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An Experiment to Investigate the Impacts of ICT-Based-Games on Students' Interest and Academic Achievement

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ABSTRACT

"Mathematics is the mother of all sciences" is common phrase that we all know very well. Even it is the least interesting subject among the students. Teaching method is a common but known factor which makes this subject least interesting. Therefore, an experiment was conducted to explore whether game-based teaching can change students' interest and improves achievement? For this, 108 female students and 10 elementary mathematics teachers participated in this study. Researchers used one group pre-test/post-test research method to measure the impacts of ICT-based-games on students' achievement and interest in the subject of mathematics. An achievement test and an interest inventory was used as tools of this study. Teaching mathematics through ICT-based-games and participants' prior knowledge of playing online games were the independent variables. While participants' interest and achievement in the subject were the dependent variables. It was concluded at the end that teaching mathematics with the help of games has no significant impact on students' interest in the subject of mathematics but their achievement scores were improved at the end.

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1. Introduction

Students are encouraged to learn through doing by-self and being involved in playing games (Musselman, 2014). Games motivate the learner to achieve a target in a challenging but in an interesting mode. In educational institutes games are used as an aid to involve learners actively by means of learning by doing, constructing knowledge actively participating in the classrooms and thus resulting in deeper and more persistent knowledge and engagement in the learning. Game – based – learning started in late 20th century and is now rapidly making its position in the field of education (Setiadi, 2018). Traditional teaching methods has been changed due to the incorporation of games in teaching-learning environment. Games effectively enhance learning motivation, active participation and

concentration among students (Liu and Chen, 2013). Chen, Nurkhamid, Wang, Yang and Chao (2014) recommended that 'a learning environment must be designed to support physically active learning that comprises body movement'. Games are effective teaching aids for students of all ages because they are highly motivating and enable the teachers to communicate difficult concepts efficiently and interestingly of many subjects including the mathematics. Tokac, Novak and Thompson (2019) added in the same direction as:

> *"Learning mathematics presents various challenges for many children due to the difficult and often tedious nature of the subject. Educational video games have the potential to address these challenges and positively impact mathematics learning and attitude".*

Technology has made it possible to play games through any source or medium i.e., either through desktop computers or on any mobile device (Kebritchi, 2008). Online game or video game is a mental contest played with a computer according to certain rules for amusement, recreation, or winning a stake (Noemi & Maximo, 2014). Same as, Setadi (2018) added as digital game-based learning integrate learning process into digital games itself'. Games designed specifically for the purpose of educating children can motivate self-learning and problem-solving skills (Dadheech, n.d.). Dadheec further expressed that a well-designed educational game should combine the learning objectives which is a difficult task practically. Increased motivation, controlled competitiveness, strategy simulator, less stress, improve memorization and class cooperation, attentiveness, friendly and funny source of learning, and source of critical learning skills are the key features of game-based learning (Victoria, 2017).

Mathematics is mother of all sciences. Mathematics facilitate individuals to understand the world and enhance social interactions skills. It also supports individual to analyse world experiences, explain and solve life problems scientifically and systematically (Sayan, 2015). However, the subject is important, many students found it boring and difficult. Teacher educators have tried to solve these difficulties through changing teaching strategies, teaching aids and traditional instructional strategies – even than it remains a forbidden course for many students (Hung, Huang, and Hwang, 2014). According to Hung et al. (2014), reducing mathematical anxiety, promoting mathematical self- efficacy, interest, learning motivation and learning achievement are the challenging and the critical issues. Due to the advancement in educational technologies and its implications in teaching and learning process – it is expecting that the above mentioned problems in teaching and learning of mathematics could be reduced to some extent. Game-based learning is an important domain of research at international level but still neglected in our country. Due to its importance, researcher found this idea interested and innovative for her research thesis. Therefore, this research problem was selected by keeping the aim of understanding the effects of games on students' interest and their achievement in the subject of mathematics at elementary level. The study is aimed to measure the difference between the achievements of elementary students in the subject of mathematics taught with or without games. This study also analyses the effects of ICT-based-games on interest of elementary students in the subject of mathematics.

