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The Effectiveness of Math Educational Software on Creativity and Academic Achievement

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Abstract

The present study aimed to evaluate the effectiveness of Mathematical Educational Software on the creativity and academic achievement in male students in the fifth grade of primary school in Tehran. The design of the study was quasi-experimental and according to the nature of the theme, its objectives and hypotheses were applied ones. The study population consisted of all male students in the fifth grade in district 1 in Tehran in 2015-2016 and the statistical sample of the study included 60 male students in the fifth grade of Azadegan primary school. Who were selected using convenient sampling technique and were randomly divided into control and experimental groups. Software education and regular classroom education were used for the experimental and control group, respectively. In order to assess the subjects, Abedi Test of Creative Thinking and a researcher-made academic achievement test (pre- and post-test) were used. Data analysis was performed using analysis of covariance. Based on the obtained results, the first hypothesis is confirmed and it was concluded that educational software has a positive impact on the academic achievement in mathematics in male students. According to the obtained results, the second hypothesis is confirmed and it can be concluded that educational software has a positive impact on the creativity of the male students in the fifth grade of primary school in mathematics and its components. The results of the study showed that Mathematical Educational Software has a positive impact on the creativity and academic achievement in male students in fifth grade of primary school.

Keywords : Mathematical Educational Software; creativity; academic achievement.

Introduction

Nowadays Educational technology has the ability to create a fundamental revolution in education. This technology consists of a variety of tools and Electronic plans that help to provide learning materials and support the learning process in order to achieve learning goals [1]. The concept of instructional technology left a fast path behind. Although it is believed that from immemorial time, even five century B.C, some (sophists) used basic tools to transfer knowledge; the first attempts for applying the instructional technology refer to 1900s AD [2]. In the beginning of the current century, professionals realized the importance of using audio-visual equipment in education and it has significantly been developed since the twentieth century [3].

The rapid penetration of information technology among people has changed their lifestyle. The rapid evolutions from the application of technology including productive and information technologies in human life have brought about dramatic changes in industrial, economic, political and civil structures of societies and these changes have been a significant impact on the life and work of people around the world and seriously dealt with the traditional methods of teaching, learning and educational

management [4]. Computer is used as a powerful and yet affordable tool for any work and activity in human life. The use of computer in education has dramatically increased in recent years and computer and related technologies are now used in many schools around the world [5]. According to recent reports from the National Center for Education Statistics 91 percent of schoolchildren have access to computers and student-to-computer ratios in public schools are 3.8. [6], since technology makes students learn, its use in education is essential [7].

Researchers have always tried to find an answer for filling learning gaps, solving problems and deficiencies caused by defects in the process of teaching and learning [8]. They have sought for ways to change daily and frustrating exercises into interactive and enjoyable learning experiences for managing students in a way that students understand fundamental and necessary bases of deep mathematical concepts. Instructional technology aims to provide the conditions which should present the possibility for easier learning along with more efficiency [9]. Instructional technology can allow that in other ways that learning may occur, it is a means to improve learning in all subjects, to make creative abilities of students develop,

encourage students to be responsible for their own learning and encourage them to a interaction with a larger community [10].

With the rapid development of technology, computer has become an integral part of our society and education is not an exception in this case. In the past two decades, various discussions have been done on the integration of the computer with the educational system and how to use it and that it has been effective results [11]. By growing of computer technology in recent years, the use of software has been able, using simulation of mathematical concepts, to understand many of the key concepts of mathematics more clearly and easily for elementary students [12]. Slavin et al. [7] believed that the effects of the thirty years' researches have shown that educational technology has a positive effect on student success in mathematics Slavin et al. [6]. The art of instructional technology is that it can integrate new educational media with a variety of new learning methods and get the best result. Since the mathematical concepts are thought traditionally and using abstract examples and words in most Iranian schools and most students have a little creativity and academic achievement on the course, by the growth of computer technology in recent years, using educational software can make a lot of important mathematical concepts easier and clearer for elementary school students so that it leads to enhance their creativity and academic achievement [13].

