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The Impact of Metacognition Strategies in Teaching Mathematics among Innovative Thinking Students in Primary School, Rafha, KSA

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Abstract

The study aims at finding out the impact of metacognition strategies in the teaching of mathematics in developing creative thinking among gifted primary school students in Rafha province in the Kingdom of Saudi Arabia. They are defined in this study as the students whose IQ score is (120 and above) according to the Wakslar measurement for children intelligence and are selected by their teachers. The study sample consists of 40 male and female students from the fifth class in the primary stage. They were divided randomly into two groups; experimental group which was taught by the methods and strategies of the suggested teaching program and a control group upon whom the ordinary method was applied. Each group included 20 male and female students. For the purpose of the study, a creative thinking measurement in mathematics, designed by the researchers, was used for data collecting. The program was implemented for three successive weeks, three sessions per week each one lasting for one period. After finishing the program, a post measurement was conducted for all the study variables for both the experimental and control groups. The results show statistically significant differences at the significance level (0.05) between using the metacognition strategies on one hand and the ordinary method on the other. The differences were in favor of the metacognition strategies.

Keywords: metacognition, mathematics, creative thinking, gifted students

1. Introduction

1.1 Statement of the Problem

Interest in gifted and talented students has increased lately at international level in general and at the Arabic level in particular. This interest emerges because this category is considered a national wealth that excels any other national wealth. Thus, it should be utilized to benefit from their abilities in development. This will not be attainable without providing them with the utmost care.

Creative thinking is one of the most important variables which many studies attempt to examine its correlation with a large number of variables. It is also one of the most important outputs on which educational institutions are based.

(Ismail, pp. 78-79, 200) has indicated that the thinking process has special status in mathematics syllabi. Training students on the appropriate thinking methods is a basic objective of teaching mathematics. Due to the nature of mathematics, its content, and its teaching methods it is considered as a rich field for training students on the proper thinking methods.

(Shihab, 2000, p. 2) confirmed that one of the most important objectives of teaching is to teach students how to think by developing their abilities on metacognition in addition to how to manipulate data to make use of them in the various situations of life. This is to give students the ability to select, renew, innovate and make use of thinking skills and processes in the various fields of life. In addition to that it is also important to develop the students' abilities on self-learning and obtaining knowledge from its different sources to face the present challenges and the future potentialities.

(Shahata et al., 2003, pp. 42-43) mentioned that the metacognition strategies are defined as the mental procedures followed by the learner to manage his/her learning process. Metacognition strategies are known as the assisting strategies because they help the learner in carrying out the cognitive processes. They are defined by (Henson & Eller, 1999, p. 258) as a group of measures taken by the learner to realize the activities, mental

processes, learning styles and self-control that are used pre/during and post learning for memorization, understanding, planning and management, solving problems and the other cognitive processes.

The following are some metacognition strategies used in the teaching program of this study:

Planning strategy: (Pollard, 2002, p. 159) set a series for training on the planning skill which starts with raising a question or a group of questions to determine the aim of the learning activity and planning, then taking specific steps to go on the learning process.

Modeling strategy: (Fathi Jarwan, 1999, pp. 393-394) mentioned that learning by modeling is one of the most successful and effective methods of learning when it is associated with illustrations and comments provided by the model. The teacher can use this strategy by taking the initiative or by seizing the opportunity when one of the students raises a problem or a suitable question about the lesson topic.

Self-speech strategy: (thinking in loud voice) (Baumann et al., 1993, p. 185) asserted that thinking in a loud voice is a style where the individual uses his voice in his ideas while reading. The aim of this strategy is to help students to develop the ability of monitoring reading and to understand and use strategies to control and facilitate thinking.

Asking questions strategy: (Ciardiello, 1998, pp. 210-211) indicated that self-asking questions is an essential cognitive strategy because it encourages students to search for the answers that a student wants to know about himself. Through self-asking questions, the learners can evaluate the strategies used, search the main points, support the details and determine the extent of relations between the content and their personal experiences.

Direct teaching strategy: (Fathi Jurwan, 1999, pp. 395-396) mentioned that this strategy requires the teacher to make his presentation according to the following steps: the teacher writes the name of the skill then presents the outlines and examples of the anticipated difficulties.

Students duel interaction strategy: (Tanner & Jones, 2002, p. 153) stated that students in this strategy are allowed to assimilate the thinking process or think by contemplating on others works.

