



Original Article

The effect of educational computer games on learning of mathematics concepts among students with autism spectrum disorder

Rahim Moradi

¹ Ph.D. student in educational technology, Allameh Tabatabaee University, Tehran, Iran

Abstract

Introduction: Despite technological capacity and its positive effects on the quantity and quality of teaching and learning, training students in the field of special educational needs unfortunately, far transformations has occurred and requires serious attention in this field. The aim of this study the impact of computer games on learning mathematics concepts among students with autism spectrum disorder.

Materials and Methods: This clinical trial was conducted in 2013-14. Participants consisted of 30 students with autism spectrum disorders in Tehran who were randomly divided into two groups: experimental and control. Pre-test learning in both experimental and control groups were conducted by the researcher. In the experimental group, teacher educated mathematics concepts (addition, subtraction, multiplication and division) completely then the computer games provided as a complement to concepts being taught. The descriptive and analytical statistics (covariance analysis) used for data analysis.

Results: The results showed that the significant difference in the mathematics learning in experimental group compared to the control group ($P \geq 0.001$).

Conclusion: It seems that computer games can be used in mathematics learning among students with autism spectrum disorder and it is suggested that modern educational technologies especially computer games use in teaching of mathematical concepts in addition to traditional methods.

Keywords: Autism spectrum disorder, Computer games, Education, Learning

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Introduction

Despite technological capacity and abilities and its positive effects on the quantity and quality of teaching and learning, unfortunately students training zone who have Special Educational Needs (SEN) has been far away from occurred changes and requires serious attention in this field. Secondary technologies based on computer especially computer educational games increase student ability who has special need in being independent in doing homework (1). This will cause learning and improving self-esteem of Autism spectrum disorders students. Computer educational games can have an important role in forming knowledge and skills of Autism spectrum disorder students by properties such as personalizing

education and matching education to needs and properties of the learners (2). Computer educational assistive games can affect the learner in making motivation, improving attention, external reward and reinforcement, increasing performance and social interaction, mediator of social interaction between therapist and Autism people, developing imitation and learning (3).

Investing in technology, policy developing, and action in taking part of students with special educational needs, has concluded unique opportunities for all the students' attendance in meaningful learning experiences in any place (4). Technology is a great moderator because lots of incapable people can use it as a type of alternative means of cognitive in overcoming or compensating differences against other learners (5).

Digital media have different types among them computer games 2 have been known as the most interactive (6). Nowadays developments that have

*Corresponding Author: Faculty of psychology and educational sciences, Allameh Tabatabaee University, Tehran, Iran

rahimnor08@gmail.com

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occurred in IT and communication field before everything have lead to improvement in education and learning for students with special educational needs in Autism spectrum disorders. The expression Autism disorders are a domain of neuro-growth which includes Autism special diagnostic, Asperger syndromes, and growing pervasive disorders that otherwise haven't been recognized (7). Autism spectrum disorders is one of 5 complexes of neuro-growth disorders which includes primary defects in social abilities and interactions, connections, limited interests and behavioral patterns (8). In addition this disorder is accompanied by other problems such as mental disabilities, challenging behaviors, mental damages, epilepsy, sleeping disorder and nutrition problems (9).

During the last few years, tendency to games which are presented as computerize and digital are being appeared. Learning through computer games will lead to students' satisfaction toward other ways in education. Through using educational computer games, student can use their knowledge in games and benefit from acquired learning experiences in virtual world to form their behavior in future (10). The importance of using this educational method in learning and education process is so much that in some of the countries in the world such as Malaysia, is a university field. Also regarding little research done in using new technologies specially computer games in education to Autism spectrum disorders students, this research can have great effect in education to these students and can be used as a research history by other researchers who intend to do survey in usage of computer technology in Autism spectrum disorder students' education.

Recent researches have lead to positive results for using games in class (11). Velayati, Zareyi Zavaraki and Amir Teymuri did a research named "effect of educational computer games on learning, remembering and motivation of academic achievement of mentally retarded girl students". The results found in this research showed that mathematics learning computer game in multiply concept causes learning and motivation of developing increase in retarded students in mathematics (12). Akhvast did a research named "effect of educational games on learning amount of some of math concepts in learnable retarded boy students". Results showed the difference of average scores of two groups of test and control in math total concepts was meaningful. Also this interference caused an increase of test group average scores in each of the math concepts than control group (13). Baghbanipour and Shokuhi used Yadeyar computer

game to improve meta cognition in people who have severe intellectual disability. In education with computer assistance he checked success in special abilities education in general cognitive process and reached positive and meaningful results (14). Mohamadi did a case study on effect of game in learning and emotional-social development in mentally retarded elementary students.

