

Effects Of Gamified Classrooms On Students' Cognition In Elementary Classrooms

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Abstract

This study aims to find out the effect of gamification on students' cognition in mathematics at elementary level. Real numbers, Financial Arithmetic and Geometry were taught via gamification methods. Three lower levels of Bloom's Taxonomy Knowledge, Comprehension and application were analyzed in this study. The true-experimental design is preferred as the research design. Achievement test was developed and administered for collection of data. Attitude. Participants of the study consisted of eighth-grade students (n = 46). As a result of the study, statistical difference was observed in the achievement test in favor of the experimental group. Study recommended the use of gamification strategy for improving cognition of the study.

Key words: teaching strategies, learning, mathematics learning

Introduction

Engaging of the students is pivotal for concept making in the learning process. In educational research, abundant of researches conducted and they recommended new and advanced strategies for the engagement of students in the classroom (Balakrishnan & Lay, 2016; Eleyyan, 2021; Liu et al., 2020; Ndibalema, 2020)..Number of research studies have showed when students are allowed to construct and involve in learning activities by their self and creating learning resources, it increases the cognitive development of the students (Kafai, 1996; Druin, et al, 2003; Cassell, 2002).

Conceptual mathematics teaching is, a complex task for teachers. Abstractness of mathematics means that it has less or no relevancy with real life. They believe that for becoming good mathematician needed the memorization of facts rules and formulas. In this situation it is crucial, that students participate and involved in the learning process. The aim of the current study was to employ some new instructional strategies named as "gamification" and investigate its effects on the learning abilities named as "cognitive abilities" of the students. (Deng et al., 2020; Gök, 2020; Moon &Ke, 2020).

Literature Review

Gamification positively effect academic achievement in secondary level Mathematics course (Karamert & Vardar, 2021). Gamification is a relatively new term, but not a new concept. The origin of gamification belongs to the media industry and its goes back to 2008. The term funware is initially called out for gamification. Initially the term "funware" was used by Gabe Zicherman. He defines it as:

"Funware is the art and science of turning your customer's every" day interactions into games that serve your business purposes." (Zichermann & Linder, 2010). Gamification and its mechanisms are commonly discussed in various field but use in educational setting not so common. It is also works as factor of arousing intrinsic motivation((Lincoin C. Wood, 2013). When talking about gamification in education, its application and combine gaming elements in such a way that it will motivate students for learning, struggle for doing excellences and keep trying experimentation (Sarah, 2011).

Gamification is mechanism that engage individuals in a way to interact with elements of game, like, fun and joy, in non-gaming situation for solution of the problems (Gabe, 2010).Gamifying a classroom means to provide exciting activities of competition, rewards, challenges, teamwork, increasing levels and healthy classroom culture with fun for learning purposes. Students are rewarded when they succeeded (ChristopherPappas, 2013). Games can put the students in experimentation, experience the trial and error and challenging situation and this guides the educators to planned such type of strategies to convert traditional ways to new learning models that infuses educational games in the curriculum (Khine and Saleh, 2009).

Playing games in mathematics classroom comparatively more beneficial than any other type of practice and drilling for teaching mathematics because having an element of fun and joy, games have also the ability to develop reasoning skill regarding mathematics (Adama). Games have the elements of fun, so it ensures full engagement of students in learning process. Students' engagement can be observed through discussion, questioning and interaction and this behavior provide a base for constructive learning (Booker, 1996). Students' performance in studies correlated with variables of interest and enjoyment (Schukajlow, 2014).

Cognitive abilities like remembering and more complex activities are improved by playing digital games repeatedly even helpful in dealing with learning disabilities (Klingberg, Forss berg and Westerberg, 2002). Such type of ability is to

acquire and utilize knowledge. Cognitive performance includes both simple and complex brain-based skill that we utilize in our actions. It includes perception, motor skills, decision making, language. To utilize the knowledge, we gained through perception and reasoning is known as cognitive ability. All type of knowing, intuition, motor skills, decision making, and language skills comes under the umbrella of cognitive abilities (Nissila).

Cognitive abilities are classified in categories of higher and lower order thinking skills. knowledge, comprehension, application, analysis, synthesis, and evaluation are the six levels of cognitive ability in order of goes to higher order complexity level. The cognitive processing activities directed towards learning outcomes in terms of changes in a student's knowledge, understanding and skills.