As a result technology improves student learning its application in teaching and learning mathematics is essential [14]. The use of educational software in learning environment is a convenient and necessary way to discover and access to information resources in order to prepare learners for future life Snyder, Dillow [5]. The quality of education depends on the proper and continuous utilization of educational software in the classroom. Educational software programs are often controlled by teachers and coordinating teams in school and using specific criteria of educational software [15]. Teachers should know the basic skills of working with hardware and software applications to use these tools for active learning [16]. The most applied aspect of educational and learning software is ease of access to content by learners. Learner is in the core of learning and interacts with his environment by applying educational software programs [17,18]. Software application makes learning motivation [19]. In the perspective of US 2030 education planning, it is kind of supposedly meta-cognitive software that improves one's knowledge of oneself or cognitive processes [20]. Educational progress in mathematics especially in elementary school is very important. Students Through educational software, experience more active learning strategies in relation to math concepts in everyday life [21]. Also, educational software provide rich resources which can be an opportunity for learners' growth i.e. the creation of a collaborative environment that allows learners and teachers to search and examine a variety of issues while they cannot enhance the quality of teaching and learning alone. This means that learning and teaching environment, providing the content, learning activities, how to implement learning

activities, the process to evaluate the performance of learners and the process of feedback should be proportionally formed. Otherwise, there is no guarantee for achieving educational objectives [22]. Therefore with innovative approaches and by creating conditions for active learning and the provision of new ways it is possible to acquire the necessary skills and independence in students [23].

Despite the significant increase in the number of computers in schools, teaching methods in school is in a way that teachers can use computer less [24]. In this context, the proper use of software which has been designed based on the ability to understand in students and experiences from teaching and raises student's maneuverability and analysis in stating and solving problems and gives learner the ability for control and feedback at the same time and facilitates the active learning of mathematics for students can greatly reduce the problem of teaching for teachers and make learning with insight more easily for students [25]. Accordingly, in this study, it is tried to examine the impact of educational software on creativity and academic achievement in mathematics in students in the fifth grade. According to the numerous studies on the use of computers and multimedia software in teaching and the creativity and academic achievement of students, it can be said that educational and technical software which can be applied alongside traditional teaching methods in the classroom may improve the learning outcomes. The most pivot point to be debatable is that educational software is a great transformation in communication and information technology [26].

Human civilization owes to one's creative ideas and its durability will be impossible without the use of creativity because it is the most excellent performance of human mind. In the current situation, creativity is not a necessity but a condition for survival. Therefore, the emphasis of education system on the individuals who are creatively able to solve unpredictable problems is necessary [3]. Creativity is talent, divergent thinking, possibility of new and genuine thinking and deviation from conventional ideas [27]. In educational system, especially at the primary school i.e. the pinnacle of flourishing this talent, many factors prevent the flourishing of the talent and eradicate it [28]. Academic achievement as a dependent variable is not influenced by only one factor but a number of factors such as Academic talent Lowlerviggen cognitive factors such as general intelligence Gederela educational self- efficacy Wang 1998, self-regulation strategies Gerben the structure of the classroom Maya educational motivation Agurogloo, Wallberg and the ability of learners, teaching teachers and motivation of learners Keith, Cool have an impact on it [29].

In the study by [30] entitled "the impact of computer-assisted language learning on the development and motivation of students in elementary school in English as a foreign language in the United Arabic Emirates", the results showed a significant difference between the two groups and was in favor

of the experimental group [31]. The study entitled "the design of educational software for students through collaborative design along with the game" showed that the proposed framework may facilitate the development of effective and efficient collaborative design sessions to use educational software in the educational environments. In his study, [32] indicated that teachers are well interested in the use of educational software. In their study, Olga Pili, Meral Aksu [4] showed that using computer in learning and teaching mathematics is an effective tool for students in the fifth grade in elementary school in North Cyprus. In an investigation into the effect of computer-assisted education on the academic achievement of students in mathematics in high school [33]. Examine the impact of computer-aided education on the academic achievement of high school students in mathematics and concluded that computer use has a significant effect on students' academic achievement in this lesson. From the findings of the research it can be concluded that educational software is likely to be effective in the level of creativity and academic achievement of students' mathematical lessons [34] during the research titled « design of educational game with ten steps to learn complex issues» Which was made in the form of multimedia software concluded that the educational game designed through this model would make learning more attractive and make learning more efficient and effective. Paulin, Worckman conducted a research entitled «The effect of the learning-learning process on promoting creativity and innovation». The results showed that problem-solving teaching methods are more effective in promoting creativity. Anivo examined the issue whether the use of educational materials based on multimedia in the learning of social studies lessons influenced and concluded that the use of multimedia has had a significant impact on students' interest in learning and learning [35] examined computer simulations in teaching and learning physics. The results of the study showed that the experimental group has a better understanding of the acceleration and the speed of the launch and obtained higher scores.

