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RESEARCH PAPER

Effect of Gamification on Students' Mathematical Learning Abilities at Primary Level

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ABSTRACT

Gamification is a process of using game elements in a non-gamified context to make it interesting. It is a gaining process in business, marketing, and well initiatives. Its application in education is still an emerging trend. The present study aimed to analyze the effect of gamification on the development and progress of students at their own pace, depth, etc. This study was quantitative; quasi quasi-experimental research design was adopted. The study sample was selected by matching the students' pre-test scores. The sample of the study consisted of 30 students, grade 4th, of which 15 were in the control group and 15 were in the experimental group at the public sector of primary school level in Sialkot. The comparison of gamified and traditional teaching methodology was tested through a paired sample t-test. The present study found that gamification improves students' mathematical learning abilities more effectively. This study concluded that using the gamification method is more effective. Using only game-based learning may distract from learning purposes. The overall conclusion was that gamification is an important and effective method to improve students' mathematical learning abilities. This study suggested that teachers should use gamification of education to encourage a better learning environment.

| **KEYWORDS** | Game Elements, Gamification, Mathematical Learning Abilities, Primary Level Students |

Introduction

The gamification process has become an emerging trend in education, increasing the intention level of students(de-Marcos, Garcia-Lopez, & Garcia-Cabot, 2016). Teachers use different models and techniques to engage students during classroom practice. Educators also use strategies, such as digital games, to engage students in classroom practice. Digital games are very expensive in educational contexts, but some educators use game elements to engage users in a non-game context. This technique type is called gamification(Hew, Huang, Chu, & Chiu, 2015). The term elements allows us to separate gamification from serious games. At the same time, Serious games are fully developed games serving a specific non-entertainment purpose(Deterding, Khaled, Nacke, & Dixon, 2011). Game elements support student's involvement in the learning process dealing with computational thinking. The game elements are structured into performance, response, and progress. Each element included in their context is modified in the light of constructivist learning theory and to be well-suited to learning activities(Bartel, Figas, & Hagel, 2015). Yongwen, Jhonson, Moore, Brewer &Takayama(2013) refer to gamification as using game elements in context, which does not mean using video or serious games.

The main idea of gamification in education assumes that courses should not only convey and attain knowledge but relatively concentrate on comprehensive skills that

enable students to solve problems in different and complex contexts. Gamified education leads to learning as an active and constructive process. Learners become self-responsible for learning and play an active role in the learning contexts; lecturers usually serve as mentors (Bartel, Figas, & Hagel, 2015). Gamification in education means making boredom and serious content more interesting and entertaining for individuals. Game design elements are those elements that are characteristics of games, i.e., that can be found in many games and that are significant to the meaning of the game (Deterding, Dixon, Khaled, & Nacke, 2011). The gamification process is often used as a process of driving user motivation and engagement towards context, especially in a non-gamified boredom context, to make it interesting by using game elements like competition, leaderboard, status, badges, score, and achievement(Buisman, 2014). This research was conducted to learn about the effect of gamification on students' mathematical learning abilities during classroom practices at primary-level schools. Due to a lack of technology and resources, research only used game elements, board games, points, countdown, and leaderboards instead of organizing video games. The researcher used game elements like leaderboard, storytelling, game cards, board games, and competition between students as an instructional method to determine the effect of gamification on students' mathematical learning abilities.

Literature Review

Gamification and a gamified structure of education become an emerging approach in educational context(Kasurinen & Knutas, 2018). With meaningful growing of popularity and number of game users, there is an increase on its potential as an innovative teaching tool. Researchers explained that games are so attractive due to combination of fantasy, challenges, curiosity and a level of flow where users are not distracted(Seixas, Gomes, & Filho, 2016). Gamification provides multidimensional performance for improving users experience and potential for gaining across domains (Editorial, 2017). Gamification has become the most accepting an emerging development for individual engagement and encouragement (Majuri, Koivisto, & Hamari, 2018). Doan (2018) concluded that using gamified structure moderated for context.

Full game-based instruction for teaching learning process is difficult to develop, time consuming and expensive and typically achieved single set of objectives as selected by the game designer while incorporate of game thinking and game structure instead of full pedagogical game is cost effective, time saving and more flexible method to generate fruitful learning environment and to boost learners' engagement and inspiration to do more(Dicheva, 2017). Gamification for education is an important domain (Kasurinen & Knutas, 2018)has gaining significant attention in educational context as Tan & Hew, 2016) promising technology to improve learning outcomes and to increase academic achievement (Araya, Ortiz, Bottan, & Cristia, 2019). Klock et. al,(2018) explained that the purpose of gamification in the educational context is to promote a better user experience by improving students' inspirational level and positive assignation with classroom environment. Researchers evaluated that gamification has proved to be more effective at enhancing student interaction than at increasing engagement and motivation. Although study indicate that gamification also effect negatively to certain aspect of classroom environment. Use of gamification as an instructional aid considered a promising approach to engage students through providing joy of playing and recognition, create a competitive atmosphere by setting typically targets for learning purposes (Dicheva, 2017). Roy and Zaman (2018) illustrated that using gamification of education raised motivational level at the end of the certain learning period and promote self-determination among them.Gamification for learning is an exploring technique to

overcome teaching learning gap and gaining insight on improving students' comprehensive ability (Kasurinen & Knutas, 2018).