Following research questions were formulated to conclude the results:
Q1. Whether game-based learning has significant impact on students' academic achievement?
Q2. Whether game-based learning can improve students' interest in the subject of mathematics?

2. Research Methods & Instruments

2.1 Research Design

This study used a Quantitative Research Design method which is the most popular method of research amongst the educationists. Daniel (2016) expressed that quantitative research is an approach which use statistical data as a tool for saving time and resources. In this research, researcher used one group pre-test/post-test research method to measure the impacts of ICT-based-games on students' achievement in the subject of mathematics and questionnaire was used to measure the effects of these games on their interest in the subject (Creswell, 2012). Gay, Mills & Airasian (2016) helped to understand that experimental design compares usually one of three types: comparison of two different approaches; comparison of a new approach and the existing approach; and comparison of different amounts of a single approach. In this study, researcher applied second approach of comparison in which game based teaching method (new approach) was compared by the traditional teaching method (existing approach) in the subject of mathematic to the students of class 8^{th} of a government public school, Multan.

2.2 Dependent, Independent and Intervening Variables of the Study

The dependent variables of this study included:

- Achievement scores of the participants in the subject of mathematics – measured by the Mathematics Achievement Test (MAT) prepared by the researchers with the help of that secondary school mathematics teachers which are currently offering their services in the schools. This test was based on MCQs type test and students' were required to mark only one option out of four.
- Interest of the participants in the subject of mathematics before and after the treatment.

The independent variables of this study were:

- Computer based Games – to be used by the teachers and students as treatment.
- Prior knowledge and/or experience of playing mathematical computer-based-games by the participants.

The intervening variables of this study were the technical problems of computer system which occur during teaching and playing mathematical games in the computer laboratory. These variables were tried to control with the help of technical staff available in the computer laboratory of the selected school. Moreover, only those online available games were use during treatment which was relevant to our course outlines. Some more interesting games were excluded because of their irrelevance and difficulty in playing through Tablets and/or Cellular Phones. During Experiment some Extraneous Variables were unable to control like IQ level, Individual differences etc.

2.3 Participants

The research participants were teachers and students of an urban high school at Multan city. The school was selected on the bases of following reasons:

- Easy to approach. Personal contacts were used by the researcher to get permission from the principal of this school.
- Feasible to conduct the experiment of the study because a well-furnished computer laboratory was available in the school.

- Although the students of the school were females only but the school was well reputed and always got distinct position in the board of intermediate and secondary school examinations (BISE, Multan).
- Due to the cooperative attitude of principal and teachers, it was feasible for the researcher to develop positive relationship with students which was deemed important to conduct the experiment successfully.
- Again due to cooperation of school principal, all the ethical code of conducts (administrative approval, teachers' permission and setting of time table for the experimental group, and permission of using computer laboratory for the experiment) were approved and possible to follow throughout the experiment.
- The game based teaching-learning method has not been previously used by teachers or students in this school.
- The participants of this study have already covered the syllabus of mathematics before conducting this study. Therefore, requirements of control group was already fulfilled because the students have already been taught mathematics with traditional method of teaching and hence treatment (game based teaching-learning) was given to all students of class 8^{th} which were enrolled in the school at that time.
- As stated above that students' have already been covered the syllabus of mathematics; and teachers have already been start conducting school/classroom based tests after completing the courses; therefore, results of last two tests of each participant were collected and recorded as Bench Mark Test. This result helped us to determine students' previous knowledge of mathematics taught without any treatment or to say without any game-based learning process.

The role of sampled mathematics teachers was quite important in this study. They were already teaching the relevant subject to the secondary classes and were also trained in using computer and other technological devices. So, they were informed about the objectives of the research and were requested to participate in the research to facilitate the researcher in conducting the successful experiment. Therefore, total 06 teachers showed their interest in the study were included in the study as the facilitator to conduct the experiment in computer laboratory. Total 06 mathematics teachers and 108 secondary school students participated in the study.