Aims and hypotheses

According to the results of the mentioned studies, it can be inferred that educational software are likely effective on creativity and educational achievement of students in mathematics. Therefore, the main issue of this study was to investigate the effect of educational software on creativity and academic achievement of students in mathematics at the fifth grade elementary school in Tehran. In so doing, the following hypotheses were formulated:

- a) Hypothesis 1: Educational software has a positive effect on the academic achievement of male students in mathematics at the fifth grade elementary school.
- b) Hypothesis 2: Educational software has a positive effect on creativity of male students in mathematics at the fifth grade elementary school.

c) Hypothesis 2-1: Educational software has a positive effect on mental or fluid ability of male students' thought in mathematics at the fifth grade elementary school.

d) Hypothesis 2-2: Educational software has a positive effect on the flexibility of male students' thought in mathematics at the fifth grade elementary school.

e) Hypothesis 2-3: Educational software has a positive effect on the expandability of male students' thought in mathematics at the fifth grade elementary school.

f) Hypothesis 2-4: Educational software has a positive effect on the innovation or originality of male students' thought in mathematics at the fifth grade elementary school.

Materials and Methods

This is an intervention (quasi-experimental) study designed in order to investigate the effect of educational software on creativity and educational achievement of male students in mathematics in the fifth grade of Tehran primary school in 2015-2016. When you cannot select sample of investigated community randomly quasi-experimental designs are used. The applied independent variable is multimedia software in mathematics including fascinating game and interactive and multimedia solutions. The dependent variable is creativity and academic achievement of male students in mathematics in the fifth grade of Tehran Azadegan primary school. The population of the study consisted of all male students in the fifth grade of primary school in the academic year of 2015-2016 who were studying in public schools of district 1 in Tehran. The statistical samples of the study included 60 male students in the fifth grade of Azadegan primary school who were selected using convenience sampling technique and were randomly divided into control and experimental groups in a way that a class of 30 individuals in the fifth grade was considered as a control group and a class of 30 individuals as an experimental group. After taking pre-test of creativity and academic achievement in mathematics, the trial intervention (education using mathematical educational assistance software) was presented for two weeks and after completing the educational program, post-test was administered on both groups. To assess the validity of the researcher-made pre- and post-test and evaluate the academic achievement of students in mathematics, the researchers first presented the mentioned questions to director, deputy director and teachers of the fifth grade to obtain their opinion and assess their validity after designing the questions of pre-test and post-test and then, they did the necessary changes based on their recognition and discretion.

In order to determine the reliability of the teacher-made test, the method of Kuder Richardson (KR20) were used and the reliability of 88% and 86% were determined for the pre-test and post-test. Finally, the difficulty index (Pi) of mathematical questions was also calculated and all questions were selected based on a scale of $30\% > P_i > 70\%$. Torrance creativity test which