Gamification for mathematics is an interesting approach to teaching and learning designed to be a fun and an active method to develop motivation of learning (Doan, 2018). Student's mathematical learning abilities at primary level boosted more effectively with gamified structure than traditional lecture method. It is more effective to develop ability of math fluency and in developing students' adaptive number knowledge but less effective to promote comprehensive knowledge of pre-algebra knowledge (Brezovszky, et al., 2019). Game elements for math practice have a potential to improve students' math anxiety to increase math learning. It generated positive effects on math achievement(Araya, Ortiz, Bottan, & Cristia, 2019). Within a gamified structure students perform learning tasks with the feeling of relatedness, completion of given task promote self-determination, make students more confident to make effort to reveal unknown knowledge(Roy & Zaman, 2018). Gamification approach broads students' competency level towards learning. Its need more time for instructional process as compare to lecture method because of using game elements(Severengiz, Roeder, Schindler, & Seliger, 2018). Gamification of education is an effective technology to boost students' learning (Araya, Ortiz, Bottan, & Cristia, 2019).

Research Hypotheses

1. H_o: There is no significant effect of gamification on improving students' mathematical learning abilities.

2. H_o: There is no statistical difference of students' learning taught through gamification and   students taught by traditional lecture method.

Material and Methhods

The present study focused on measuring the effect of gamification in improving mathematical learning abilities of students. This study was also focused upon analyzing effectiveness of gamificationin contrast with the traditional lecture-based method. The nature of this study was quantitative in which quasi experimental design was adopted to study the effect of gamification on students' mathematical learning abilities. Pre-test-post-test control group design was incorporate to examine the extent to which gamified elements will apply as a substitute to traditional learning method and quantified the effectiveness of gamification on students' mathematical learning abilities.

The non-randomized pretest-posttest control group design explained by:

E	O1	X1	O2

_____

C	O3	X2	O4

E = Experimental group,
C = Control group
X1 = Treatment (gamification)
X2 = Treatment (traditional lecture method)
 _____ = non-randomization of experiment and control groups
O1 and O3 = Pre-test scores of experimental and control groups
O2 and O4 = Post-test scores of experimental and control groups

The academic performance of both groups was assessed before and after the intervention of independent variable. A self-developed pre-test was developed to examine the performance of both groups before the invention of independent variable.

Sampling Technique

The sample from the population wasselected by non-random sampling technique. Only one school was selected non-randomly from the area of Sialkot city. Government primary school wasselected and only 4thgrade students were selected to choose the desired sample. Sample was selected through matching pre-test scores of students.

Table 1
Sample of the Study

Category	No. of class	No. of students in control group	No. of students in experimental group	Total
Students from 4th standard of primary school	1	15	15	30

Instrumentation

Self-developed pre-test and post-test control group design was conducted to study the effect of gamification on students' mathematical learning abilities at primary level.

Data Analysis

Data was analyzed through using paired sample t-test to find-out the effect of gamification on students' mathematical learning abilities at primary level. With paired sample t-test, the post-test mean score of the control group was compared with the post-test mean score of the experimental group, with the pre-test scores used as a covariate.

Table 2
Summary of the Research Methodology

Research Objectives	Hypothesis	Instrument	Data analysis techniques
To identify the effects of gamification on improving mathematical learning abilities.	There isno significant effect of gamification on improving students' mathematical learning abilities.	Pre-test and post-test	Mean and standard deviation
To find out the difference ofstudents' learning in mathematics using gamification and traditional methodology.	There is no statistical difference on students' learning in mathematics using gamification and traditional methodology.	Pre-test and post-test	Paired sample t-test

SPSS was used for the analysis of the effects of gamification on students' mathematical learning abilities.

Analysis and Interpretation of Data

The analysis and interpretation of data is presented in sequence with regard to research questions framed for the study.

Table 3
Effect of gamification on students' mathematical learning ability

	Group	N	Mean	Std. Deviation
Pre	Experimental	15	6.9333	1.79151
Post	Experimental	15	13.4667	1.12546

Table 3 indicates mean scores intended to compare the pre and post test score of experimental group (taught through gamification) to measure the statistically significant effect of gamification on students mathematical learning abilities. There wassignificant difference in scores of pretest and post-test.The pre and post mean and standard deviation scores of experimental group are (M-pre =6.9333, S. D=1.79; M-post=13.466,S.D=1.12546) and total number of students were 15 in experimental group. So pre and post test score of experimental group have differences. So,the result showed that gamification process is effective to improve students' mathematical learning abilities.

