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# THE EFFECT OF THE ADEY & SHAYER MODEL ON THE ACHIEVEMENT AND REFLECTIVE THINKING OF HIGH SCHOOL - FOURTH-GRADE STUDENTS IN MATHEMATICS

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**Abstract:**

The aim of the current research is to identify (the effect of the Adey & Shayer model on the achievement and contemplative thinking among fourth-grade students in mathematics). The research sample consisted of (62) fourth-grade students, distributed equally to two experimental and control groups of (31) students in each group. A test achievement was prepared consisting of (40) objective items of the (multiple choice) type with four alternatives. A test of contemplative thinking consisted of (30) items. The fact and reliability of both tests were verified. After the experiment was completed, the two tests were conducted to the students of the two research groups. The results showed that the experimental group students who studied with the Adey & Shayer model outperformed the control group students who studied the traditional way in the two tests.

**Keywords:** Adey & Shayer model, achievement, reflective thinking, mathematics.

**Research problem:**

The low achievement of students and their level of thinking in mathematics is one of the educational problems that occupy all people in the educational field, and that its teaching still faces several problems, including: What is related to its curricula and methods of teaching, and the nature of the material and the formulas of its organization and breadth (Al-Kubaisi and Al-Shammari, 2018, p. 21). The researcher noted through his experience in teaching mathematics that there is a noticeable decrease in the achievement of fourth-grade students in mathematics, which may be due to the lack of

students' ability to fundamentals of mathematics and its concepts, especially as it is a cumulative topic in which new ideas depend on concepts and generalizations that they have already learned and understood. The student needs to conduct thinking processes and develop discovery, problem solving and the ability to deal logically with what is around him. The subject of mathematics relies on understanding and application more than memorizing and remembering. As such, the researcher asked the students a question: What is the result (4 x 2 + 3) to (60) students from the fourthgrade. There were 20 wrong answerswith a percentage of (80%) while the correct answer were (14) with a percentage of ( 20%). The answer to the question is mainly through the level of recall, because it depends on the student remembering that the multiplication process precedes the addition process. Then, the researcher discussed the reasons for the low achievement with a group of teachers of mathematics and the teachers in training courses (for mathematics teachers) held by the Preparation and Training Department at the General Directorate of education in Anbar.The researcher asked three questions to (20) teachers who have experiencewith not less than (5) years in teaching. The questions are?

1. What teaching method do you use in teaching mathematics?

95% of the answers said that they use the traditional method based on providing information by the teacher in the form of ready-made examples (as in the textbook) which depends on dictation, memorization and conning, and the lack of giving any role to the student to participate in the teaching process.

2. Are you interested in developing reflective thinking skills by teaching mathematics?

Most of the answers were twists and turns, and that the development of thinking needs a long time, .The content of mathematics is usually large and requires a long time to complete, and the level of some students is weak in mastering the four arithmetic operations, so how can we develop reflective thinking.

3. What are reflective thinking skills as per your knowledge?

The researcher presented this question to ensure the respondents answer the second question. It was (95%) as if they did not have knowledge about reflective thinking skills, so how will they help students develop reflective thinking?

From the above, the current research problem emerges in the presence of a decline in the fourth-grade students ’academic achievement and reflective thinking in mathematics. Therefore, the urgent need arose to find modern models based on constructive theory in teaching this subject. This led the researcher to choose the Adey & Shayer model and experiment in teaching

mathematics to the fourth scientific students and know its effect on their achievement and reflective thinking. Hence, the research problem is determined from answering the following question:

**What is the Effect of the Adey & Shayer Model on the Achievement and Contemplative Thinking of the Fourth-grade Students in Mathematics?**

**The Importance of the Research:**

Mathematics is one of the most important curricula in education, and an influencing factor in progress and development for advanced countries such as Britain, the United States, Russia and Japan. So, creativity in mathematics is an indication for technical progress availability, even described as the ship of the developed countries. (Al-Zuhairi, 2018 a, p. 25).