was made based on Torrance theory about creativity in 1984 by [35] in Tehran has 60 3-item questions including four subtests of fluid (questions of 1 to 22), expansion (questions of 23 to 33), initiative (questions of 34 to 49) and flexibility (questions of 50 to 60). Scores of zero, one and two have been considered for down, medium and high creativity, respectively. The total scores of the subjects in four subscales show the total score of their creativity. The range of total score of creativity will be between 0 and 120 for each subject. To calculate the validity of the test, Torrance Test of Creative Thinking was given to 60 students in the third grade of the middle school at the same time with Abedi creativity test. Torrance Test was used as the indicator of concurrent validity. The correlation coefficient between the total score of Torrance test and the total score of the new test was obtained equal to 46% [36]. The correlation coefficients between the scores of test parts and the scores of other tests of creativity were significant beyond the statistical level of 10%. Through the test re-test of students in Tehran middle school in 1984 in the four parts of the test, the reliability of Abedi creativity test was obtained as: 85%, 82%, 84% and 80% for fluid, initiative, flexibility and expansion parts, respectively. In the present study, using Cronbach's alpha, the reliability coefficient was obtained as 79%, 76%, 69% and 73% for fluid, initiative, flexibility and expansion parts, respectively and total score of creativity was obtained 84%. Data analysis was done using SPSS software and by mean, percentage and standard deviation at the descriptive statistic level and via covariance analysis at the inferential statistic level. Meanwhile, for testing the hypotheses, the level of significance was considered as 0.05. Contents selected for training were as follows: Understanding common fractions, addition of common fractions, and subtraction of common fractions [37].

Results

Hypothesis 1: Educational software has a positive impact on educational achievement in mathematics (Table 1). The results of Table 1 shows that the mean score of the experimental group has increased compared to that of the control group. To ensure that the experimental and control groups are equivalent i.e. they are similar in terms of the studied parameters, they were tested using Levine Test and the results indicated that F value is equal to 0.935 which is not significant at the level of ($P>0.05$). Therefore, the assumption of equal variances is confirmed and according to observing other assumptions, the statistical test can be done for data analysis (Table 2).

Table 1: Mean and standard deviation of the scores of mathematics in pre- and post- test in separate groups.

Stage	Group	Number	Mean	SD
Pre-test	Experimental	30	14.34	2.47
	Control	30	15.20	2.24
Post-test	Experimental	30	18.55	0.95
	Control	30	15.50	1.91

Table 2: Results of covariance analysis of educational software on the academic achievement of students in mathematics.

Effect resource	Total squares	Level of freedom	Mean squares	F	Level of significance
Pre-test	56.13	1	56.13	42.16	0.001
Groups	166.51	1	166.51	125.08	0.001
Error	74.55	57	1.331		
Total	17319	60			

The result of the above-mentioned test showed that the mean score of academic achievement before the intervention has an effect on the score of academic achievement after the intervention ($P<0.05$). Therefore, for adjustment, a significant difference was observed between the mean score of academic achievement after the intervention in the control and experimental groups ($P<0.05$). Based on the obtained results, the first hypothesis is confirmed and it was concluded that educational software has a positive impact on the academic achievement in mathematics in male students (Table 3).

Table 3: Comparison of the adjusted means of academic achievement score in post-test in separate groups.

Group	Number	Mean	SD
Experimental	30	18.74	0.22
Control	30	15.32	0.21

Hypothesis 2: Educational software has a positive impact on the creativity of male students in mathematics in the fifth grade of elementary school.

2-1- Educational software has a positive effect on mental or fluid ability of male students' thought in mathematics at the fifth grade elementary school.

2-2- Educational software has a positive effect on the flexibility of male students' thought in mathematics at the fifth grade elementary school.

2-3- Educational software has a positive effect on the expandability of male students' thought in mathematics at the fifth grade elementary school.

2-4- Educational software has a positive effect on the innovation or originality of male students' thought (Table 4).

The data in Table 4 show that the mean score of experimental group has increased compared to the control group in post-test and to ensure that the experimental and control groups are equivalent i.e. they are similar in terms of the studied parameters, they were tested using Levin Test that according to the conducted calculations, the statistic test values of F is not significant at the level ($P>0.05$). So, the assumption of equal variances is confirmed and with respect to other assumptions, the statistical test can be done for data analysis (Table 5).

Table 4: Comparison of mean score of creativity and its components before and after the intervention in students in separate groups.

