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The Effect of Using Puzzles and Games on Students' Mathematical Thinking at the Faculty of Educational Sciences and Arts (UNRWA)

Mohammad Al-absi
Faculty of Educational Sciences and Arts UNRWA, absi702000@yahoo.com

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أثر استخدام الأحاجي والألعاب في التفكير الرياضي لدى طلبة كلية العلوم التربوية والآداب (الأونروا)

Mohammad Al-absi

محمد العبسي

Faculty of Educational Sciences and Arts UNRWA- Amman, Jordan

E-mail: absi702000@yahoo.com

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Abstract

This study aimed at investigating the effect of using puzzles and games on students' mathematical thinking at the faculty of educational sciences and arts (UNRWA), according to their self-efficacy, by using the qausi-experimental approach, with nonequivalent control group design. The sample of the study consisted of (79) students, registered the "basic concepts in mathematics" course, distributed to two sections, one section chosen randomly as an experimental group who was taught during the "Number theory" unit by teaching them through puzzles and games, and the other section as a control group who was taught using the traditional method of instruction. Results of the study revealed that puzzles and games had a positive effect on improving students' mathematical thinking, and there is no statically significant difference in the mathematical thinking, attributable to the interaction between the group (experimental, control) and self-efficacy (high, moderate).

Keywords: Puzzles, Games, Mathematical Thinking, UNRWA.

ملخص

هدفت هذه الدراسة إلى فحص أثر استخدام الأحاجي والألعاب في التفكير الرياضي لدى طلبة كلية العلوم التربوية والآداب (الأونروا)، حسب مستوى الفاعلية لديهم، باستخدام التصميم شبه التجريبي، القائم على مجموعة ضابطة غير مكافئة للمجموعة التجريبية، وقد تكونت عينة الدراسة من (79) طالباً وطالبة مسجلين لمساق "مفاهيم أساسية في الرياضيات"، وموزعين على شعبتين، إذ تم اختيار إحدى الشعب عشوائياً كمجموعة تجريبية تعلمت وحدة (نظرية الأعداد) من خلال تدريسهم بالأحاجي والألغاز، والشعبة الأخرى كمجموعة ضابطة تعلمت الوحدة نفسها بالطريقة التقليدية، وقد أظهرت نتائج الدراسة أن الأحاجي والألعاب لها تأثير إيجابي في تحسين التفكير الرياضي لدى الطلبة، كما أنه لا يوجد فروق ذات دلالة إحصائية في التفكير الرياضي لدى الطلبة تعزى للتفاعل بين المجموعة (تجريبية، ضابطة) ومستوى الفاعلية الذاتية (مرتفع، متوسط).

الكلمات المفتاحية: الأحاجي، الألعاب، التفكير الرياضي، الأونروا.

Introduction

Educators gave much attention to the subject of thinking; even some of them stated that the learning is thinking. Thinking is a skill that can be developed through practice and doing things effectively in certain conditions (De Bono, 2003). Mathematics is the most subject that students can be interested in thinking, and the modern perception of teaching mathematics is based on teaching students how to learn math more than teaching them what they learn, and this confirms the role of mathematics in modern individual development and improves his thinking skills (NCTM, 2000).

Abu Zeina & Ababneh (2007) defined mathematical thinking as a process of looking for the meaning in the position or experience related to the mathematical context, where the position is represented in numbers, symbols, forms or mathematical concepts. It is not only important for solving mathematical problems and for learning mathematics (Chick, 2003), it is essential for teaching other elements of the mathematical knowledge, such as: concepts, facts and skills.

Teaching thinking to students of the basic stage is one of the most important skills that must be owned by a teacher who will teach students at that stage; which requires from the teacher to see patterns of thinking, knowledge and skills, and strategies employed in teaching to contribute to the creation of the thinker student (Abbas & Al-Absi, 2009).

There is no unique definition of thinking, where scientists have different views of the definition, and this difference is a result of the theoretical foundations that they depend. It is a mental process that the individual can do something meaningful; which is a result of the experience that he passed. (Guershon & Larry, 2005) stated that the definition of thinking requires taking into account the difficulties and obstacles referenced to the theoretical and practical knowledge related to the specific way of thinking.

