

Effects of the intelligence games approaches on academic achievement and attitude of students with mild intellectual disability in mathematics course

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Abstract

The aim of this study is to determine effects of the intelligence game (Tower of Hanoi) on academic achievement and attitude of students studying at 5th class of secondary school with Mild Intellectual Disability (MID) in mathematics of the course. In the study, pretest-posttest design, one group of pre-trial model, was used. The participants of the research consisted of 8 students with MID. To the students at the beginning of the study, "Mathematics Achievement Test", "Mathematics Attitude Scale" and "Concept Acquisition Interview" pretest - posttest was applied. The data obtained from the achievement test and attitude scale were analyzed by using rank test signed non-parametric Wilcoxon on SPSS 16.0 software. The data obtained in the interview form were interpreted by using the content analysis method. It was found that at the end of the study, students improved their academic achievement in mathematics education meaningfully in the course taught with Tower of Hanoi and the attitudes to the course were developed in a positive direction.

Keywords: Mild intellectual disability, intelligence game, mathematics course, academic achievement, attitude.

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1. Introduction

Developmental retardation, occurring early in life, is a condition that its effects will last in acquiring the skills needed for individual growth throughout the life. Mental disability, which is one of developmental retardation, is the situation where significant limitations and shortcomings in mental functions and conceptional, social and practical adaptive skills of individuals can be seen (Fidan Kurtdede & Akyol, 2011). Secondary education is the most important step that effective ways of learning are taught in accordance with individuals' development characteristics, readiness and education level. One of the most appropriate courses that learning can be carried out effectively at this education level is Mathematics (Math) course. However, answering the question of which method, approach or education program is the most appropriate for students with MID is very important (Scruggs, Mastropieri & Bonn, 2008). Emotional levels and personalities of these students should be taken into account and necessary targets should be established in order to achieve an active and meaningful participation if any work is going to be performed for these students (Bigge, Best, and Heller 2001).

Math education needs to be fun and interesting. Motivation for learning and learning in education increase when students enjoy math courses equipped with projects, concepts, demonstrations and similar activities (Cornell, 2000). Teaching with game requires more attention, creativity, imagination and synthesis power (Bilen, 1999). As stated by Yildiz (1997) if intellectual, theoretical basis and practical details of game are well known by teachers, the effect of the game in education is going to be more effective. Game that is one of the best ways of making students active in math allows them to establish connections with their own worlds (Foster, 2004). Games often are a way to make ordinary math practices fun. However, some games contain thinking and speculating strategies (Dunn, Steward & Williams, 2003).

According to Piaget, every act of intelligence is determined by balancing between assimilation and compliance that are two opposing trend. Persons encompass events, objects and situations into current thinking forms that constitute organized mental structures. While persons accommodate the requirements of the external reality with wit action, they maintain their mental structures fully at the same time. Games on the contrary are determined by mastery of assimilation over compliance; that is, persons takes events and objects into current existing mental structures (Piaget, 1962; quoted by Nicolopoulou, 2004). The impact of Vygotsky on game research is much more complex and extensive than Piaget. According to Vygotsky, game is always a social activity. Games typically include more than the subject of the child and issues, stories or roles in game components demonstrate grasp of children over socio-cultural material of their communities. Therefore even a kid playing a game alone, Vygotsky considers that such a game is a social as issues and components of the game expressing sociocultural elements. Vygotsky considers that games contribute significantly to cognitive development rather than simply reflecting cognitive development. The child is above the average age, daily behavior every time during the game as if a bit older than himself. Games cover all cognitive trends intensively such as in the focal of the magnifier; that is, the child in the game is like trying to jump over the level of normal behavior (Vygotsky, 1967, quoted by Nicolopoulou, 2004).

Mathematicians have always interested in the games since ancient times. Perhaps the most important reason for this curiosity for mathematicians is that games and math are similar in some aspects. They identify math with the game and even see math as a game. Umay (2002) state that "the game is largely math, the math is totally game." Davis and Hersh (2002) express in their study of "Formalist Philosophy of Math" that math, starting from arithmetic, just a logical inference game for formalist mathematicians. Leibniz wrote a letter to De Montmort in 1715 stating "Mankind never become as clever as the invention of the game. Spirit finds itself in leisure time in games. A comprehensive course, which dealt with games mathematically, is a desirable situation (Guzman, 1990). From past to present, people focused on many games formed by mathematicians and they guided various studies in math. The most famous of games are; the ring game of Recorde and Cardan, Hanoi Towers of Lucas, problems formed by Fibonacci, horses' tour problem of Taylor, seven bridges