Index Variable	Stage	Group	Mean	SD
Mental or fluid ability of thought	Pre-test	Experimental	20.27	3.96
		Control	18.63	2.89
	Post-test	Experimental	24.57	2.43
		Control	20.23	4.28
Expandability of thought	Pre-test	Experimental	10.57	3.16
		Control	8.43	2.53
	Post-test	Experimental	17.47	1.18
		Control	9.17	2.7

	Pre-test	Experimental	14.1	4.6
Innovation or originality of thought		Control	13.27	2.95
	Post-test	Experimental	25.47	2.56
		Control	14.53	3.81
Flexibility of thought	Pre-test	Experimental	10	3.64
		Control	8.07	2.24
	Post-test	Experimental	17.73	1.26
		Control	8.93	2.88
	Pre-test	Experimental	54.93	8.38
Total		Control	48.5	6.28
creativity	Post-test	Experimental	95.23	4.91
		Control	52.87	9.84

Table 5: Results of covariance analysis on the effect of educational software on students' creativity and its components.

Variable	Changes' source	Total squares	Level of freedom	Mean square	F	Level of significance
Fluid ability of thought	Pre-test	220.56	1	220.56	26.07	0.001
	Groups	2552.62	1	2551.62	301.75	0.001
Expandability of thought	Pre-test	101.86	1	101.86	28.49	0.001
	Groups	801.12	1	701.12	196.2	0.001
Innovation of thought	Pre-test	193.49	1	193.49	26.42	0.001
	Groups	1665.79	1	1665.79	227.45	0.001
Flexibility of thought	Pre-test	97.85	1	97.85	29.69	0.001
	Groups	862.11	1	862.11	261.55	0.001
Total creativity	Pre-test	608.6	1	608.6	11.96	0.001
	Groups	19634.85	1	19634.85	385.9	0.001

Table 6: Comparing the adjusted means of scores of creativity and its components in post-test in the two groups.

Variable	Group	Number	Mean	SD
Fluid ability of thought	Experimental	30	24.11	0.54
	Control	30	20.69	0.54
Expandability of thought	Experimental	30	16.97	0.36
	Control	30	9.66	0.36
Innovation of thought	Experimental	30	25.29	0.5
	Control	30	14.71	0.5
Flexibility of thought	Experimental	30	17.32	0.34
	Control	30	9.35	0.34
Total creativity	Experimental	30	93.83	1.36
	Control	30	54.27	1.36

The result of the mentioned test showed that the mean score of creativity and its components before the intervention has an effect on that after the intervention ($P < 0.05$). Therefore, to adjust, the mean score of expandability, fluid ability, innovation or originality, flexibility and creativity of thought before invention were considered as 9.50, 19.45, 13.73, 9.03 and 51.72, respectively. After adjustment, the mean scores of creativity and

its components after the intervention was statistically significant in both experimental and control groups ($P < 0.05$). According to the obtained results, the mentioned hypothesis is confirmed and it can be concluded that educational software has a positive impact on the creativity of the male students in the fifth grade of primary school in mathematics and its components (Table 6).

Discussion and Conclusion

The present study aimed to evaluate the effect of educational software on creativity and math achievement of male students in the fifth grade of Tehran elementary school. In general, the results suggest that educational software has a positive impact on educational achievement and creativity of students in the fifth grade of elementary school in mathematics in district 1 in Tehran. Findings from the first hypothesis showed that educational software has a positive effect on the academic achievement of the mathematical course of elementary school male students in the fifth grade of elementary school. It was consistent with the study by Almikhlafi [30] entitled "the impact of computer-assisted language learning on the development and motivation of students in elementary school in English as a foreign language in the United Arab Emirates" whose results showed a significant difference between the two groups and was in favor

of the experimental group. The results of the study confirm the study conducted by Trianta fyllakos [31] entitled "the design of educational software for students through collaborative design along with the game" showed that the proposed framework may facilitate the development of effective and efficient collaborative design sessions to use educational software in the educational environments and Olga Pili, Meral Aksu [5] showed that using computer in learning and teaching mathematics is an effective tool for students in the fifth grade in elementary school in North Cyprus, as well as, Adeyemi [33] concluded that in the investigation of effect of computer-assisted education on the academic achievement of students in mathematics in high school, the application of computer has a significant effect on the academic achievement of students in this course.