Cognitive abilities develop where students engage verbally and physically in the environment. Gamification allow students to work cooperatively, decision making and moving forward based on mutual communication. As they are working in free environment, they feel safety and feel no threat for him or herself from the teacher's side and their fellows as they are playing games. They think freely, discuss freely, and share freely what they understand. Gamification allow students to try out various strategies and assess the output and know which one is the better one (Romano, Papa, & Saule).

Gamifications provide a medium for distributed knowledge. It involves participants in group work and achieving common goals. Distributed knowledge increases the pace of learning. It tries out to combine the understanding and knowledge of all the group members. The participants usually willing to provide information for solving the target problems. This lead to combine information from multiple sources that result in better understanding (Hakli & Sara).

The skills like problem solving increase during playing games and it may be transfer outside the gaming situation. On the other hand, skills that learned during the class is normally difficult to transfer beyond the classroom boundaries (Egenfeldt-Nielson, 2007). So the gamified class learning is long lasting and the it can be transferred to real life situation. This is the only way to keep learning experiences and problem solving skills persistent beyond the learning situation. It make easy to use content knowledge in practical life (Curtis & Lawson, 2002).

Methodology

It was experimental study to investigate the effects of gamification on students cognitive performance in 8th grade mathematics classroom for six weeks. Teaching methodology (gamification) and achievements (cognitive abilities) were two variables of the experimental study. Teaching methodology (gamification) was independent variable and academic achievement (cognitive abilities) was dependent variable. Experiment was conducted with voluntarily selected female school of district Mardan, KPK. Thirty Eight students of grade eight were randomly assigned to two groups. First group was taught with routine adopted lecture method and second group was kept on gamification. Both groups were treated for five weeks. Pre-test

post-test control group experimental design was employed to explore the effects of gamifying the mathematics classroom in female government schools of KPK at eighth grade considering the variables of cognitive abilities and attitude.

This study focused on three levels of cognitive abilities; knowledge, comprehension and application, proposed in classification of educational objectives (Bloom, 1956). Data was collected through achievement test made on three chapters of mathematics textbook; real numbers, financial arithmetic and practical geometry.

Two groups was selected randomly for experiment. The pre-test-post-test control and experimental group design was used for this study. The pre-test-post-test control group design can be represented as: (Louis Cohen,2007)

Experimental R	O	X _T	O
Control R	O	X _C	O

Population of the Study

The population contained female schools situated in rural locality. All the 8th grade classes of government girls high schools of district Mardan were constitute the population of the study.

Sample of the study

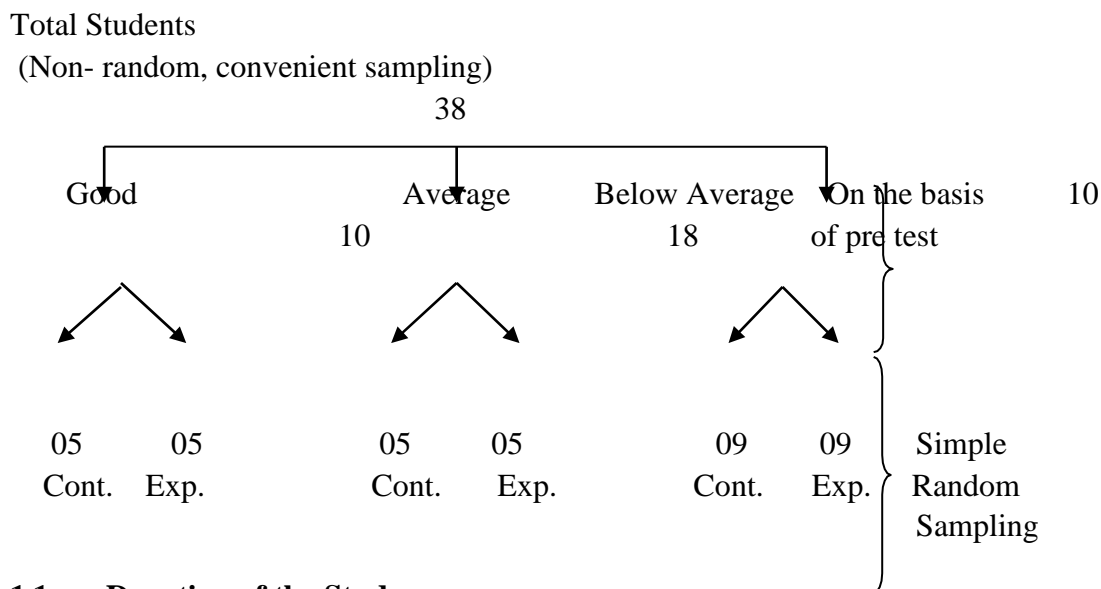
Gay (1996) has recommended at least fifteen subjects in each group for an experimental study. So, researcher selected nineteen in each group to ensure the internal validity of the experiment. In this way total sample comprised of thirty eight female students.