Co-operative learning strategy: (Ashaman & Conway, 1997, pp. 143-144) indicated that this strategy depends on forming small groups inside the class to participate in the learning process. This strategy aims to encourage co-operation and group work which ensures learning to the group and members of the other groups.

Self-assessment strategy: both (Willen & Philips, 1995, p. 136) think that this strategy is based on the idea that metacognitive thinking has two components: the individual awareness of his/her cognitive behavior during the learning task and his ability to plan his learning strategies to overcome any difficulties that might occur by using alternative strategies besides his ability to review and self-control his behavior.

In the light of the modern trends of teaching mathematics (Al-Suwaai, 2005) ascertained that the students are responsible for taking many decisions which were previously regarded as responsibilities of the teacher and the text book. These decisions include for example, selecting the suitable solution method, forming the hypotheses and assumptions and determining to what extent the solution is suitable. The student is also responsible of explaining the method he used for solving the problem to other students, defending it and trying to persuade them with it. The teacher has to select the instructional material and activities that suit his students and challenge their thinking and stimulate them to search for a solution. He also provides the suitable circumstances to ensure involving the students in learning.

The current study will depend on modeling strategy in developing creative thinking of gifted and talented students. Both (Willen & Phillps, 1995) suggested that the lesson goes on according to metacognition strategy, which is known as modeling strategy, as follows:

Preparation: where the objective of the learning process is to be explained, the lesson is to be connected with the previous experiences, the anticipated errors to be identified by the teacher. It also includes definition of the skill, its importance and the thinking process it includes through examples.

Modeling by the teacher: the teacher presents a model for the mental processes included in solving the mathematical problems as well as providing several various and new solutions.

Teacher interaction with student: this step is taken if the teacher feels that there is a difficulty in the modeling and monitoring process.

Modeling by the student: Each student models the skill as the teacher did but in another problem.

Assessment: After the students finish the activity, the teacher selects a student randomly and asks him to answer the activity questions.

(Obeid et al., 2000, p. 38) asserted that mathematics has situations that require its learners to be trained on recognizing the relationship between its elements and planning for it, and acquire the insight and deep understanding that lead them to cope with such situations. (Abu Umeira, 2002, p. 26) indicated that creativity in mathematics is connected with the divergent product and given data in a new form in such way that the product will be unique and unexpected. Measurement of creativity in mathematics depends on the production questions oriented towards the multi-solutions and the various ideas far away from the model answers and the ready-made solutions imposed by open answers questions.

(Mann, 2005) stated that the mathematical gift and creativity in mathematics is often measured by speed and accuracy in performance and the original mathematical tasks that require divergent thinking.

(Al-Mufti, 1995, p. 220) indicated that the teacher, when presenting the final results in mathematic lessons should focus on the new solutions for the mathematical problems and on the students' skills in recognizing the relationships and connecting the causes with the results for developing creative thinking.

Role of Metacognitive Strategies in Developing Creative Thinking

(Pesut, 1990) indicated that creative thinking is known as a metacognitive process based on self-organization. (Maansy, 1995, p. 233) mentioned that the creative person is the one who is capable of realizing the hidden relationships between things and capable of rearranging old elements in a new form.

(Al-Zayat, 2002, p. 193) indicated that the mentally talented, gifted and creative persons always analyze cognition and metacognition and assess the principles upon which they based their decisions, choices and solutions, they ask many questions and reformulate the same question in a different vision.

It is obvious from what previously mentioned that for developing creative thinking, the teacher must confirm metacognition processes and practice its skills and strategies. Teachers should be aware of the meaning of creativity and the techniques of developing it in addition to the necessity of modeling the creative processes by the teacher in front of the students. It is also important to clarify the difficulties facing them in order to arrive to creative solutions.