Findings from the second hypothesis showed that educational software has a positive effect on the creativity of the mathematical course of elementary school male students in the fifth grade of elementary school. In explaining the findings it can be said that since the students of educational software in an open and active environment discover the facts so the learner is creative and is free from the rules of imposed and superficial rules. And this independence in learning makes the students flexible in learning and can easily express their beliefs and expectations which will lead to a positive attitude toward learning as well as the motivation for progress. Toosi University of Technology who came to the conclusion that new creativity approaches are more effective than older ones and with research result of Enfield [34] titled» design of educational game with ten steps to learn complex issues» Which was made in the form of multimedia software And with research of Paulin, Worckman titled» The effect of the learning-learning process on promoting creativity and innovation» and the results showed that solving teaching methods are more effective in promoting creativity and It is also consistent with the results of research by Jimovianis, Kumys [35].

The other results of the study were that the use of educational software in the development of students' mental or Fluid thinking was more effective than traditional teaching methods. Educational software provides the basis of fluidity through the presentation of content and assignments in a variety of ways. In explaining these findings it can be said that the use of educational software allows students to come up with many responses and ideas about a new and complex subject. Another finding was that the use of educational software is more effective than traditional teaching methods in the development of student initiative and thinking.

Educational software enhances the initiative's ability to respond to students' ideas and activities. In other words the use of educational software provides a background for the students' innovative ideas. This is one of the goals of the current education and training systems. Also the result of the study showed that the use of educational software in the development of flexibility of students' thinking is more effective than traditional teaching

method. It can be said that the use of educational software can increase the importance of this in students who in dealing with problems and problems when they are transformed or made from another dimension change their thinking and be consistent with the problem. This is contrary to the view and practice of a large number of instructors because many teachers always encourage students to answer questions in the same way as textbooks.

The result of this method is the development of students in a moldable and non-flexible way that this issue should be given due consideration to the necessary justifications and appropriate training of instructors, teachers and practitioners. The results also showed that the use of educational software in the development of students' thinking ability is more effective than traditional teaching methods. The use of educational software increases the ability to expand in student responses, In other words using this method can enable students to pay attention to details when dealing with a new subject such as scientific, literary and social While Pay attention to the concept and the main content in detail and be able to provide descriptions, explanations and proper explanations of the details. Most students in school have learned the concepts in general and show less attention to detail. In fact the element of expansion is the ability to pay more attention to the problem, accuracy, follow-up and ultimately its outcome. Considering the effect of educational software on student's creativity it is suggested that this model be used as a suitable model for gaining learners a deep understanding of the subject and increasing divergent and creative thinking.

Given the bulk of studies conducted, educational software can play a decisive role in academic achievement and creativity of students because students cannot be expected to achieve a high level of learning in classes where new educational tools are not applied and have a boring environment due to applying traditional teaching methods. It can be said that with the advancement of science and educational principles, using educational software shows more desirable effects than the traditional system of education and allocates greater percentage of success in the academic achievement of students. Applying educational software in learning environments is a convenient way to discover and access information resources in order to prepare students for future life. The quality of education depends on taking proper and continuous advantage of educational software in the classroom. Learner is in the center of learning by applying educational software programs and interacts with its environment.

In general, given the effectiveness of educational software, it can be said that the necessity of using educational assistance tools is one of the needs of today's education. Educational software with emphasis on learner-centered learning leads to students' academic achievement. Students in learner-centered learning environment will experience more in-depth and more sustainable learning. Educational software helps to increase the creativity of students by creating an

interactive and dynamic environment. Challenging learning environments, emphasis on exploratory learning methods, accountability of learners in learning and engaging learners with content are other educational software features that lead to mental ability, flexibility of thinking, expansion of thinking and authenticity of student thinking. Therefore, the education officials are recommended to have greater emphasis on the use of educational software and educational assistance software and grant some advantages for teachers. Meanwhile, according to the new policies of education and increasing the number of smart schools, in order to raise the growth of creativity and academic achievement of students, especially in mathematics, it is suggested to put the value of private producer companies of educational software on their agenda so that enough incentive be provided in the country to produce more such software. This study also had some limitations. The limitations in this study were limited to a small sample size and subject's selection was available in a way.

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