Volunteer sampling was used to select a school for conducting this experimental study. The school was asked to volunteer for this study. The study was conducted with 8th grade students of G.G.H.S. There were 38 students in eighth class of the selected school. For placement of students in experimental and control group, students were divided on the basis of pre-test score as good, average and below average. Simple random sampling was used for placement of students in experimental and control group.

Formation of Experimental and Control Groups

Initially there were 42 students in the voluntarily selected G.G.H.S district Mardan for this experimental study. But in time of conducting the experiment, four students were drop out so the number of students in the class was 38. The total number of students were divided equally in control and experimental groups. To do so, three groups good, average and below average were formed on their pre test score. The pre test score was arranged in descending order. Top ten students from 1 to 10 formed good students group, next ten from 11 to 20 formed average students group. Last group of below average comprised of students from 21 to 38 on the list. Experimental and control group comprised halves of each good, average and below average. This was done through simple random sampling.

Diagram: 1 Formation of Experimental and Control Groups



1.1 Duration of the Study

This study was executed during November- December academic session 2021-2022. Forty minutes period was specified to teach the class. The experiments was prolonged for Five weeks.

1.2 Treatment

Students were involve to participate in games as players of games for the period of five weeks on various mathematics topics. The control group was kept on traditional methods. Gamification was used for two purposes. Firstly for learning and secondly for the purpose of evaluation. Exercise was covered in two steps process. Brief description and introduction about the exercise by the teacher on the first day of starting new exercise.

At second step, students' designation was changed as players instead of students. Students practically involved in the learning process (gamification) as players. The class was divided in groups. Each group was asked to send their one member in front and select question from a basket. Then he was go back to the group and solve the question with discussion.

To gamify the classroom, teacher formed five groups of students. Each group was given a unique identity name and color. They grouped as red, yellow, green, blue and pink. Group formed including all mental level students i.e good, average and below average. On first day of the exercise the teacher gave brief lecture about the topic, explain term with examples.

Involving the students in gamification, questions were written with their option (MCQs) on the pages and put it in the basket. One student from each group was asked to come in front and select question from the basket. Before going in the group she must be display question on board besides their group name. Return to the group, they were start work on solving the problem by mutual discussion. Finalizing

the answer, one student came in front and solve the question on the board. The answer of the question matched with the given answer on the back side of the question displayed on the board. Groups were given score on correct answer. Score board was used for the purpose.

Reliability and validity of the data

Item analysis and Chronbach Alpha were used to validate the data collection tool. Research tool comprised of 33 items.

Data Analysis

Descriptive statistics mean, standard deviation were applied. Due to the small size of the sample normality test was necessary. Levene's test was applied to check the normality of the data collected through achievement test. Paired sample t test was applied to find out the differences between control and experimental groups.

Results

Table 1 shows the overall mean score and compare the score of experimental and control groups in sub parts of the test separately. The overall mean score for control group is 5.89 with standard deviation 2.82 and for experimental group the overall mean score is 6.42 with standard deviation 3.02, which shows a little difference. But this difference is not statistically significant. So the equivalency of groups were

Groups	Levenes' Test		mean	Std.de	t	df	Sig	Cohen'
	T	Sig.						
Total	.217	.644	5.89	2.82	.55	36	.583	0.18
Control			6.02	3.02	4			
Experimenta								
l								
Real	.044	.834	3.21	2.14	-	36	.602	0.17
Numbers			3.58	2.16	.52			
Control								
Experimenta								
l								
Financial	.095	.759	1.26	1.15	.13	36	.890	0.043
Arithmetic			1.21	1.13	9			
Control								
Experimenta								
l								
Geometry	.065	.800	1.47	1.02	-	36	.659	0.14
Control			1.63	1.16	.44			
Experimenta								
l								

assumed. The significance value is .583 which is greater than .05. It shows that the difference between the overall score of experimental and control groups is not significant. This fact is also confirmed by the Cohen's D value. Cohen's D value sued in the research parallel with t test significance shows the effect size. Cohen describes three levels of the observed effect. These levels are:

- a) small if = or < than 0.2
- b) medium if round about 0.5
- c) large if = or > than 0.8

The Cohen's D value is 0.18 which is smaller than 0.2. It confirms that there is no significant difference in the score of experimental and control groups. It was concluded that experimental and control were equivalent on pre-test performance prior to start of the study.