Programs offered to talented students are complicated because they are oriented to special category of students who are characterized with outstanding mental abilities, close observation, interest in acquiring knowledge and ability of thinking. The great educational interest that must be focused on in designing these programs is the type of thinking. Interest has shifted from educational programs that depend on memorization and instruction to the education that aims mainly at developing thinking skills. Through the researchers' frequent visits to elementary schools at Rafha province and their follow up of the teaching practice students, they observed that teachers of mathematics depend on instruction and delivering lessons while teaching mathematics—this traditional method of teaching mathematics arouses feeling of alienation, dissatisfaction and lack of motivation among mathematics learners. This feeling stems out of the fact that the knowledge acquired by this method does not give the students any importance in their life nor help to solve their problems. The students' relationship with this knowledge ends by the end of the study and bypassing the exam, consequently, this teaching method produces generations who are incapable of making up their minds, and lack the basics of accurate thinking. Therefore; it is necessary to teach students how to think by combining school courses in general and mathematics courses in particular with teaching strategies that help the learner to use knowledge, benefit from it and make it useful. Thus, it is necessary to train students how to think (using metacognition strategies) during the teaching process. As a result of this, the researchers realized the significance of carrying out such study. In the light of what has been mentioned, the problem of this study is determined by the following question:

What is the impact of metacognition strategies of teaching mathematics in developing creative thinking of the gifted and outstanding students at elementary stage at Rafha province in the Kingdom of Saudi Arab?

1.2 Significance of the Problem

The study will be a significant endeavor in:

- Concentrating on a sector of learners who need special care and support, those are the talented and brilliant students.
- Developing a teaching program and investigating its effectiveness in developing creative thinking in mathematics.
- Offering a teaching program that can be regarded as a model to be used by some experts in fields of education and psychology for developing creative thinking of the gifted and outstanding students.

1.3 Previous Studies

The following is a presentation of some of the previous studies related to this study, and selected within the place and time limits of the study, in addition to the available facilities:

Shihab (2000) conducted a study to explore the effectiveness of using metacognitive strategies in acquiring knowledge and developing skill of integrated knowledge processes and creative thinking of the preparatory third class students. The study revealed statistically significant differences among the subjects of the experimental and control groups in all the study tools used in favor of the experimental group students.

In a study carried out by (Koch, 2001) the aim was to identify the effect of using metacognitive strategies in developing reading comprehension of physics texts. The results showed outstanding performance of the experimental group students compared to their counterparts in the control group students in the reading comprehension test.

Husam Adeen's study (2002) aimed to measure the effectiveness of metacognitive strategies in developing reading comprehension and achievement in science courses for the preparatory second class students. The results indicated that the experimental group students surpassed their counterpart, the control group students, in both the reading comprehension test and the achievement test at levels of memorization, comprehension and application.

A study carried out by (Teong, 2003) aimed at identifying the effect of using metacognitive strategies in teaching pronunciational issues for the intermediate school students by using computer. The strategy is based on students' co-operation, whereas they work in pairs to think in a high voice during solving pronunciational problems. The sample consisted of (36) students, the results revealed that metacognitive strategies help in increasing students' awareness and perception in solving the pronunciational problems and increasing their achievement.

A study carried out by (Park, 2004) aimed at identifying the effect of the open activities in mathematics and the high voice thinking strategy on reducing mathematics difficulties. The students' results of achievement tests in mathematics, based on parents and teachers views, showed that students managed to overcome most of the difficulties as a result of thinking in a high voice as one of metacognition strategies.

Suleiman's study (2005) aimed to identify the effect of free teaching activity at mathematics club for talented students at elementary stage on achievement and creative thinking. The free activity used depends on brain storming, writing and problem solving strategies. The results of the study showed effectiveness of the educational activity in increasing achievement and developing innovative thinking for talented students at elementary level.

Khatab's study (2007) aimed at identifying the effect of using metacognition strategy in teaching mathematics on achievement and developing creative thinking for the second stage students at basic education. The results of the study revealed superiority of the students who studied by using metacognition strategy over the ones who studied by the ordinary methods, in achievement and creative thinking in mathematics.

Ozsoya & Ataman study (2009) aimed at finding out the effect of using metacognition strategy on achievement of pronunciational problem solving. The study indicated that students' performance in the metacognition group has improved notably in metacognition skills and pronunciational problem solving.

Bayat & Tarmizi study (2010) assessed the cognitive and metacognitive strategies during Algebra problem solving for university students. The results of the study revealed that the metacognitive strategies have a great effect on the students' mathematical performance in comparison with the cognitive strategy.

Al-Filmbani study (2011) aimed to explore the effectiveness of a training program based on metacognitive skills in developing problem solving skills for low achievement preparatory first class students. The study showed statistically significant differences between the two means of the experimental group scores in the pre/post test of problem solving skills in favor of the post test. There are also statistically significant differences between the two means of the experimental and control groups scores in the post test for the problem solving skills in favor of the experimental group.