The results showed that there is a meaningful connection between game and learning of mentally retarded children and game will cause increasing social emotional growth in mentally retarded children (15). A research named effect of educational games on delicate motion skills in children aged between 4 to six years of Amene supportive nursery center was done by Farahbod. The results showed there is meaningful difference in coordination of eye and hand, coordination of two hands and the speed of handy skills of left and right side in two groups of children and this meaning was to the benefits of test group (16). A research named "computer games for developing math of different students" by Kim and Chang has been done. The results of this research showed that students who speak English language and have used computer games, compared to students who did not use games, had better operation in mathematics (17). Reis and colleagues did a case study titled "Using information technology based on multimedia exercise in teaching mathematics to cerebral palsy and mental retarded students in elementary level". Using multimedia instead of notebook for mathematics exercised leaded to more positive attitude to learning math in student who had used multimedia. Also researchers observed that via multimedia exercise and solving, this student became more interested, more active and more independent and could learn math concepts easily and showed more enthusiasm toward continuing (18). So this current research is looking for checking the effect of education computer games on learning math concepts of Autism spectrum disorder students in mathematics.

Materials and Methods

The method of doing this research is quasi-experiment with pre-test post-test design with control group. Statistical society of this research includes all the boy students of third grade in elementary school with Autism spectrum disorder in Tehran city who have been studying in 2013-14 educational years. This study was done after the confirmation of Alame-Tabatabayi University Faculty of Education and Psychology Research Committee. Statistical society included 30 people

who were selected via sampling available 15 people as control group and 15 people as test group. To regard the research ethics and the rights of the subjects it was clearly declared that it is volunteering and it was noted also orally (before the test) and written that the information asked in these questionnaires are just aimed to do research. Researcher's made learning test was used for students' learning. This test included 20 questions as short answer, blanks and multiple choices. Validity of learning test was checked using content validity. Stability of learning test in this research was calculated with retest method 0.86. Performance method was first selecting 30 boy students by sampling available from Peyk-e-Honar elementary school in Tehran city (special for Autism spectrum disorder) and then 15 people were placed in test group and 15 people in control group randomly. Then pre-test learning was conducted in both control and test groups. The questions of these two tests should be read personally by the researcher for each and only student and their selected answers should be written or chosen by the researcher. In the next level class teacher had to teach both test and control groups and the researcher had the main role in using educational computer games in test group and other necessary means and tools for this kind of teaching. In this case first the teacher presented the lesson (addition, subtraction, multiply and division concepts) completely to the students then in test group computer games were used as an exercise for the concept being taught. Meanwhile in control group the exercises were done the common way. In the next level, post-test was done on each and only student by the researcher. The researcher analyzed the out coming data in the last level. In this research descriptive statistics were used to calculate central tendencies and dispersion such as standard deviation and average and inferential statistics (covariance analysis) was used to analyze the data.

Results

Based on the results of this research, 9 people (30%) of the research samples' parents have associate degree, 15 people (50%) hold bachelor degree and 6 people (20%) hold MA degree. 1 person (3.3%) of the family has below 1 million incomes, 17 people (56.7%) between 1 to 1.5 million, 12 people (40%) between 1.5 to 2 million income. 4 people (13.3%) of the students were 9 years old, 9 people (30%) were 10 years old, 9 people (30%) were 11 years old, 7 people (23.3%) were 12 years old and 1 person (3.3%) was 13 years old.

Descriptive indexes in test and control group are presented in chart (1). There is a significant difference based on the presented data in post-test compared to pre-test.

Table 1. Pre-test and post-test descriptive data in control and witness group

Group	Pre-test		Post-test	
	Average	SD	Average	SD
Experimental	13.16	3.81	16.08	1.66
Control	13.08	3.42	12.03	2.85

Information shows the average and standard deviation of learning in control and test group in pre-test and post-test. The average of test and control groups in pre-test and post-test are not different very much. But there is significant difference in post-test scores in both groups which is to the benefit of test group.

Univariate analysis of covariance was used as the research hypothesis. Analysis of covariance is a statistical method which is used to adjust the basic differences in subjects. In this case each of the scores in pre-test is used as diffraction in post-test scores. In covariance analysis observation of the suppositions (such as homogeneity of the slope of the regression line and homogeneity of error variances) is necessary. Also in this research first the suppositions were checked and then since these suppositions were (homogeneity of the slope of the regression line: ($F=2.26$, $sig=11$) and homogeneity of error variances: ($F=0.73$, $sig=0.43$), we used the analysis of covariance to compare the average of learning scores in test and control groups and the results are presented in the below chart.

Research hypothesis: compared to common method in learning mathematics concepts in elementary school third grade Autism spectrum disorder students using educational computer games is effective in mathematics lesson.