2.4 Treatment

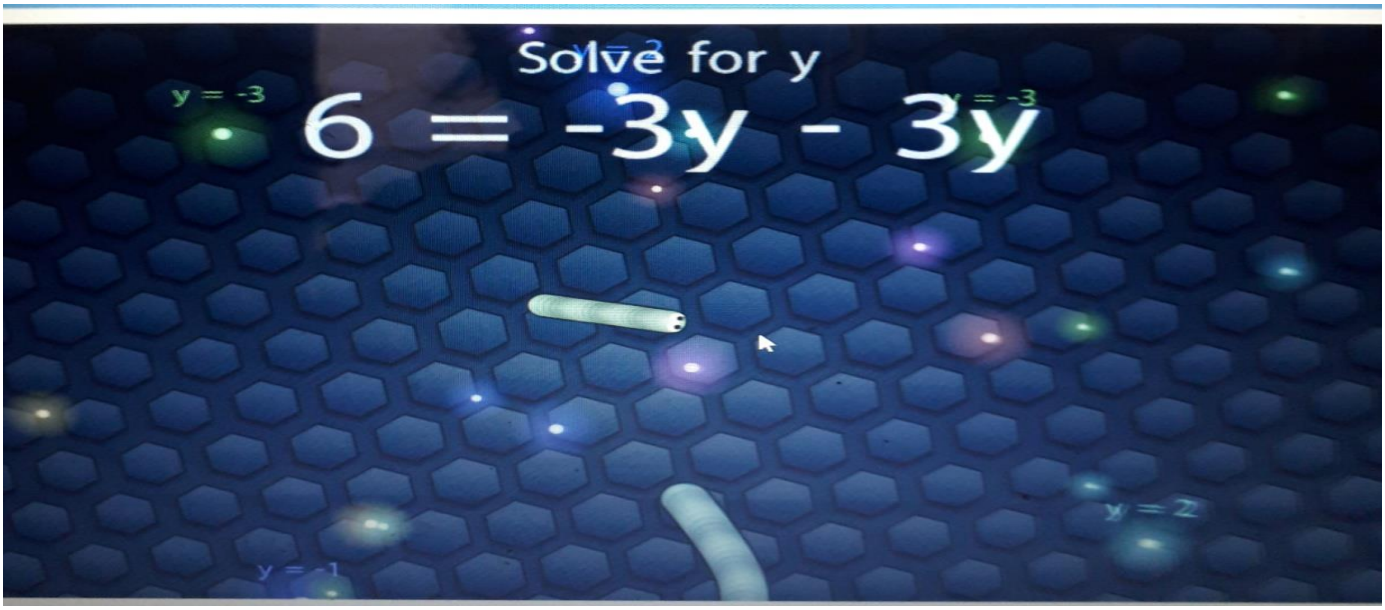
Computer based games were used as treatment of this experimental study. This took 3 weeks (total 18 working days) to complete the treatment and post-test was conducted after these 3 weeks. As it is mentioned in the above section that teachers were already trained in using computer and other technological devices and they were also familiar with computer based games. So, it was easy to manage in the computer laboratory to teach mathematics through computer based games to the participants of this study. Each teacher took responsibility of 18 students to teach and observe while students playing mathematical games and laboratory time table was set accordingly. Game delivery issues – (i.e., content based issues, time management, recording students' progress and technical issues) were shared with teachers in advance. At this stage, the technical staff of computer laboratory supported to minimize the technical problems in accessing and playing games on the computer systems available in the computer laboratory.