Mathematics has a close relationship to the skills of thinking in terms of providing the connection between ideas, organizing information, and re-explaining and arranging them. The answer of the mathematical problem is not sufficient if it is written alone (Swan, 2002), but the most important thing of solving the problem is to ask the student for recording the strategies that he applied to solve the problem.

One of the important goals of the professional development for mathematics teachers is to emphasize the goal of developing an understanding of how students think (Sowder, 2007). So the goals of teaching mathematics in various countries of the world concentrate on the development of using different thinking skills, where the aims of teaching mathematics are to develop the ability to detect and innovate and to accustom students to the process of abstraction and generalization.

The upgrading of the thinking skills among students requires a good work on a strategy to acquire those skills, instead of focusing on the rote teaching of the information and facts, and the need for attention to divergent and higher cognitive questions, because this type of questions has the characteristic of providing great freedom for the students to search for solutions, as it allows many entrances to answer these questions, which provoke a divergent thinking starts from a problem offering alternatives to solve the problem and lead to a variety of different solutions that enhance teaching and curriculum.

Mathematical thinking requires using strategies to solve problems in different patterns (Van Zoest; Jones & Thornton, 1994), such as: Intuition, work systematically, make changes, circular, search for specific examples to clarify and resolve issues related to the easiest, work in reverse, representation of information through the figures and tables, and inspection and testing of mathematical ideas.

Mathematical thinking and reasoning and proof provide a strong way to develop ideas about various phenomena, and the ability of thinking is an important thing to understand mathematics (NCTM, 2000). Students perceive that mathematics is a meaningful through the development of ideas and phenomena discovery and interpretation of the results and the use of mathematical conjectures in all content areas and at all levels of the classroom. Mathematical reasoning and proof cannot be taught in isolation or only in a unit about logic in the textbook, or through demonstrating arithmetic and geometrical problems, but it must be firmly a part of the student's experience, starting from pre-kindergarten, and then followed by a work on the development of his thinking through the continued employment of positions that require the use of mathematical thinking patterns in multiple contexts.

The word (Puzzle) means a riddle that may be in the form of a question or crosswords or a game, and so forth of the meanings that represent a position contains an appeared or hidden information about a phenomenon, which needs an individual thinking in a manner commensurate with the level of the degree of ease or the difficulty of the puzzle or riddle (Al-Absi, 2009).

The puzzle or riddle are known things since ancient times, and people were competing to put those riddles and puzzles, and they devote considerable material rewards to people who can solve some riddles and puzzles. Mathematical puzzles can engage students in rich mathematical explorations and logical reasoning in the classroom (Evered, 2001).

As the thinking is a mentality process the individual from which can do something meaningful, it means that the riddles or puzzles are real and ideal examples to use critical thinking skills (Su, Marinas & Furner, 2010), and to put the individual in positions requiring him to use multiple styles of thinking according to the maximum extent of his abilities and potential to solve the problem.

Wanko (2010) conducted that students' deductive-reasoning skills have increased through using a ten-week supplementary curriculum, which has a series of lessons, built around language-independent logic puzzles. Students also have shown great interest in solving puzzles, discussing their problem-solving strategies, and applying what they have learned to other logic problems.

The game can be defined as a meaningful activity in which players make great efforts to achieve a certain goal in the light of certain laws. Several individuals, who can compete in this activity, are subject to the laws of the game to achieve the desired objective (Al-Heeleh, 2005).

Playing is directly related to the lives of children, it forms the content of their lives and their interaction with the environment, and it is a configuration and developmental tool of the children's personality and of their behavior. It acts as an educational intermediary on the formation of the child's behavior in the formative stage, which is a critical stage of human development, and an effective tool to teach children to think (Smith, 2013).

Al-Heeleh (2005) defined playing as a child's need for the mental, social, moral and physical development, which introduced to him as a means of multiple aspects in the form of activity, movement, or a free work, as drivers to satisfy the young needs of growth, adjustment, entertainment, fun, and health.

Lane & Harkness (2012) conducted a study by using three game shows: "Survivor", "The Biggest Loser", and "Deal or No Deal?" and the results showed that students generally did not engage in the process of mathematical thinking unless directed to do so.