Falia (2014) conducted a study that aimed to investigate the extent of effectiveness of using metacognition strategies in developing some patterns of mathematical sense for elementary school students. The sample of the study is composed of two groups: one of them is an experimental of (40) students taught by using metacognition strategies. The other one is a control group of (40) elementary forth class students taught by the traditional method. The results of the study showed the effectiveness of using metacognition strategies in developing some patterns of mathematical sense for the experimental group students.

Abd el Razig (2014) carried out a study to identify metacognition skills and its relationship with innovative

thinking, psychological flow and effectiveness of a training program based on metacognition strategies for developing psychological flow for a sample of secondary school gifted students. The sample of the study consisted of (40) first class secondary students. The sample was divided into two groups: experimental group of (20) students, and a control group of (20) students. The results revealed statistically significant relationship between metacognition skills and innovative thinking.

Fuad (2015) carried out a study that aimed to investigate the effect of metacognition strategies for solving problems in developing mathematical power and self-esteem of proficiency in mathematics for the second stage students of basic education. The sample was divided into two groups: experimental group of (35) students and a control group of (35) students. The results revealed the effectiveness of using metacognition strategies in developing mathematical power and improving self-esteem of proficiency in mathematics for the experimental group students.

General Conclusions of these studies:

Some of the previous researches and studies discussed the measurement of effectiveness of using metacognition strategies in developing innovative thinking for experimental group students such as Shihab (2000), Husam Adeen's (2002), Suleiman's (2005), Khatab's (2007) and Abd el Razig's (2014). Results of these studies revealed effectiveness of using these strategies in improving innovative thinking for the experimental groups students

Other studies also investigated the effectiveness of using metacognition strategies in comprehension and achievement for the experimental groups students such as: (Koch, 2001; Park, 2004), Ozsoya & Ataman study (2009), Bayat & Tarmizi study (2010), Al-Filmbani study (2011), Falia (2014) and Fuad (2015). The results of these studies revealed effectiveness of using these strategies in improving comprehension and achievement among those students.

To the best of the researchers' knowledge, there is no study that illustrates the effect of metacognition strategies of teaching mathematics in developing innovative thinking for gifted and talented students at elementary stage. The current study connects these two variables.

1.4 Hypotheses of the Study

- There are no statistically significant differences at level (0.05) in creative thinking between the experimental and control groups in the post test regarding the whole score of the creative thinking test in mathematics.
- There are no statistically significant differences at level (0.05) in creative thinking between the two means of the experimental group scores in the pre/post-tests of the creative thinking test in mathematics.
- There are no statistically significant differences at level (0.05) in creative thinking between the means of the experimental group scores in the post and the follow up tests of the creative thinking test in mathematics.

2. Method

2.1 Terminologies of the Study

Metacognitive strategies: (Henson & Eller, 1999, p. 238) believe that metacognitive strategies are a group of procedures carried out by the learner to know the activities, mental processes, styles of learning and self-control which are used before, during and after learning for memorization, understanding, planning, management, problem solving and other cognitive processes. The procedural definition of metacognitive strategies is that: "they are procedures used by the learner to observe his performance, review his ideas and deductions before, during and after solving the problem".

Creative thinking in mathematics is defined by (Suleiman, 2005, p. 289) as: "the ability to produce a number of original and abnormal ideas with high flexibility". Researchers define it procedurally as: "ability to produce a number of solutions of the various mathematical problems and produce unusual mathematical relations, and to realize the mathematical problems in the different situations. It is measured by the scores achieved by the students in the creative thinking test".

Gifted and talented students are defined by (Al-subeiai, 1977) as "those learners, male or female who are nominated by their teachers because they enjoy a mental gift, talent and fine achievement performance". The percentage of their intelligence quotient score is 140 and above. Gifted and talented students are identified in this study as those whose intelligence quotient score is (120 and above) by Wakslar measurement for children intelligence.