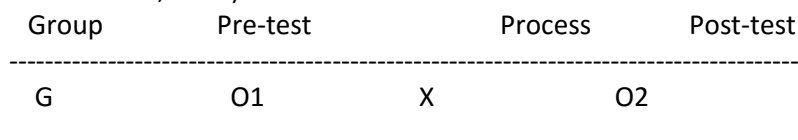
problem of Konigsberg, thirty-six workers problem of Euler, chess problems of scientist Raymond Smullyan, cube of Hungarian Erno Rubik (this game made about a hundred million sales worldwide) and the game of magic squares. In math curriculum of 5th grade, topics such as natural numbers, arithmetic operations with natural numbers, fractions, exponential numbers and geometrical shapes are covered (MEB, 2013). In this context, topics that are in the math curriculum have a rich content for math education through the game of Hanoi Tower. In this work we sought to answer following questions:

What is the impact of the game of Hanoi Tower in the topic of natural numbers in math on the academic success of students with MID?

What is the impact of the game of Hanoi Tower in the topic of natural numbers in math on the attitudes of students with MID?

2.Methods

In this study, single group pretest-posttest design among the pre trial models was used. This model does not include random sampling and pairing. Symbolic appearance of the model is as follows (Buyukozturk et al., 2008):



G indicates the group; O1 indicates pre-test measurement from the experimental group; X indicates the experimental process; O2 indicates post-test measurement from the experimental group (Buyukozturk et al., 2008).

2.1. Study Group

The study was carried out by 8 students with MID in Pupa Student Integration Unit at Education Faculty of Karamanoglu Mehmetbey University.

2.2. Data Collection Instruments

“Math Achievement Test” developed by the researcher, “Attitude Scale” developed by Ocak and Donmez (2010) for math activities of 4th and 5th grade students, and “ Concept Acquisition Interview Form” developed by the researcher were used to gather data in the research.

2.2.1. Math Science Course Development an Achievement Test

The achievement test was designed for the topic of natural numbers in math for 5th grade and implemented experimentally. The achievement test that consisted of 22 multiple questions was assessed by three academics and two classroom teachers and the test was reduced to 16 questions. The reliability and validity of item was tested by 25 students in the pilot study and internal consistency was calculated using SPSS 16 package program. 3 items whose item discrimination power was under .30 removed from the test and ultimately 13 questions were included. While Cronbach alpha reliability coefficient of the scale was found as .91, item difficulty index was calculated as .57 and item discrimination value was calculated as .62.

2.2.2. Math Science Course Attitude Scale

In the study, the scale, 5-point Likert-type and consisting of 19 items, developed by Ocak and Donmez (2010) in the study of “Development of the Attitude Scale for Math Activities of 4th and 5th grade Students” was administered in the study group as pretest and posttest. Kaiser-Meyer-Olkin (KMO) value was found as .90 and the significance value of the Bartlett test was found as .000. Cronbach Alpha value of the scale was obtained as .91

2.2.3. Conception Acquisition Interview Form

In the study, semi-structured interview form consisting of open-ended questions developed by the researcher was used to determine acquired conceptions after explaining the topic of natural numbers with the game of Hanoi Tower. Two measurement specialist academics and three teachers consulted while forming the interviews and structure and content validity of the interview form was provided. For reliability, the pilot study was conducted with two students and two faculty members coded their answers independently. The obtained data indicated the themes of “consensus” and “difference of opinion” and coding was performed accordingly. The reliability formula proposed by Miles and Huberman (1994) was used in the reliability calculation of 10 questions in the form. With the method of Reliability= Consensus / (Consensus + Dissidence), coefficient of agreement between researchers has been found as .90 (9 / 9+1). This indicates the reliability of coding. It is considered that reliability value over .70 is accepted for research (Miles & Huberman, 1994).

2.2.4. Implementation of Practices

In the study, common outcomes of the topic of natural numbers in math for 5th grade in accordance with individualized education program designed for 8 students were determined and teachers and students decided to do teaching and learning with the game of Hanoi Tower intended to acquire these outcomes (Image1).