(Khairiree, 2015) conducted a research aimed to illustrate how Tangram puzzle can be used to enhance students' creative thinking in mathematics and to use dynamic geometry software the Geometer's

Sketchpad to develop the pictorial representations and geometrical shapes. In the year 2015, action research was carried out in a lower secondary school Bangkok, Thailand. The research finding revealed that the teachers used GSP to construct Tangram puzzle and Egg Tangram. The students explained that were able to use GSP to drag, rotate and translate the pieces of virtual Tangrams to form the shapes given to them. Creative thinking and problem solving skills were developed while students solved and created tangram puzzles. The students were able to express their geometric imagination and their understanding of mathematics concept by verbal interactions. The students had fun and positive attitudes towards mathematics.

Educational games can be used to teach a lot of topics, such as teaching computation to the lower elementary stage students. Teacher can use some types of activity granulated into the hearts of students, which raise their interest in learning, and help them to learn the concepts of counting, reading, writing, arranging numbers, and the place value in numbers (Al-Absi, 2009).

According to the National Council of Teachers of Mathematics (NCTM, 2006), “through identifying, describing, and applying number patterns and properties in developing strategies for basic facts, children learn about other properties of numbers and operations, such as odd and even” (p. 19).

The objectives of the games in the learning process aim to achieve goals in variant aspects, they are not directed to one aspect only, such as the emotional aspect, through the students' feeling of fun during the instructional game, but they must aim to acquire cognitive and psychomotor aspects also (Al-Heeleh, 2005).

Games have some results that form negative behaviors, such as fraud and deception, harassment, conflict or interest in the game without paying attention to the educational goal (Abbas & Al-Absi, 2009). To avoid falling into such negatives we must take into account the following matters:

1. The use of the game should not turn to recreational or entertaining activity.
2. The game should not turn to win or loss only; because looking for a win by any means is a behavior that eliminates the spirit of the positive competition, and leads to fraud and deception, which does not help to acquire and develop new skills.
3. The game must be compatible with the social values, so we should not encourage students to do games encounter our values.
4. The teacher should explain to students that the educational games that are implemented are purposeful activities that used to serve the goals and assist in their investigation, so the important thing here is to achieve the educational goal not to interest in the game itself.

Self-efficacy is one's beliefs in their capabilities to produce given attainments. People who have high levels of self-efficacy beliefs in a certain domain tend to persist longer at tasks in order to reach their goals. People high in self-efficacy are also more likely to eventually succeed in reaching challenging goals than their counterparts with low self-efficacy even when their skills are equal. We must have a better idea of how we can develop an environment in a game that promotes self-efficacy among our students (Kato, 2012).

In (Hung; Huang & Hwang, 2014) study, a mathematical game-based learning environment is developed on e-books for helping children reduce mathematical anxiety and improve their self-efficacy, motivation, and achievements in learning mathematics. To evaluate the effectiveness of the proposed approach, an experiment was conducted on an elementary school mathematics course. With quasi-experimental research, a total of 69 pupils in three classes were selected as the research subjects. One class was assigned to be experimental group A, another class was experimental group B, and the third was the control group. Each group consisted of 23 students. In the experimental process, the three groups took pre-tests, had experimental instruction, and then took post-tests. The experimental results show that the game-based e-book learning model effectively promoted the students' learning achievement, self-efficacy, and motivation of mathematics.

Research problem

Solving puzzles and playing games are two great ways to develop and strengthen reasoning and logical thinking skills that are essential to math. The National Council of Mathematics (NCTM, 2000) Standards highlight the importance of reasoning in all aspects of mathematics.

Good puzzles present a perplexing task that is not readily solved. At the same time they are designed to be fun and engaging, so that the puzzle solver will work to figure out the solution. In math, students often give up on challenging problems that they would be able to solve with some effort. Puzzles that are not focused on math can be an engaging way to develop persistence.

(NCTM, 2000) recommends that reasoning and problem-solving should be embedded throughout the math curriculum at all grades. Puzzles games are two ways that students can develop these skills in a non-threatening environment. Puzzles and games can be used at any time and many can be solved in a relatively brief period.

The current study aims to examine the effect of using puzzles and games on students' mathematical thinking. This study tried to answer the following questions:

1. Is there any statistically significant difference between means of the experimental group (which was taught by using puzzles and games), and the control group (which was taught traditionally) on the mathematical thinking test?
2. Is there any statistically significant difference between means of the students on the mathematical thinking test, attributable to the interaction between the group (experimental, control) and Self-Efficacy (high, moderate)?