2.2 Sample of the Study

The sample of the study was composed of (40) students (males and females). The students were nominated by their teachers and Wakslar measurement for children intelligence was applied upon them in order to pick the sample and determine whose intelligence quotient score is (120 and above). The sample was from the fifth elementary class in Rafha town. Subjects of the study were divided into two equal groups: experimental group and a control one, (20) students for each group. The two groups were distributed equally in regard to; age, gender and class. The sample was selected purposively from four schools for the academic year 2015/2017. Table 1 shows the distribution of the subjects of the study

Table 1. Distribution of the subjects of the study

School	The control group			The Experimental group			Total of the control and experimental
	Males	Females	Total	Males	Females	Total	
Ibn Katheer Elementary	_	_	_	10	_	10	10
Muaaz Ibn Jabal	10	_	10	_	_	_	10
Sixth Elementary	_	_	_	_	10	10	10
Third Elementary	_	10	_	_	_	_	10
Total	10	10	10	10	10	20	40

2.3 Tools of the Study

The tools of the study are composed of: Wakslar measurement for determining the research sample, the innovative thinking test in mathematics (functions and equators chapter) (prepared by the researchers) and the teaching program based on metacognition strategies.

- Wakslar measurement for determining children intelligence: the measurement consisted of twelve tests and divided into two parts: an oral part and a practical one. The twelve tests were shortened into ten tests: five oral tests and other five practical ones. This measurement is used to investigate and identify the gifted and talented students from the subjects of the field work after being nominated by their teachers (prepared and Arabicized by Maleeka, Ismaeil, 1999).

- Innovative thinking test in mathematics: for the purpose of the current study, Innovative thinking test in mathematics was used (functions and equators chapter). It was prepared by the researchers for measuring the level of Innovative thinking in mathematics among the elementary fifth class students. The test was the starting point from which the study proceeds at evaluating the level of innovative thinking in mathematics after applying the program. The level of innovative thinking in mathematics was developed using the program based on metacognition strategies. The test was composed of (20) questions to be answered by the students by providing large number of responses and various solutions accesses.

Test validity: The test developer investigated the test validity by providing ten referees from the Department of Special Education and Psychology with the measurement items to evaluate them. The referees were asked to review the extent of the test questions suitability and the extent of wording accuracy. The referees' observations were considered.

Test reliability: the test designer investigated the test reliability through testing and retesting method on (30) students with time interval fifteen days, the co-relation amount was (0.74).

- The teaching program (prepared by the researchers): the following is a description of the procedures and steps followed by the researchers to achieve the main objective of the research; which is preparing a teacher guidebook (in the functions and equators chapter) for the fifth elementary class. To improve the innovative thinking level in mathematics among them through using metacognition strategies.

Steps of program design: the researchers prepared the teacher guide book on metacognition strategies based on the literature reviewed and the relevant studies. The researchers made an initial formulation of the teacher's guide book and presented it to a group of experts and specialists making use of their views and suggestions on the extent of the suggested program suitability to develop innovative thinking in mathematics for the gifted and talented students at the elementary fifth class. A committee of experts and specialists was formed from a number of staff members in the Northern Boarders University.

Program Content: the researchers designed it (in the functions and equators chapter) from the mathematics book

for the fifth elementary class according to the modeling strategy. The unit of functions and equators is formed—by using metacognition strategy—from seven lessons; each one contains a number of examples and activities. The following is table 2, a distribution of the teaching plan for the unit:

Table 2. Distribution of the teaching plan for the unit

Lesson	Topic	No. of periods
First	Formulating adding and subtracting equations by using models and solving them	2
Second	Formulating multiplication equations by using models and solving them	2
Third	Solving a problem by using table construction plan	1
Fourth	Naming points on the coordinate level	1
Fifth	Representing the points on the coordinate level	1
Sixth	Finding the function base	1
Seventh	Choosing the best plan for solving the problem	1
Total		9

2.4 Strategies Used in the Program

- Preparation: where the objective of the learning process is clarified and the lesson is connected with the previous experiences.
- Modeling by the teacher: the teacher provides a model for the mental processes included in solving the mathematical problems and offers several, various and new solutions.
- Teacher participation with student: this step is done if the teacher feels there is a difficulty in the modeling and observing process.
- Modeling by the student: each student models the skill as the teacher did but for another problem.
- Assessment: when the students finish answering the activities in the lesson, the teacher asks a question to assess the student's performance and determine the strengths and weaknesses points.