Mathematics contributes to the development of thinking, because of its nature, which is related to induction, deduction, innovation, etc. It is famous of accuracy, logic, objectivity and brevity in expression, and therefore it is a fertile field for acquiring different types of thinking and developing them. There is no mathematics without thinking or thinking without problems, so mathematic goals are included in most countries that emphasize interest in giving students different thinking styles. (Zahran, 2018, p. 164).

Reflection thinking is one of the types of thinking and a basic requirement in the student's life, because many situations require a solution to the problems of our daily life. It is the most complicated form of human behavior, and the importance of teaching students this type of thinking helps them to make sound decisions about the situations and events that confront them. (Al-Zuhairi, 2017, P. 492).

There has been an increasing interest in employing modern teaching models based on structural theory to teach mathematics to keep pace with scientific development and to develop students' ability to think, make decisions and reach the desired goals. Especially, the teaching of mathematics which is proportional to the structural theory. It has a cumulative structure that starts from the simple to the complex, and from a group of postulates that derives the results and theories by taking steps of reasoning governed by the laws of logic (Al-Kubaisi and Hassoun, 2014, p. 17).

The Adey & Shayer model is a teaching model that was designed based on constructive theory ideas that combines different modern teaching methods such as: problem solving, investigation, discovery, and practical presentations. It makes the student the focus of the educational process, and helps modify their behavior to move towards practicing general thinking skills, reflection and thinking in particular. This model depends on two processes: the organization that the individual exercises in facing the situations facing him

and gaining his experiences from them. The process of perception in which what the individual is facing is subjected to his sensory abilities at different levels (Tamimi and Al-Khyani, 2019, p. 44).

The aforementioned importance of this research is based on keeping pace with modern educational trends in employing teaching models emerging from learning theories, especially constructive theory and also benefit from them in the teaching of mathematics. The researcher wanted to know the effect of the (Adey & Shayer) model on achievement and reflective thinking for students of the fourth scientific grade in Mathematics subject This research (according to the researcher's knowledge) can be considered the first in the Iraqi environment in dealing with this model with the dependent variables. The importance of the research also lies in its handling of the preparatory stage (fourth scientific students) who represent the middle of the preparatory stage, and a real and qualitative transition from middle school to university level.

**The Aim of the Research:**

The current research aims to identify (the impact of the Adey & Shayer model on achievement and reflective thinking among fourth-grade students in mathematics).

**Research hypotheses**: In order to achieve the two research aims, the following two hypotheses were formulated:

1. There was no statistically significant difference at the significance level ($0.05 \geq \alpha$) in the achievement test between the mean scores of the experimental group students who studied the Adey & Shayer model and the mean scores of the control group students who studied in the usual way.

2. There was no statistically significant difference at the significance level ($0.05 \geq \alpha$)in the reflective thinking test between the mean scores of the experimental group students who studied the Adey & Shayer model and the mean scores of the control group students who studied in the traditional way.

**The Scope of the research**: The current search is limited to:

1. Subjects: Fourth - Grade Science field Students.

2. Time limits: the first course of the academic year 2018-2019.

3. Spatial boundaries: Ramadi, the center of Anbar Province, Iraq.

4. The objective limits: chapters from mathematics textbook of the fourth scientific grade, namely: the second chapter (equations and variations), the third chapter (foundations and roots), and the fourth chapter (trigonometry).

**Defining terms:**

1. Effect: Define:

* (American Dictionary (2010): “It is the power or ability to achieve results or impressions produced on the subject's mind according to the design or method used. It is the thing that results between a specific impression or supports the tried and tested design.”) (American Dictionary, 2010, p10).

Procedural definition: The result that is expected to change the level of academic achievement of fourth-graders (the experimental group) after teaching mathematics in the form (Adey & Shayer), and can be measured by the ETA square equation ($^{2}\eta$).