Research hypotheses

The current study aimed at testing the following hypotheses:

1. There is no statistically significant difference at (α=0.05) between the mean scores of the experimental group and the control group on the mathematical thinking test.
2. There is no statistically significant difference at (α=0.05) between the mean scores of the students on the mathematical thinking test, attributable to the interaction between the group (experimental, control) and Self-Efficacy (high, moderate).

Research importance

- The use of puzzles and games is an alternative method to assess students' level of mathematical thinking; it enhances what teachers tend to know about students' understanding to help them overcoming their misconceptions and measuring their performance in a real situation.
- This study is considered as one of the few studies in the Arab world that examines the effect of using puzzles and games in improving students' mathematical thinking, attributable to their self-efficacy.

Operational definition of terms

- **Puzzles and Games**: are assessment types in the learning process, which requires posing the student with questions and situations that have using higher order thinking skills to reach the solution.
- **Mathematical Thinking**: is a process of looking for the meaning in the position or experience related to the mathematical context (Al-Absi, 2009). The mathematical thinking is measured by the students score on the test, which is applied in this study.
- **UNRWA**: United Nations Relief and Works Agency for Palestine Refugees in the Near East.
- **General Self- Efficacy:** is the existing knowledge about the self that contains self-expectations regarding the ability of the individual to overcome situations and tasks successfully (Bandura, 1977). It is measured by the students' ratings on the tool applied in the current study.

Limitations of the Study

- Instrument of the study was developed by the researcher, so the interpretation of the results depends on the validity and reliability of these instruments. Though the researcher verified these psychometric characteristics.
- The study was applied to the faculty of educational sciences and arts, and this makes the generalization of results specific to the study population or a similar community.

Methodology and Procedures

Methodology

The qausi-experimental approach, with nonequivalent control group design was used in the current study.

Study Population and Sample

The population of the study consisted of all class teacher students at the faculty of educational sciences and arts, in the year 2013/2014, their number is about (800) students. The sample of the study consisted of two sections registered the “basic concepts in mathematics” course, which is one of the mandatory requirements in the class teacher specialization plan. The two sections were randomly selected from four sections. One section (38 students) was selected randomly as an experimental group, who was taught by using puzzles and games, and the other section (41 students) was selected as a control group, who was taught by the traditional method, and the two sections were taught by the researcher.

Instruments of the Study

Puzzles and Games

Puzzles and games were designed and developed by the researcher, to be applied during the learning process. They were given to the experimental group students as tasks related to the subject learned, during the instructional process, as an assessment tool, and the researcher follows-up the solution that is introduced by the student, then he discusses the task with the class. The control group was taught the same unit traditionally, by using the tasks in the textbook only. Nearly one task in every lecture, either a puzzle or a game, and students were asked to work on these tasks.

When deciding to use a puzzle in the classroom teaching and learning process, researcher planned for various levels of the puzzle. Figure 1 describes a puzzle of turning ball(s) to switch the shape 180.

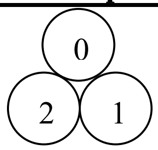
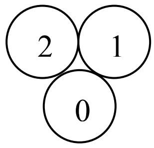
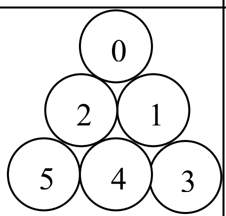
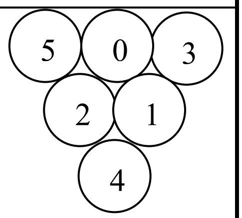
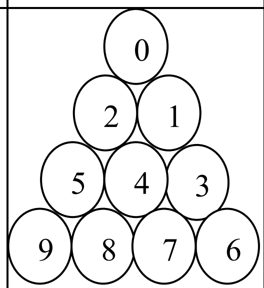
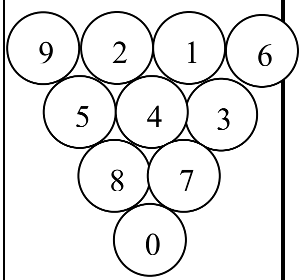
level	Original shape	Required	Solution
A		Turn one ball to re-arrange the number of balls from ascending amount to descending amount.	
B		Turn two balls to re-arrange the number of balls from ascending amount to descending amount.	
C		Turn three balls to re-arrange the number of balls from ascending amount to descending amount.	