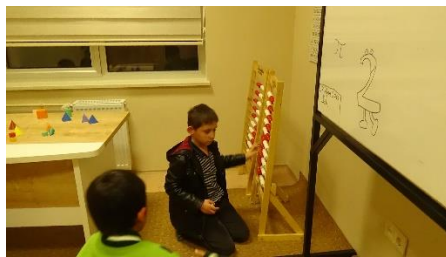


Image 1. Preliminary study

Math education with the game of Hanoi Tower lasted 2 weeks. Training was conducted individual (Image 2)

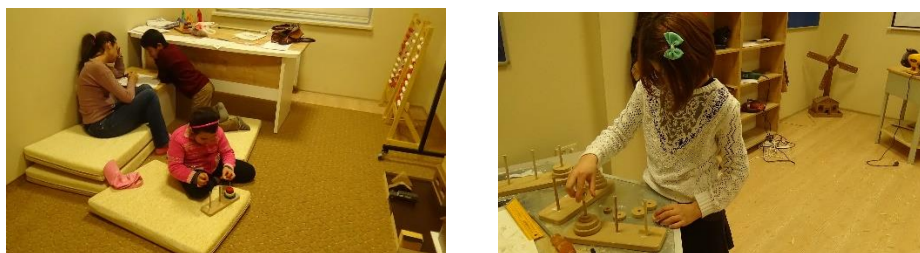


Image 2. Education with the game of Hanoi Tower

2.2.5. Analysis of The Data

SPSS 16.0 software package was used to analyze the data. To determine whether there is a significant difference on the academic achievement and attitudes with/without the game of Hanoi Tower, non-parametric Wilcoxon Signed Rank test for repeated measures with the significance level, standard deviation and the mean have been looked. Furthermore, data obtained by interview forms were analyzed and interpreted using content analysis, which is often preferred in qualitative analysis methods.

3. Results

3.1. Findings Regarding Math Achievement Test Score of Study Group

Table 1. Pretest posttest mean and standard deviation of the study group

	N	Mean	Standard Deviation
Pretest	8	22.5	9.63
Posttest	8	47.5	8.86

There has been an increase in achievement test mean scores of students with mild mental retardation in the course conducted with the game of Hanoi Tower. It can be said that math with the game of Hanoi tower was effective in increasing success. Table 2 gives Wilcoxon signed rank test results regarding pre-test/post-test achievement scores of the study group with mind game.

Table 2. Wilcoxon signed rank test results regarding pretest and posttest achievement scores of the study group

Pre test Post test	N	Mean Rank	Rank Sum	z	p
Negative Ranks	0	.00	.00		
Positive Ranks	8	4.50	36.00	-2.53	.01*
Equal	0				

Note: *Significant at the .05 level.

Difference between pre-test and post-test scores of students of the study group after the experimental procedure is in favor of post-test and significant [$z=2.81, p<.05$].

3.2. The results regarding Math science course attitude scores of the study group

Table 3 gives Wilcoxon signed rank test results of the study group with the game of Hanoi Tower regarding pretest and posttest attitude scores.

Table 3. Wilcoxon signed rank test results regarding attitude scores of the study group with/without Hanoi Tower game

Pre test Post test	N	Mean Rank	Rank Sum	z	p
Negative Rank	0	0	0		
Positive Rank	7	4	28	-2.38	.01*
Equal	1				

Note: *Significant at the .05 level.

Table 3 indicates that there has been statistical significant difference regarding attitude scores of students before and after the game of Hanoi Tower [$z = 2.38, p < 0.05$] and seems to be in favor of post-test scores.

3.3. Findings regarding Math Conception Acquisition Interview Form of the Study Group

To measure what extent students have received targeted acquisitions in the scope of the curriculum, content analysis was carried out in the context of themes and answers were coded. Emerging themes, codes, frequency of codes and percentage distributions were presented in Table 4.

Table 4. Theme and sub-themes of the Conception Acquisition Interview Form

Themes	Codes	Frequency	Percentage
1.Hanoi Tower Game	Ring Number	6	75
	Step Counting	8	100
	2 Base	4	50
2.Exponential Number	3 Base	4	50
	Cake Number	6	75
	Triangle	7	87.5
3. From Geometric Shapes to Exponential Numbers	Square	7	87.5
	Cube	8	100

Answers to the conception acquisition interview form revealed to what extent students gained information on the subject of natural numbers with the achievement test. The interview form consists of three main themes. 6 participants (%75) stated '28' to the question of how each ring in the game of Hanoi Tower in Figure 1 is considered 2 base.



Figure 1. Ring Number of the game of Hanoi Tower

8 participants (%100) stated '23' when asked how many moves of rings become the ultimate in the game of Hanoi Tower in Figure 2, starting from the left.