Table 4
Significant difference of students' mathematical learning ability using gamification and traditional methodology

	N	Mean	Std. Deviation
Pre test	30	6.8667	1.90703
Post test	30	12.0333	2.56614

Table 4 showed the results of the difference ofstudents' learning in mathematics using gamification and traditionalmethodology.There was a statistically significant difference from pre-test (M=6.8667, SD=1.90703) to post-test (M=12.0333, SD=2.56614), and there was total 30 students in both groups 15 in experimental and 15 were in control group. It is concluded thatgamification method is better to improve students' mathematical learning abilities.It was showedthe differences of students' mathematical learning abilities using gamification and traditional lecture method.

Table 5
Effect of Traditional lecture method on students' mathematical learning ability

	Group	N	Mean	Std. Deviation
Pre	Control	15	6.8000	2.07709
Post	Control	15	10.6000	2.82337

Table 5 indicates the effect of traditional lecture method on students' mathematical learning abilities. There was a statistically significant difference from Time 1 (M=6.8000, SD=2.07709)to Time 2 (M=10.6000, SD=2.82337) , and total no of students were15 students in control group. So there is a difference between pre and post score. It is concluded that taught through traditional method was also effective to improve students' mathematical learning abilities.

Table 6
Comparing the statistical difference of experiment and control group on students' mathematical learning ability

	Experiment group		Control group	
N	15		15	
	Pretest	Post-test	pretest	posttest
Mean	6.9333	13.4667	6.8000	10.6000
Std. Deviation	1.79151	1.12546	2.07709	2.82337

Table 6 indicates comparison of the pre and post test scores of control and experimental groups. There was significant difference in scores of control group and experimental group because there is difference in pre and post mean scores of both groups. The pre and post mean and standard deviation scores of experimental group are (M-pre =6.9333,M-post=13.4667);(SD-pre=1.79151,SD-post=1.12546) and the pre and post mean and standard deviation scores of control group are (M-pre=6.8000,M-post=10.6000);(SD-pre=2.07709,SD-post=2.82337), there was total 30 students, 15 in each groups. So there is statistical difference between both pre and post score of groups so it is concluded that students taught through gamification process performed better than those taught through traditional lecture method. It was concluded that gamification method of teaching is more effective to enhance students' mathematical learning abilities with traditional lecture method.

Findings

The data analysis reveals the following:

1. The mean and standard deviation scores of experimental group which was taught through the gamificationmethod was (Pre M=6.9333,SD=1.79151;Post M=13.4667,SD=1.12546). Statistically there is significant difference between pre and post-test score of experiment group. This result has rejected the null hypotheses because there is a significant difference on students' mathematical learning abilities taught through gamification method. So, it was found thatgamification is more effective to improve students' mathematical learning abilities.

2. The mean and standard deviation scores of control group which was taught through the lecture method was (Pre M=6.8000,SD=2.07709; Post M=10.6000,SD=2.82337). Statistically there is significant difference between pre and post-test score of control group. So, it was found that traditional lecture method is also effective to improve students' mathematical learning abilities.

Conclusion

The gamification method is more effective in enhancing the students' academic success. In the gamification method, students are active participators, and the learning gained is expressive and comprehensive. Using game elements for educational purposes is beneficial in enhancing the potential of lower achievers. Similarly, gamification is also effective in developing a higher potential to solve problems at one's own pace. Furthermore, the gamification method has improved students' mathematical learning abilities. Utilizing game elements for learning in schools can lead to the students' cognitive development, through which they can apply their learning in their practical lives. The previous researchers had shown that the gamification method is more effective than the lecture method. Students were more engaged in learning using this method than the traditional one. This study supported the finding of previous researchers that using game elements with another instructional method for educational purposes is

more effective than using them alone to meet educational objectives. It is concluded that incorporating gamification methods with the teaching process can lead to an optimistic future for the educational process

Recommendations

On the basis of the results derived from the study following recommendations were suggested:

1.   The study's findings revealed that students taught through the gamification method explored significant academic achievement compared to those taught through the traditional method. So, for the meaningful learning to take place, it is recommended to teach the students through the gamification methods.

2.   The gamification method fosters the engagement of students in learning. The curriculum developers may focus on using new trends and interventions in the curriculum.

3.   Pre-service teacher training institutions should include gamification methods in their curriculum to train the pre-service teachers to use different types of game elements effectively.

4.   This study analyzed the effects of the gamification method on the mathematical learning abilities of 4th-grade students and proved to be very effective. Further empirical studies should be conducted with similar research on other grades and subjects.

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