Table 2. Covariance analysis results of using educational computer games on Autism students' learning mathematics concepts

Source	Sum of squares	Degree of freedom	Square average	F	Significance degree
Pre-test	73.22	1	73.22	75.638	0.001
Group	82.30	1	82.30	86.703	0.001
Error	25.385	27	0.953		

Based on Table 2 amount of F calculated for group factor was 86.703 which is meaningful ($P<0.001$). It means that after fixing the effect of pre-test in developing scores of learning factor, there is a meaningful difference between average of test group and witness group in post-test. Also regarding the

averages, the average of test group in post-test was 16.03 and average of control group was 12.83. The members of test group got higher scores than control group in mathematics. So the effect of educational computer games on learning mathematics concepts in Autism spectrum disorder students is confirmed.

Discussion

Video games can be an effective way for entertainment and skill development and motion coordination in people. According to Mazurek and Wenstrup studies, the people with Autism spectrum disorder spend most of their time watching TV and video games (62%) (19). They spend more than 4 hours a day for video games and games which are more complicated every day. Regularly children with Autism spectrum disorder spend 4.5 hours of their time on watching TV and video games everyday. Of course these kinds of people may prefer the video games for more reasons such as: being predictable, simplicity, easiness and motivation and academic development. Also video games can be used to help Autism spectrum disorder people to be involved in sport activities and learning sport rules (20). Educational games are effective and meaningful strategies for education and learning. There are various writings that consider educational games as a key element of motivation in students. Educational games are an innovative and new approach to promote interest and learning in educational environment. The student decides, solves the problems and reacts to his decisions as an active participant (21).

Games can mix various active learning strategies such as role play, discussion, collaborative learning activities, small group discussion, reading and writing and speaking. Current research results showed learning amount of students who had been taught by educational assistance games were in more favorable levels compared to students who were taught in traditional method. This result is in the same way with the results of studies of Moradi and Zareyi Zavaraki, Velayati, Zareyi Zavaraki and Amir Teymuri, Akhvast, Asie, Baghebani Por Shokuhi, Teymuri, Mojde Avar, Mohamadi, Farahbod, Ezborn Hid, Ginji and Beltehem, Kim and Chang, Reis and colleagues, Mazurek and Wenstrup, Ferguson and others, and Noten and others (1,10,12-20).

The studies done in this field states that assistive strategies specially educational computer games can be effective to educate students with special needs and specially Autism disorder students. These

educational technologies can be effective in learner to make motivation, self-esteem, attention reinforcement, as reward and outer reinforcement, operating and social interaction increase, intermediary between therapist and student with special need (22). These technologies decrease frustration and academic failure in Autism disorder students, prepare stability and predictability and increase student ability in independence to do the homework (23). If we want the educational games to have positive effect on learning and teaching procedure and don't make harm, we should design them suitably and they must involve a suitable educational framework.

Limitations of this research were scenario design time consuming and producing educational computer game in mathematics for Autism disorder students, limited research society to Tehran, instead of all the cities in the country. Also we can say using computer game beside current traditional method for learning and educating students with special educational needs specially Autism disorder student come into attention of teachers and both be used together. So we suggest the teachers and education officials to benefit from this new method to educate Autism disorder children to improve learning and increasing self-esteem and motivation of students. It is suggested to produce suitable games based on educational principles for Autism spectrum disorder students and be offered to students and schools so they can use the advantages of these games. Also it is suggested to use educational computer games in other lessons of elementary school and to use the technologies and facilities of educational technologies in all the school subjects in education levels. Checking the available researches based on the result found we can conclude that considering the properties and specifications of Autism spectrum disorder students and their learning style which is visual and based on images, using new technologies based on game as intervention works because of using several feelings in education procedure can affect their attention quality as an enjoying and at the same time effective technology in learning. In general we can say that game with abilities such as personalizing education and adjusting the education with needs and properties of learners, making motivation, attention developing, as reward and outer reinforcement are used for these people. Game helps consolidation of learning and stability of curriculum and leads to better quality of education and also causes learners' motivation to increase and as a result their trying and effort to learn more and get better scores and

positive attitude strength in students toward themselves and their abilities.

Conclusion

Regarding the importance and favorable advantages of game and according to learning condition of Autism spectrum students, using educational games in teaching lesson concepts will develop learning amount of students by increasing motivation and enthusiasm amount. Teachers of Autism school always remark that despite spending a lot of time and energy, the result of these children is not satisfactory. Since choosing suitable teaching method is one of the basic principles of education, using a game which has been accepted as a teaching method by educational organizations and its positive effect on education, learning, physical, mental and

social growth, children's motivation increase has been confirmed, can be effective in educating these children.

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