From the textbook of Mathematics at elementary level, the portion of algebra was selected for this study. The reason of selecting the portion of algebra was the online games and their relevance with the content in the textbooks of class 8^{th}. In this regard, teachers cooperated with researcher in finding

and selecting the games for the experiment. Following games were selected from the web site of https://www.mathgames.com/grade8:

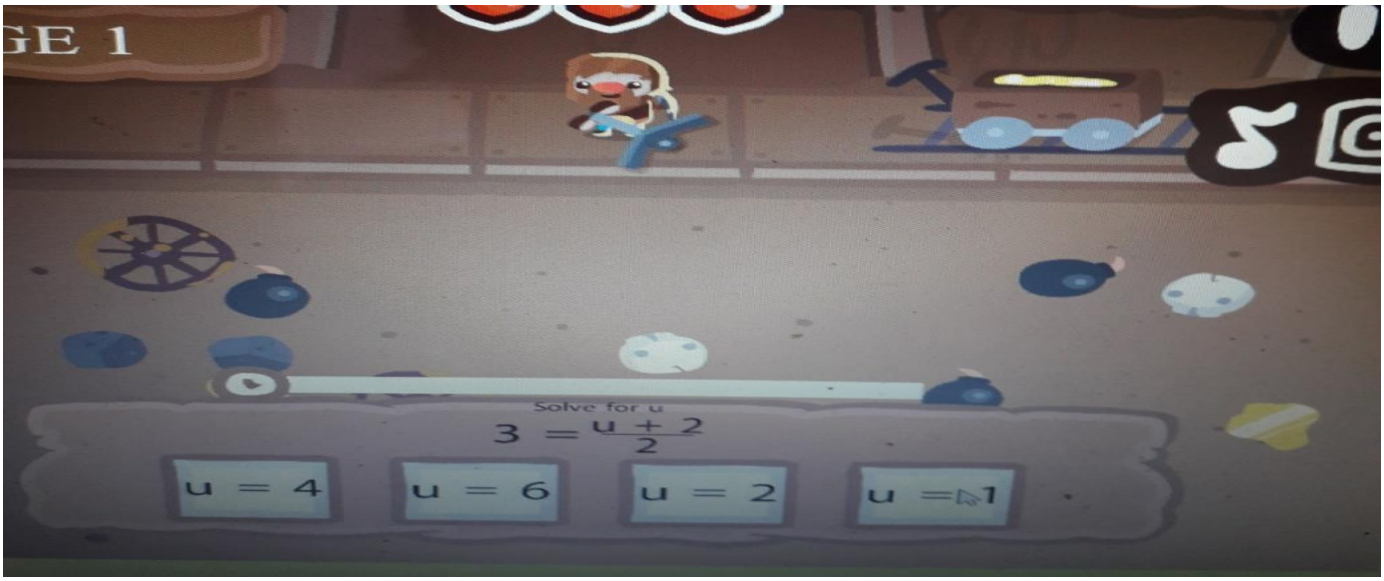
The website contains very vast data over concepts of mathematics i.e. practice sheets, work sheets and games with the related concepts. Website contains every concepts of mathematics related to Punjab Text Book Board of classes one to 8th. Total 27 games were present in the website in which 9 games were paid games but researcher selected only 3 games which were easy and free to play. Games names were as follows:

2.4.1 Math slither



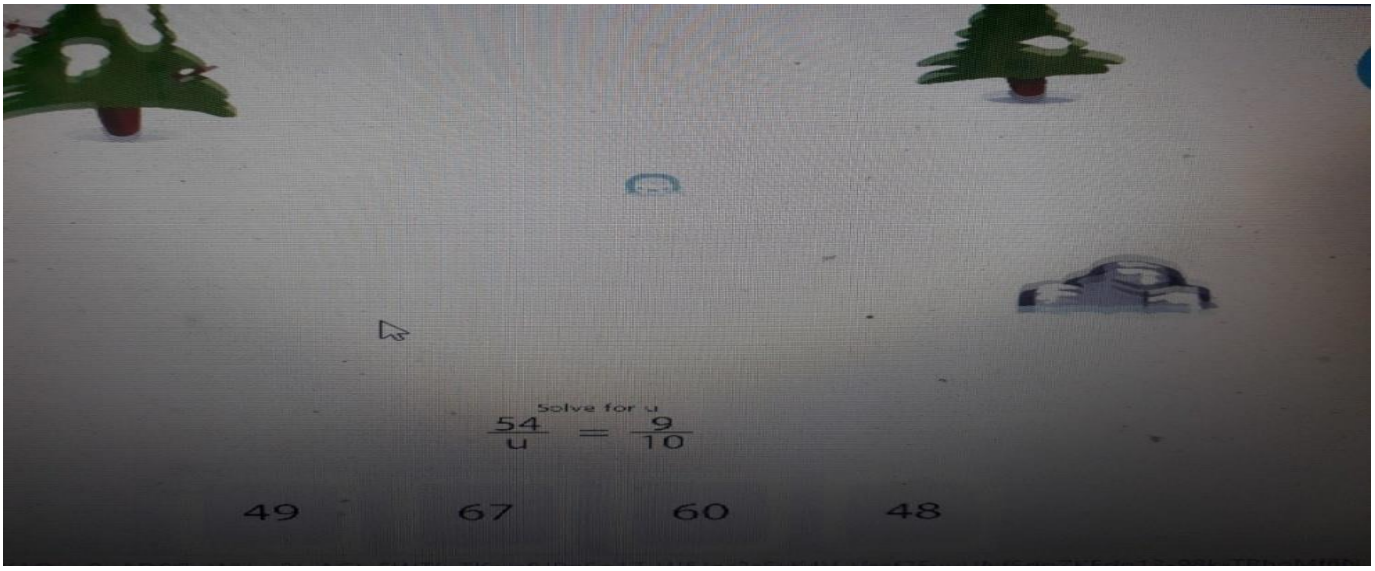
It is a one player mathematical game, played by the students selected as sample of the study. Game contains all the concepts of mathematics related to text book of all the classes from preschool to elementary classes. Group of 36 students played the given game in the supervision of selected teachers.

2.4.2 Math Miner



It is also a one player mathematical game, played by the students selected as sample of the study. Game contains all the concepts of mathematics related to text book of all the classes from preschool to elementary classes. Group of 36 students played the given game in the supervision of selected teachers.

2.4.3 Math Snowball



It is also a one player mathematical game, played by the students selected as sample of the study. Game contains all the concepts of mathematics related to text book of all the classes from preschool to elementary classes. Group of 36 students played the given game in the supervision of selected teachers.

2.5 Research Instruments

To fulfill the objectives of the research two types of instruments are composed:

- Result of teacher made tests were collected as Bench Mark Test results to compare students' prior knowledge of mathematics with the knowledge gained after treatment. This was relevant with objective 1 of this study.
- An achievement test of MCQs type items in the subject of mathematics at elementary level was constructed to achieve objective 1 of this study.
- An interest inventory constructed as second tool of the research for measuring objective 2 of this study.

Development of the Achievement Tests: An achievement test was constructed to measure the impacts of games on students' achievement. For this, a MCQs (Multiple Choice Questions) based test was constructed with 50 items. The content was taken from their text book (Punjab text book board class 8^{th} English medium). The researcher initially developed 50 items with the help of research supervisor and subject specialist of mathematics. This test was used as pre- and post-test i.e., before and after treatment test.

2.5.1 Scoring

One mark for each response was awarded and zero for each incorrect response negative marking was avoided. For scoring, an answer key was also prepared. Total scores were recorded for item analysis.

2.5.2 Development of Interest Inventory

An interest inventory was developed by the researcher to measure the interest of the students in the subject of mathematics. Interest inventory consists of two parts Part A and Part B. Part A was having questions related to interest of the students in mathematics subject and class through lecture method. Total 18 items were included in this part, every statement was provided with seven levels i.e. completely disagree (CDA), Strongly disagree (SDA), Disagree (DA), Slightly disagree (SDA), Agree (A), Strongly agree (SA), Completely agree (CA). The weightage of these graded-options id assigned as under.