Figure (1): A Puzzle of turning ball(s) to switch the shape 180.

The puzzle has three levels, level (A) is the easier level, and level (C) is the hardest level; whereas level (B) has a moderate difficulty in comparison with levels (A) and (C). Figure 2 also describes an instructional game about basic facts and properties of numbers.

Level	Shade the squares that have even numbers								Solution						
A	54	82	36	27	4	89	22		54	82	36	27	4	89	22
	26	45	40	9	72	30	43		26	45	40	9	72	30	43
	8	12	98	91	58	55	78		8	12	98	91	58	55	78
Shade the squares that have Multiples of 3									**Solution**						
B	15	27	36	43	30	13	6		15	27	36	43	30	13	6
	12	23	9	53	45	18	32		12	23	9	53	45	18	32
	42	3	21	35	33	34	24		42	3	21	35	33	34	24
Shade the squares that have prime numbers									**Solution**						
C	5	41	17	15	11	21	3		5	41	17		11		3
	23	9	2	27	29	31	45		23		2		29	31	
	43	13	37	39	7	33	19		43	13	37		7		19

Note: read the word that formed from the shaded squares, (it is OK).

Figure (2): Educational game about basic facts and properties of numbers.

The game has three levels, every level about a basic fact or a property of the whole numbers. The game can be assessed by students themselves (self-assessment), because the correct answer of the play will shape the word (OK), so the solution can be easily verified from one look to the whole solution.

The Mathematical Thinking Test

The mathematical thinking test which applied in the current study was prepared by (Al-Khatib, 2004) and developed by (Al-Absi, 2005) through choosing (16) items from the test, and these items representing the mathematical thinking aspects in the original version of the test. The test has been corrected by marking one score of each item, so the total score of the mathematical thinking test was (16).

For the purposes of validity, the mathematical thinking test has been applied to a sample of (40) students of the study population (not included in the ample), and the consistency of each item of the test were computed using the Pearson correlation between the item scores and the whole test scores. The correlation coefficients were between (0.43 – 0.81), which are an acceptable values for the purposes of study.

For the purposes of confirmatory, the mathematical thinking test has been applied to a sample of (40) students of the study population and the reliability of the test were computed using the split – half method, since the test items can be divided into two equal parts. The reliability coefficient was (0.86), which is an acceptable value for the purposes of study. Appendix (A) reveals the mathematical thinking test in its final form.

General Self- Efficacy Scale

In the year 1986 (Jerusalem & Schwarzer) developed a predicted self-efficacy scale, which was translated to Arabic language, and a verification of the content validity was made (Al-Masaeed, 2011). The scale is a consisted of (10) item, each item has the tri-gradation (large, medium, few), so the ratings of the responses to the scale were in the range (10 – 30). These rating were used to distribute students to (high self-efficacy, moderate self-efficacy, and low self-efficacy) according to the following criteria:

- High self-efficacy: the range of scale responses is (24 - 30).
- Moderate self-efficacy: the range of scale responses is (17 - 23).
- Low self-efficacy: the range of scale responses is (10 - 16).

For the purposes of validity, the self-efficacy scale has been applied to a sample of (40) students of the study population and the consistency of each item of the test were computed using the Pearson correlation between the item scores and the whole scale scores. The correlation coefficients were between (0.37 – 0.86), which are an acceptable values for the purposes of study.

For the purposes of confirmatory, the self-efficacy scale has been applied to a sample of (40) students of the study population and the reliability of the scale were computed using the test - retest method. The correlation coefficient between the two applications was (0.82), which is an acceptable value for the purposes of study. Appendix (B) reveals the self-efficacy scale in its final form.

Study Procedures

- Before the beginning of the study, a mathematical thinking test was administered to the two groups as a pre-test.
- A general self- efficacy scale was administered to the two groups, and depending on their results, students were classified into two categories according to their self- efficacy: (high, moderate), since there was no student in the low self-efficacy category. This classification for the statistical analysis only to examine the second hypothesis, which studies the effect of the general self- efficacy as a moderator variable.
- The experimental group was taught during their study the unit “Number theory” by using puzzles and games in the regular mathematics lectures, in addition to the textbook; meanwhile, the control group was taught by the traditional method using the textbook only.
- The period of the study was four weeks, which took 12 hours distributed to 12 lectures.
- After the completion of the study, a mathematical thinking test was administered to the two groups as a post-test, and data was analyzed by using SPSS program to test the hypotheses of the study.