2.5 Study Application Procedures

When the researchers finished developing the teaching program and preparing the tools of the study in their final forms, the study was applied by following these steps:

- Appointing the elementary schools from which the sample was selected.
- Appointing the gifted and talented students upon their teachers' nomination. The students' IQ score is (120 & above). The students were chosen from the elementary fifth class in Rafha town after applying Wakslar measurement for children intelligence.
- Dividing the students randomly into two groups: (experimental and control).
- Before carrying out the program, a pre-test was conducted on the sample subjects of the two groups, the experimental and the control, by applying the innovative thinking test in mathematics as a tool of the study.
- Teachers of mathematics carried out the teaching program. The number of lessons was nine and the time allotted for each is (45) minutes. There were three lessons a week.
- Immediately after finishing the teaching program, a post test was conducted on the sample subjects of the two groups—the experimental and control—by reapplying the tool (the innovative thinking test in mathematics)
- Carrying out the suitable statistical procedures to investigate the hypotheses of the study.

2.6 Methodology of the Study

Design: this study is an experimental one that includes two variables: an independent variable and a dependent one. The design of the control and experimental groups was used by a pre/post-tests as follows: see table 3.

Table 3.The study design

The group	Pre test	procedure	Post test
Experimental	innovative thinking test in mathematics	Teaching by using metacognition strategies	innovative thinking test in mathematics
Control	innovative thinking test in mathematics	Teaching by using the traditional method	innovative thinking test in mathematics

Study variables: the current study consisted of the following variables:

- Independent variable: the teaching program in which metacognition strategies is used in teaching.
- Dependent variable: innovative thinking in mathematics.

Results were analyzed using equivalent groups method to determine the effect of the independent variable on the dependent variable. The study used a group of statistical methods to analyze the results:

- Correlation, medians, means and standard deviation
- T-test to find out the significance differences between the means

3. Results

3.1 The Results Concerning the First Hypothesis

To investigate the accuracy of the first hypothesis which stated the following; "there are no statistically significant differences at level (0.05) in innovative thinking between the two groups the experimental and the control in the post test on the whole score in favor of innovative thinking in mathematics".

The means, standard deviations and the T value of the significance differences between the independent groups were calculated. Table 4 shows the results which the researchers reached from innovative thinking in mathematics.

Table 4. The means, standards deviations, T value of the significance differences between the two means of students' scores in both groups, the control and experimental, regarding the post test on the innovative thinking in mathematics

Tool	Group	No	Mean	Standard Deviation	Degree of Freedom	T Value	Significance level	Eta square
Innovative thinking test in mathematics	Control	20	10.950	2.645	38	8.987	0.5	0.680
	Experimental	20	18.250	2.489				

It is clear from table 4 that there are statistically significant differences between the two means of the students of the experimental and control groups on the innovative thinking test in mathematics in the post test in favor of the students of the experimental group where T value was significant at level (0.05). This indicates the effectiveness of the suggested teaching program. The percentage of the program effect was 68.007%.

3.2 Results Concerning the Second Hypothesis

To verify the second hypothesis which stated that: "there are no statistically significant differences at level (0.05) in innovative thinking between the two means of the experimental group scores in the pre/post-tests in innovative thinking test in mathematics".

The means, standard deviations and T value of the significance differences between the correlated groups were calculated. Table 5 shows the results arrived at by the researchers on the innovative thinking test in mathematics.

Table 5. The means, standards deviations, and T value of the significant differences between the two means of students' scores in the experimental group in the pre/post tests on the innovative thinking test in mathematics

tool	Test	N	Means	Standard deviation	Degree of freedom	T value	Significance level	Eta square
innovative thinking test in mathematics	pre	20	6.250	4.789	19	13.643	0.05	0.907
	post	20	18.250	2.489				

It is clear from table 5 that there are statistically significant differences between the two means of the experimental group in the pre/post tests on the innovative thinking test in mathematics in favor of the post test whereas the T value is significant at level (0.05). This indicates the effectiveness of the teaching program used. The percentage of the program effect was 90.737%

3.3 Results Concerning the Third Hypothesis

To verify the third hypothesis which stated that: "there are no statistically significant differences between the two means of the experimental group scores in the pre/post tests on innovative thinking test in mathematics".

The means, standards deviations and T value for the significance differences between the correlated groups were calculated. Table 5 shows the results arrived at by the researchers on the achievement test in mathematics.