Statement	Completely disagree	Strongly Disagree	Disagree	Slightly disagree	Agree	Strongly Agree	Completely Agree
Positive	1	2	3	4	5	6	7
Negative	7	6	5	4	3	2	1

Part B was included questions related to student's knowledge and skills about online games and learning through mathematical games. In this part 11 questions were asked from the students. Difference between the responses of the students before treatment and after treatment was compared by statistical methods.

2.5.3 Administration of Tools

The researchers in their presence administered achievement test and interest inventory through each teacher at the same day and time to collect pre-test results of these instruments. The nature of tools and schedule of administration was announced by the concerned teacher well in advance. All the sampled teachers were assigned 18 students equally and were responsible to control and look after the activities and problems/issues of each participant. Therefore, teaching-learning environment to conduct the experiment was controlled and apparently there was no problem of discipline at all. The test was administered in absolutely quiet and peaceful conditions. Seating arrangement was adequate. Care was taken that students might not be helping one another in test work. The researchers explained to students about the purpose of test. They told them that their performance on these tests would not affect their individual scholastic standing on school grades. An 'Instruction sheet' was also given before the question paper in which all the necessary instructions were written related to time, marks and answer sheet. All the teachers were responsible to take students' to computer laboratory on the fixed allocated time to each of them for teaching Algebra through online games. After a period of three weeks; post-test was conducted on the same pattern with the help of sample teachers.

2.5.4 Instruments Validity & Reliability

The research tools were developed, selected and adopted keeping in view the objectives of teaching algebra of mathematics at elementary level. The source of the selected and adopted material was also authentic (Punjab Text Book Board). This step validated the test in terms of its construction (Cohen, Manion and Marrison, 2018). Moreover, both instruments were presented to highly experienced educationist available in different public and private sector universities of Multan city. The format of interest inventory and achievement test were improved and redesigned in the light of their suggestions. This step was qualifies as 'face validity' of the instruments (Cohen, Manion and Marrison, 2018). To make the interest inventory more reliable – pilot study was conducted with the help of sampled teachers of the sampled school. Minor changes were observed

3. Data Analysis and Results

Following three research hypotheses were proposed to test the variables and reached to the conclusion:

- There is no significant difference between the achievement of participants who were taught mathematics with the help of ICT-based-games and those who were not.
- There is no significant difference between the interest of participants who were taught mathematics with the help of ICT-based-games and those who were not.
- There is no significant difference between the achievements of participants who have prior knowledge and/or experience of playing computer based mathematical games and those who were playing first time.

From the calculated descriptive statics in Table 1 it was found that there is no significant difference exists between the average values of interest scores before and after treatment. But average scores showed a clear difference between the calculated values of pre-test and post-test marks. It is also important to note that the average marks of students in teacher made test were higher than both of pre-test and post-test marks.

Table 1: Descriptive Statistics

	Mean	Std. Deviation	N
Interest Scores Before Treatment	88.33	9.692	108
Interest Scores After Treatment	89.23	8.785	108
Teacher Made Test	42.09	5.782	108
Pre-Test Marks	27.52	2.151	108
Post-Test Marks	36.70	7.087	108

Following Table 2 explored the relationship between the dependent and independent values of this study. All the correlated values showed positive relationship between all the dependent and independent variables. The highest correlation was found between the values of interest scores before and after treatment at $p<0.01$ level of significance or $\alpha=95\%$; the second highest correlation was found between pre- and post-test marks; the least correlated value was found between interest score before treatment and teacher made test.

