 19 | 1 |
| Mode | 20 | 20 | 0 |
| Standard Deviation | 3.11028143 | 1.48517579 | 1.81160055 |
| Skewness | - 1.61558708 6 | - 1.667362862 | 1.410009245 |

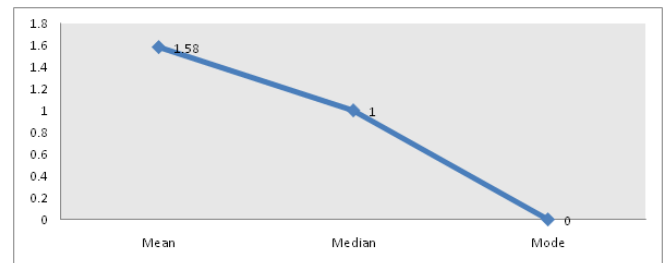


Figure 2.2: Graph showing the scores of Use of Gamification on Achievement

Section II

Significance of difference between means

To investigate the significance of difference between the means, if any, of scores of Gamification on achievement in Mathematics, the variables were assessed in terms of their scores in the test and the t-test was employed.

Table 2.3: Significance of the difference between Mean Scores of Gamification on Achievement in Mathematics

| S. No | Group | N | M | S. D. | SE _M | t-value |
|-------|---------|----|-------|-------|-----------------|---------|
| 1. | Grade 3 | 30 | 19.17 | 1.329 | 2.325 | 5.34 |
| 2. | Grade 4 | 30 | 19.14 | 1.432 | 1.811 | 4.38 |

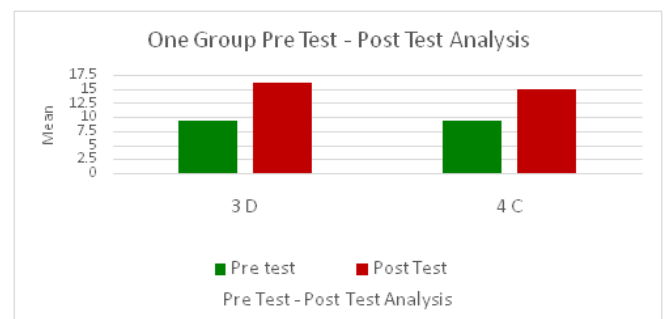


Figure 2.3: Graph showing Pre Test and Post Test Analysis of Gamification on Achievement in Mathematics of Grade 3 and Grade 4

Table 2.3 and fig 2.3 revealed that the mean scores of Gamification on achievement in Mathematics in Grade 3 and Grade 4 respectively 19.17 and 19.14 and their standard deviations are 1.329 and 1.432 respectively. The t-ratio is 5.34 which is significant at 5% level of significance. This revealed that expected value of t at 5% level of

significance for 29 degree of freedom = 1.699. As observed value of t 5.34 is more than the expected value of t -1.699, which proves the following:

- There exists a significant difference in achievement in Mathematics of the groups taught through Gamification and Traditional teaching.
- It may further be concluded that when given a gamification platform is used for teaching; students are motivated, engaged and achieve better scores in mathematics assessments as compared to the students being taught using the traditional methods.

Delimitations

- This study is limited to Ludhiana city only.
- This study is limited to 60 students of Primary school of Grade 3 and Grade 4.

Educational implications

We might say that gamification is actually about finding a means to make arithmetic interesting for youngsters, making math play instead of labour, considering that teaching mathematics can improve the holistic education of the child. The gamification of math instruction occurs when we pinpoint areas where arithmetic is problematic, whether they be in actual games or in the real world. Math serves as the basis for this procedure for the teachers. The teachers should design activity-based courses with specific, attainable objectives and choose the best teaching and learning resources from the surrounding area for their classes. Since mathematics skill development is a continuous process, they should also modify their instruction to fulfil the mathematical needs of the students at all levels of development.

In order for all students to achieve the desired level of mastery in mathematics, teachers must divide the subject into manageable learning units, create clear learning objectives for each unit, develop appropriate formative and summative assessment measures, plan and implement group teaching strategies, and allot enough time, practise opportunities, and corrective reinstruction. Mathematical instruction and learning are made easier by ICT learning platforms. In order to facilitate the teaching of mathematics, ICT teachers must assist math teachers in using online learning platforms. The adaptation of gamification frameworks in education should be thoroughly researched by educational technologists. To stay up with the new educational interventions that will emerge as time goes on, the Curriculum Research and Development Division (CRDD) of the Ministry of Education should conduct studies.

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