2. Adey & Shayer Model :

* according to the King’s College London (2004): "It is an educational strategy aimed at developing students' thinking abilities by working in small and open groups and open class discussions."

Procedural definition: A model based on the constructivist ideas of Piaget and social theory of Vygotsky and is based on a set of organized, planned, and sequential steps. The teacher applied the model in teaching fourth-grade students (experimental group) mathematics by preparing them sensitively for the subject of the lesson and placing them in front of a mathematical problem. Then, they are directed to think about thinking, organize their thoughts, and even bridge and build relationships and intellectual and objective links between the subject of the lesson and the rest of the other sciences and daily applications.

**3. Achievement:**

* according to Al-Zuhairi (2018b), it is : “The extent to which students understand what they have learned from different experiences through the academic subject. It is measured by the degree to which the student gets in the achievement or oral tests.” (Al-Zuhairi, 2018 b: 477).

Procedural definition: It is the result of what the fourth-grade students learned about mathematics subjects that they studied in a specific period. It is measured to the degree that the student gets by answering the achievement test items prepared by the researcher.

**4. Reflective Thinking:**

* according to Al-Otoum, Al-Jarrah and Bishara (2019), “It is the thinking in which the individual contemplates the situation in front of him, analyzes it to its elements, and draws the necessary plans to understand it. It is the aim of

reaching the results required by the situation, and evaluating the results in light of the plans established." (Al-Otoum, Al-Jarrah and Bishara, 2019, P. 30).

Procedural definition: A mental activity practiced by a fourth-grade student during the teaching of mathematics, by practicing the skills of "meditation and observation, revealing fallacies, reaching conclusions, giving convincing interpretations, and developing proposed solutions". It is measured by the total score obtained by the student through reflection thinking test prepared by the researcher.

**Theoretical framework:**

1. Adey & Shayer Model:

The origins of this model are from the work done in the seventies of the last century at Chelsea College, which showed that many concepts require more requirements than the current capabilities of students.In the early 1980s, a team of researchers, Philip Adey and Michael Shayer, derived a series of principles that formed the backbone of this model (Adey, 1999, p5).

This model is based on Piaget's cognitive constructivist theory and social constructivist theory For (Vygotsky). Piaget's theory is based on the fact that learning is an active, continuous and purposeful constructive process, and that the learning process involves rebuilding the student's knowledge through a process of social negotiation with others, and provides the student with the best conditions when facing a real problem or task (Al Mayahi, 2018). , P. 1008). While (Vygotsky) theory, focused on full cognitive development that requires social interaction, as it focused on the cultural and social aspects of learning. It was called the term collaborative constructivism, because of the intertwined bonds between the individual and its culture. It emphasized that the cognitive development of the individual depends on the people surrounding it.Therefore, the individual's information, ideas, directions, and certainty grow through his interaction with others. Language and culture have an important role in the individual's cognitive development, and that the teacher and students must take unconventional roles. The teacher must cooperate with his students, and teach his students that they know each other in order to be able to create new meanings in their own ways. Thus, education becomes a mutual experience for each of them (Al-Tamimi & Al-Khanyiki, 2019, pp. 48-49).

The social interaction includes the processes of mutual influence and influence between two individuals, so that each affects the other, and is affected by it. Thus, the response of one to the other becomes exciting, and the exchange between the stimulator and the response continues until the existing interaction between them also ends. It is the process in which people

influence each other through a mutual exchange. For ideas and actions; accordingly, learning in a social context is one of the positive methods in increasing students 'motivation and their ability to make decisions, and developing their self-concept through the correlation of content with their experiences. It allows the learner to learn from others who excel in their level, and work to balance between his views and the opinions of the group around him, which drives the learner towards conscious thinking, which in turn leads to the excitement of his information. Hence, work on interpretation and access to problem solving around it. (Al-Najdi, Rashid, and Abdel-Hadi, 2005, p. 376).