Study Variables

1. Independent variable: Teaching method, which has two levels: (teaching using puzzles and games, teaching traditionally).
2. Moderator variable: General Self- efficacy, which has two levels: (High, Moderate).
3. Dependent variables: Mathematical thinking.

Statistical Analysis

To test the hypotheses of the study, 1-way and 2-way ANCOVA were used to compare between the means of the two groups in the mathematical thinking post- test, and attributable to their general self-efficacy, after removing the effect of the pre-test.

Study Results and Discussion

To examine the first hypothesis: "There is no statistically significant difference at (α=0.05) between the mean scores of the experimental group and the control group on the mathematical thinking test", descriptive statistics of the two groups on the mathematical thinking post-test and the estimate values - in relevance to the pre-test results - were computed. They are shown in table 1 seen below:

Table (1): Descriptive Statistics of the Two Groups on the Mathematical Thinking Post-test and the Estimate Values in Relevance to the Pre-test.

Group	N	Pre-test		Post-test		Estimates	
		Mean	Std.	Mean	Std.	Adjuste	Std.
Experimental	38	7.13	2.01	9.05	2.44	9.33	0.14
Control	41	7.59	1.83	8.37	2.43	8.11	0.14

Table 1 revealed that there were apparent differences between the means of the two groups, in the post-test and the estimate values. To examine the significance of these differences, the ANCOVA test was administered. The results are shown in table 2 seen below:

Table (2): ANCOVA Test Results to Compare between the Two Groups on the Mathematical Thinking Post-test in Relevance to the Pre-test.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Eta Squared
Pre	395.777	1	395.777	504.428	0.0001	0.869
Group	28.789	1	28.789	36.692*	0.0001	0.326
Error	59.630	76	0.785			
Total	484.196	78				

* Significant at the significant level α = 0.05

Table 2 revealed that there were statistically significant differences between the means of the two groups, since the F- value was (36.692), and with significant level (0.0001), which was less than the critical value (0.05). Table 2 also revealed that Eta Squared equaled (0.326), which means that about 33% of the variance in the mathematical thinking due to the variance in the teaching using puzzles and games.

Analyzing the results shown in table 1, and comparing the estimated means of the two groups, it was found out that the adjusted mean of the experimental group (9.33) was greater than the adjusted mean of the control group (8.11), and this means that the mathematical thinking of the experimental group was much better than that of the control group. This result refutes the first hypothesis.

This result appeared that using puzzles and games in learning mathematics gives the students an extra power and potential in mathematical thinking, and increases their level of thinking. This seems to be a logical one since the solution of puzzles and games is closely related to the process of thinking, because it is a new position being exposed to an individual for the first time, this position does not have a ready solution at the time of the individual; so it is a real problem needs conducting a high mentality and using multiple styles of thinking to solve the puzzle or the game.

Puzzles and games also make an individual more organized and reflective for his ideas, they can develop skills in decision-making, and they make him feel that he is more efficient self in the face of problems, so this makes the student more effective in mathematical thinking.

We can say that using puzzles and games gives the opportunity for the student to make connections between the mathematical concepts, skills, and generalizations that are required to solve problems. Teachers also can benefit from using puzzles and games in the assessment process, because they can restrict and border students' mistakes during their working on the problem, so they can reform students' conceptual misunderstandings, to improve their level of thinking. This result coincides with the study results of (Wanko, 2010; Lane & Harkness, 2012; Khairiree, 2015) in the positive effect of using puzzles and games in improving the mathematical thinking. The result also coincides partially with the study results of (Hung; Huang & Hwang, 2014) in improving mathematical achievement, which includes mathematical thinking.