Figure 2. Ring step number in the game of Hanoi Tower

4 participants (%50) stated '28' when asked how to illustrate ring numbers with 2 base in Figure 3.



Figure 3. Expressing rings as exponential numbers

4 participants (%50) stated '32' when asked how to illustrate 3 base 2 as exponential numbers. 6 participants (%75) stated '23' when asked how to illustrate 2 pieces of cakes in two plates on 2 tables with 2 base. 7 participants (% 87.5) stated '23' when asked how to illustrate numbers of edges of geometric shapes with 2 base for edges of triangle and '24' for edges of square. 8 participants (%100) stated '26' when asked how to illustrate numbers of faces of cube with 2 base. According to data obtained through interviews, the participants obtained the majority of acquisitions that take place in the subject of exponential numbers processed by the game of Hanoi Tower.

4. Discussion and Conclusion

Various studies can be found in the literature reporting positive impact of game-based math education on attitudes of students and their academic achievements (Cevik & Duzgun, 2015; Yilmazer & Keklikci, 2014; Cankaya & Karamete, 2008; Beyhan & Tural, 2007; Koroglu & Yesildere, 2002). In general in the literature it is emphasized that factors such as the use of concrete materials in games, having students interact in activities, being attractive and motivating of games, providing continuing interests in course, having the learning environment address for more senses, and enabling education fun offer a great contribution to the learning process. For instance, Merrotsy (2015) state that the game of Hanoi Tower might help students in secondary schools in inductive mathematical operations. Games are considered as active learning techniques and it is emphasized that games can be used in the courses trying to give induction, hypothesis and the nature of scientific study (Acikgoz, 2003). How is the situation for students with special needs while teaching math through games possible for students with normal intelligence? In our study, outcomes of playing Hanoi Tower in math with students with MID have been positive since the game includes practices in its center and fun. In the literature various studies that measure academic achievement and attitudes or behavior changes of students with MID using different teaching methods based on practices and learning by having fun in the course of math can be found. Baki (2014), Morin and Miller (1998) the strategy of teaching with schema in math increased performance of solving verbal problems of students with intellectual disabilities. This finding supports results of our study that indicate increased academic achievement and attitudes among students with the game of Hanoi Tower for students with MID. Furthermore, gaining of some topics appear in math curriculum to students with interactive practices might be

effective. Chang and Tam (2005) identified in their study that cognitive-based learning activities in math enhance problem-solving skills of students with MID. Tezcan (2012) sought in his thesis to ensure the effective and permanent way of learning using information technologies in science and math that could facilitate their daily lives and help solve problems easier for students with MID. The study concluded that students' academic success and persistency in their learning increased. Different teaching methods on the basis of practices that increase academic achievements of students with MID support the results of this study. Increases in both academic achievement and attitudes of students with special needs are consistent with studies in the literature. Arpacik (2014) indicated that materials developed using the design-based learning approach for students with intellectual disabilities need to be designed in a simple way so that students focus on the concept in terms of content and using smart boards as learning materials is advantage but the use of them need to be in control by teachers. In this study, activities were restricted by expressing what they can or cannot do during the game of Hanoi Tower. Scruggs & Mastropier (1995) and Patton (1995) state that it is necessary to be careful when choosing topics in practice-based studies for these students as the topic is linked with the success. Learning through games and activities, no matter how largely they succeeded, the course might be disadvantaged if the preparation is not well designed. Hatch (1998) stated possible disadvantages of using games in math classrooms as too much material which is the case families and school managers would not like and space requirements for good organizations (Rowe, 2001). Therefore ensuring teacher-school-parents cooperation in schools, discussing studies approved by the class teacher in the board of school officials and class teachers and identifying school facilities at the beginning of the academic year might be useful. In our study, the subject of exponential numbers in natural numbers of 5th grade math course has been preferred considering these issues after consulting with other subject teachers (IT and Science). In order to success in math courses, teachers need to minimize students' concerns and ensure positive attitudes for the course. Courses built upon the common pleasure of students, associating with their favorite topics would facilitate developing positive attitudes to the course.

In this study, the subject of exponential numbers with natural numbers in math course with the game of Hanoi Tower was examined and different topics in math course can be studied. Furthermore, different topics of math can be studied with different intelligent games. Likewise, games of Hanoi Tower can be tested areas such as natural science and social science. Yet, implementation of the game of Hanoi Tower for students with MID can be measured to determine if their academic achievement and attitudes in the related course were affected in different disability groups.

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