Table 6. The means, standards deviations and T value of the significance of differences between the two means of students' scores in the experimental group in the post/follow up tests on the innovative thinking test in mathematics

tool	Test	N	mean	Standard deviation	Degree of freedom	T value	Significance level
Innovative thinking test in mathematics.	Post	20	18.250	2.489	19	1.000	0.330
	Follow up	20	18.050	2.438			

It is clear from table 6 that there are no statistically significant differences between the two means of the experimental group students in the post/follow up tests on the innovative thinking test in mathematics, whereas T value is insignificant. This indicates the continuity of effectiveness of the new teaching program.

4. Discussion

The results indicated the effectiveness of using metacognition strategies, which had strong effect in improving the level of innovative thinking in mathematics. It was notable for the subjects of the experimental group compared to the subjects of the control group. The following is a detailed discussion of the results relevant to the hypothesis of the study.

First: Discussion of the results related to the first hypothesis:

Results related to the first hypothesis, which stated the following: there are no statistically significant differences levels (0.05) in innovative thinking between the experimental and control groups in the post test on the full mark of the innovative thinking in mathematics. The experimental group, which was taught by using metacognition strategies, showed the effect of improving innovative thinking skills for them. That has been clear through the significant differences between the experimental and control groups in the post test. The results of this study agree with (Shihab, 2000) study which indicated the effectiveness of using metacognition strategies in achievement of sciences and development of the integrated skills of knowledge processes in addition to the innovative thinking among the female third preparatory class students. There are statistically significant differences among the subjects of the experimental and control groups in all the tools used in the study in favor of the female experimental group students. It also agreed with (Teong, 2003) study ,whose results indicated that metacognition strategies in teaching pronunciation through pair work and thinking in high voice during solving the pronunciational problems, helped to improve the students' awareness and realization in solving pronunciation problems and increased their achievement. It also agreed with Suleiman study (2005) whose results indicated effectiveness in increasing achievement and developing innovative thinking for talented students at elementary stage. Suleiman study (2005) was applied in teaching the free activities in the mathematical club which is based on mind-blowing, writing and problem solving strategies. It also agrees with Khatab's study (2007) whose results showed superiority of the students who studied by using metacognition strategy in achievement and creative thinking in mathematics over the students who were taught by ordinary methods. Finally, the results of this study agree with the results of Abdel Razig's study (2014) whose results indicated that there are statistically significant differences between the metacognition skills and innovative thinking.

Secondly: discussion of the results concerning the second hypothesis:

Results related to the second hypothesis which stated the following "there are no statistically significant differences at level (0.05) in innovative thinking between the two means scores of the experimental group in the pre/post tests on the innovative thinking test in mathematics". There are statistically significant differences between the two mean scores of the experimental group students in the pre/post tests on the innovative thinking

test in mathematics in favor of the post-test whereas T value was significant at level (0.05). This indicates the effectiveness of the teaching program. This generally agrees with many previous studies which indicated the effectiveness of using metacognition strategies in improving innovative thinking for ordinary and talented students. Results of this study agreed with (Shihab, 2000) study, (Husam Adeen, 2002) study, (Teong, 2003) study, (Suleiman, 2005) study, (Khatab, 2007) study and (Abdel Razig, 2014) study. The results of these studies indicated the effectiveness of using metacognition strategies which helped to increase students' awareness and realization in solving pronunciational problems and increased their achievement. The metacognition strategies also developed the integrated skills of knowledge processes and innovative thinking. The previous studies showed superiority of the students who are taught using metacognition strategy over the students who are taught by ordinary methods in achievement and creative thinking in mathematics. The results also indicated that there is statistically significant relationship between metacognition skills and innovative thinking. Metacognition strategies are used to satisfy the students' needs and improve their innovative thinking skills.

Thirdly: discussion of results concerning the third hypothesis:

Results related to the third hypothesis which stated that "there are no statistically significant differences between the two mean scores of the experimental group in the post/follow up tests on the innovative thinking test in mathematics". Alack of statistically significant differences between the two means scores of the experimental group students in the post/follow up tests on the innovative thinking test in mathematics was also indicated. The T values were insignificant which indicates the continuous effectiveness of the new teaching program.

5. Recommendations

Considering the results of this study, the researchers recommend the following:

- The necessity of using metacognition strategies in developing innovative thinking in mathematics as one of the effective methods of learning that leads to success in achieving many of the desired objectives particularly with gifted and talented students.
- Training the gifted and talented students and teachers on this strategy.
- Confirming mathematics syllabus designers' interest in writing text books according to the basics of metacognition strategies through activities designed mainly for this purpose and particularly for gifted and talented students.

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