Table 2: Correlation between the Variables

	Teacher Made Test	Interest Scores Before Treatment	Interest Scores After Treatment	Pre-Test Marks	Post-Test Marks
Teacher Made Test	1.000	.166	.133	.441**	.453**
Interest Scores Before Treatment	-	1.000	.986**	.192*	.237*
Interest Scores After Treatment	-	-	1.000	.193*	.225*
Pre-Test Marks	-	-	-	1.000	.643**
Post-Test Marks	-	-	-	-	1.000
**. Correlation is significant at 0.01 level *. Correlation is significant at 0.05 level					

Table 3 showed descriptive statistical report between values of pre- and post-test scores based on the prior knowledge of playing online mathematical games. It was found from the calculated values that there is not a highly significant different exist between the average values of pre-test marks of those students who either have or not have prior knowledge of online mathematical games (i.e., 28.26 – 26.97 = 1.29) but the difference increases in case of post-test marks among the same variables (i.e., 39.17 – 34.87 = 4.3). On the other hand, if we compare values of pre- and post-test among those who have prior knowledge (i.e., 39.17 – 28.26 = 10.91) and those who don't have prior knowledge (i.e., 34.87 – 26.97 = 7.9) and same as overall students' average values (i.e., 36.70 – 27.52 = 9.18); we found significant differences amongst the calculated averages.

Table 3: Report Pre- and Post-Test Scores

Prior Knowledge		Pre-Test Marks	Post-Test Marks
Yes	Mean	28.26	39.17
	N	46	46
	Std. Deviation	1.437	5.855
No	Mean	26.97	34.87
	N	62	62
	Std. Deviation	2.422	7.403
Total	Mean	27.52	36.70
	N	108	108
	Std. Deviation	2.151	7.087

Table 4 showed calculated values of t-test at 95% level of significance. In the table that the sign of the mean difference corresponds to the sign of the *t* value. The positive *t* value in this example indicates that the mean values of post-test, is significantly greater than the mean values of the pre-test group. Since $p < .001$ is less than our chosen significance level $\alpha = 0.05$, we can reject the null hypothesis, and conclude that the achievement scores of those students who were taught mathematics with the help of ICT-based games or online games is significantly different.

Table 4: Independent Samples Test

		t-test for Equality of Means						
		t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Pre-Test Marks	Equal variances assumed	3.222	106	.002	1.293	.401	.497	2.089
	Equal variances not assumed	3.462	101.594	.001	1.293	.374	.552	2.034
Post-Test Marks	Equal variances assumed	3.257	106	.002	4.303	1.321	1.684	6.922
	Equal variances not assumed	3.371	105.532	.001	4.303	1.276	1.772	6.834

From the following Table 5 it was depicted that total 46 participants expressed that they were already playing some sort of online mathematical games either through their mobile phones or through internet connection on Desktop computers. The mean interest score of those participants who were playing online games before treatment was higher than those who were not (i.e., 91.00>86.35). Same situation was sought in case of post-test mean scores after treatment but interest scores were increased a little bit in both cases (i.e., 91.89>91.00 who have prior knowledge; and 87.26>86.35 who have no experience of online mathematical games).

Table 5: Report Interest Scores Before and After Treatment

Prior Knowledge		Interest Scores Before Treatment	Interest Scores After Treatment
Yes	Mean	91.00	91.89
	N	46	46
	Std. Deviation	8.651	7.869
No	Mean	86.35	87.26
	N	62	62
	Std. Deviation	10.012	8.966
Total	Mean	88.33	89.23
	N	108	108
	Std. Deviation	9.692	8.785

4. Conclusion

It is concluded that the variable of treatment has not direct impact on students' interest in the subject of mathematics. But students' with prior knowledge of playing online mathematical games were found slightly more interested in the subject as compared to those who have no prior knowledge of playing online mathematical games. On the other hand, teaching mathematics with the help of online games has improved students' achievement of both groups either those who have prior knowledge of playing online mathematical games or not.

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This article was taken from the unpublished thesis of Lubna Rasheed (Roll #: 23, Session: 2017-19) supervised by Dr. Mubashrah Jamil, submitted to fulfill the requirements of M. Phil Education at the Department of Education, BZU Multan. So, any kind of resemblance in this regard may kindly be omitted.

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