To examine the second hypothesis: "There is no statistically significant difference at (α=0.05) between the mean scores of the students on the mathematical thinking test, attributable to the interaction between the group (experimental, control) and Self-Efficacy (high, moderate)", descriptive statistics of the two groups on the mathematical thinking post-test and the estimate values - in relevance to the pre-test results - were computed attributable to the interaction between the group and the general self- efficacy. They are shown in table 3 seen below:

Table (3): Descriptive Statistics of the Two Groups on the Mathematical Thinking Post-test and the Estimate Values in Relevance to the Pre-test attributable to the interaction between the group and the general self-efficacy.

Group	General Self-Efficacy	N	Pre-test		Post-test		Estimates	
			Mean	Std. Dev.	Mean	Std. Dev.	Adjusted Mean	Std. Error
Exp.	High	24	8.33	1.49	10.33	1.97	10.54	0.17
	Moderate	14	5.07	0.92	6.86	1.35	7.10	0.20
Cont.	High	27	8.59	1.19	9.44	2.28	9.27	0.16
	Moderate	14	5.64	1.15	6.29	0.83	6.05	0.18
Total	High	51	8.47	1.33	9.86	2.16	9.92	0.19
	Moderate	28	5.36	1.06	6.57	1.14	6.58	0.22

Table 3 revealed that there were apparent differences between the means of the two groups, in the post-test and the estimate values. To examine the significance of these differences, 2-way ANCOVA test was administered. The results are shown in table 4 seen below:

Table (4): 2-way ANCOVA Test Results to compare between the Two Groups on the Mathematical Thinking Post-test in Relevance to the Pre-test.

Source	Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
Pre	201.267	1	201.267	269.305	0.0001	0.784
Group	28.683	1	28.683	38.379*	0.0001	0.342
Self- Efficacy	4.320	1	4.320	5.781*	0.019	0.072
Group * Self-Efficacy	0.0396	1	0.03951	0.053	0.819	0.001
Error	55.304	74	0.747			
Corrected Total	289.6136	78				

* Significant at the significant level α = 0.05

Table 4 revealed that there were statistically significant differences between the means of the two groups attributable to their general self-efficacy, since the F- value was (5.781) with significant level (0.019). According to the results shown in table 3, and comparing the adjusted means of the two groups of self- efficacy, it was found that the adjusted mean of the high self- efficacy (9.92) was greater than the estimated mean of the moderate self- efficacy (6.58), and this means that the mathematical thinking of students with high self- efficacy was much better than that of students with moderate self- efficacy. Table 4 also revealed that Eta Squared equaled (0.072), which means that about 7% of the variance in the mathematical thinking due to the variance in the teaching using puzzles and games, attributable to students' general self-efficacy.

This result seems to be logical since students - with high self-efficacy – are more motivated and confident in their skills in comparison to students with moderate self- efficacy; they use self-regulatory strategies and achieve better than others, they rely on themselves, and this can help them to rise whenever they possessed the best thinking skills; because these skills can be increased through traffic expertise and active experiments, and mathematical thinking is one of the active experiences. We can say that students with high self-efficacy have a great desire to do their tasks when they opposed to a challenged opportunities, which can be found easily and obviously in the puzzles and games.

Table 4 also revealed that there were no statistically significant differences between the groups attributable to the interaction between group and general self- efficacy, since the F- value was (0.053) with significant level (0.819).

This result may occurred because the using of puzzles and games were effective on all students in the experimental group, either with high or with moderate self-efficacy, and it can increase students' knowledge, which ordinarily reflects on students thinking. The students with high or with moderate self-efficacy in the control group also opposed to similar conditions; so the difference between students with high self-efficacy in the experimental and control group equals to the difference between students with moderate self-efficacy in the two groups, and this result accepts the second hypothesis.

This result coincides partially with the study results of (Al-Masaeed, 2011) about the students' self- efficacy and its relation to students' level of thinking. The result also coincides with the study results of (Hung; Huang & Hwang, 2014) in promoting self-efficacy.

Conclusion

Puzzles and games were good tools that require using higher order thinking skills in solving the problem, by using their extreme abilities to reach the solution, and this is revealed in the current study through improving students' level of mathematical thinking. Also, students with high and moderate self-efficacy, who used puzzles and games in the learning process, appeared a significant improvement of their mathematical thinking.

Recommendations

It is recommended to use puzzles and games in the teaching process to assess students' learning of mathematics. For future work in this area, researchers might conduct other studies to examine the effect of puzzles and games on samples of other communities and other variables such as: achievement, motivation.

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