Table 2 Analysis of post test score of experimental and control group

Groups	Levenes' Test		mea n	Std.dev	t	df	Sig (2- tailed)	Cohen' s D
	T	Sig.						
Total	12.6	.001	14.7	7.132	-	36	.000	1.456
Control			4		4.49			
Experimenta l			23.2 1	4.090				
Real Numbers	8.62	.006	7.84	4.153	-	36	.000	1.28
Control			12.2 1	2.394	3.97			
Experimenta l								
Financial Arithmetic	4.20	.048	3.47	2.525	3.16	36	.000	1.02
Control			5.58	1.427				
Experimenta l								
Geometry	.986	.327	3.68	1.668	-	36	.001	5.16
Control			5.47	1.504	3.47			
Experimenta l								

Leavens test was applied to test the normality of distribution. In the third column the significance value is .644 which is greater than 0.05. It accept the null hypothesis that data is not normally distributed.

The mean scores of experimental and control groups in real numbers are 3.21 and 3.58 and standard deviation is 2.14 and 2.16 respectively. Mean score showing a little difference but t test significance value 0.602 showed that this difference is in significant. This was also confirmed by Cohen effect size value which is 0.17, less than

0.2 depicts a small effect size. Levenes test for normality of data calculate the significance equal to 0.834 which was greater than 0.05. It showed that data was normally distributed. Both groups were almost similar and there is not much variation and this difference in mean is by chance.

Table shows the overall mean score on post test. of experimental and control groups in sub parts of the test separately. The overall mean score for control group is 14.74 with standard deviation 14.74 and for experimental group the overall mean score is 23.21 with standard deviation 4.09, which depicts a difference in the scores of both groups. The p value is $0.000 < .05$ which rejects the null hypothesis that there would be no difference in the score of control and experimental groups. This fact is also confirmed by the Cohen's D value.

The Cohen's D value is $1.45 > 0.8$, shows high effect size.

Leavens test was applied to test the normality of distribution. In post test, except geometry part all data is not normally distributed. Leavens value In third column the significance value is .644 which is greater than 0.05. It rejects the null hypothesis that data is not normally distributed. It was concluded that experimental and control were equivalent on pre-test performance prior to start of the study.

The mean scores of experimental group is greater than the mean score of control groups. Standard deviation showed that control group data is more variation than experimental group. P value for all cases is $<$ than 0.05 which showed significant difference. In the last column Cohen D value calculated and it was greater than 0.8 which depicts the greater effect size.

Discussion

The study aims to determine the effect of gamification on students' cognition in mathematics course. Study used true-experimental design. Number of the students was 38 and simple random method was used to assign them to control and experimental design. Pre-test score was used for the purpose. Overall results shows that gamification has a positive effect on students cognition, this was evident from post test score comparison. also, t test shows that this result is significant. The study revealed that higher mean score by experimental group. Post test score on the selected three chapters taught through gamification, shows that students performed well. This is possibly due t age factor that students that gamification provides a learning environment like games, and this caught the students attention. The students of that age like games, this was maybe a reason of student's engagement in learning

process. Gamified classrooms provide platform for students to communicate their ideas and argument on the classmate. Argumentation is necessary for exposing one's thoughts and develop rational thinking. Besides, providing the opportunity to share and communicate, the elements of gamification like score boards, badges work as motivation.

It is noted that assembling gamification is an easy way to teach and not required extraordinary arrangements as various studies recommend like computer software etc. Because those methods may be not directly applicable for various reasons specially in rural areas where schools are usually face the shortage of space and electricity. As compared to this, gamified classrooms required little arrangements. It is evident that after the experiment, the selected school apply the method in other classes and subjects.

This study was administered in one school, future studies may be conducted more than one and compare their results with each other. This may be helpful to control the external validity issues as sample will be larger and improve the external validity of the study. Limited number of respondents, lack of proper isolation of the experimental and control groups are the aspects that threatened the validity of the results. Results may be more cleared if the above stated aspects improve.

This study was limited to only one aspect; cognitive abilities, future studies may need to be conducted on other aspects like attitude, classroom environment, teachers role etc with multiple data collection tool including classroom observations, teachers and students interview. Future researches should also be conducted in others subjects and grade levels to testify the results of this study.

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