**Adey & Shayer's teaching steps:**

Adey & Shayer (1990) presented procedural teaching steps consisting of:

**First:**

Sensory preparation: This step includes the following procedures, in addition to the teacher's role in:

1. Distributing students into several groups to be more helpful.

2. Asking a question or problem for students regarding the subject of the lesson.

3. Giving students the opportunity to express the relationships they have used or used or the procedures they have implemented.

4. Helping students link the experiences and information they gained in the lesson with the experiences of daily life.

5. The role of the teacher is that of a facilitator of the learning process, more than just a source of information.

**Second: Knowledge Conflict:**

This step includes the following:

1. The teacher presents a strange or confusing attitude to the students' hearing, which violates their expectations.

2. The result of this perplexing situation will create a state of imbalance that calls on the learners to reconsider their knowledge structure and their way of thinking, in order to adapt to the situation.

3. Growth can occur in thinking skills, and new learning occurs from the observation of cognitive progression and the transition from a lower ability to a higher ability

4. Sudden observation creates a state of exclamation and surprise that leads students to implement the activity enthusiastically and motivated to solve the problem of cognitive conflict.

5. The teacher provides difficult and confusing activities for students to reach the state of stability and balance.

Third: Thinking about Thinking: This step aims to:

1. Student be aware of his thinking in order to be able to control his new work and development.

2. That students think about the reasons for thinking about the problem through the questions they are asked, how did you do that, and why did you do it, and why did you think about that?

3. Students recognize the type of thinking and its steps they used to solve the problem, because they can self-organize their thoughts and thinking steps, which leads to faster cognitive development.

**Fourth: Bridging**:

This step aims to:

1. Linking the experiences students gained from the activity they did with their previous experiences in working life, and with other study materials.

2. Building knowledge bridges between activities and working life is necessary to launch educational experiences from theoretical framework to the practical framework and life applications.

3. Create relationships and links between new experiences and other study materials, and this helps build and build an integrated picture of knowledge. (Al-Jundi, Rashid, and Abdel-Hadi, 2005).

**2. Reflective Thinking:**

Thinking is an internal activity, and the nature of these activities differs in terms of its quality and nature. Some of which are simple, direct, and complex, so individuals differ among themselves by methods of thinking and their cognitive patterns. There is a multiplicity of thinking activity to include many types such as: reflective thinking. (Nazzal, 2018, P. 18).

Reflection focuses on how the individual uses problem-solving skills in real situations, especially those problems that do not have a clear solution. It is one of the important topics that affects the life of the individual, as being a student, he uses them in matters that represent problems for him, or in Society. It is what it faces in life and requires its solution, and this is what represents the function of reflective thinking. (Al-Mawla, 2009, p. 208).

The individual uses reflective thinking when facing a situation or problem that needs to find an appropriate solution. This type of thinking is from the higher mental processes that John Dewey touched on in his book How We Think Since 1910 AD. He emphasized that the teaching models that are provided to the students will help them develop their own methods and reflection when looking at the world and being able to face any hypothetical situation or solve any problem facing them (Swaidan and Al-Zuhairi, 2018, p. 334).

**Reflective thinking skills:**

Reflective thinking includes five basic skills:

1. Reflection and observation: the ability to display aspects of the problem and identify its components, whether through the problem or to give a drawing or shape between its components so that existing relationships can be visually discovered.

2. Disclosure of fallacies: The ability to identify gaps in the problem by identifying incorrect or illogical relationships or non-common features and differences.

3. Reaching conclusions: The ability to reach a specific logical relationship by seeing the content of the problem and arriving at specific results, by looking at all the similarities presented in the educational situation.

4.Giving convincing explanations: The ability to give a logical meaning to the results or the linking relationships, and this meaning may be based on previous information or on the nature and characteristics of the problem.

5. Developing proposed solutions: The ability to develop logical steps to solve the problem at hand, and these steps are based on expected mental scenarios of the proposed problem. (Al-Afoun and Abdel-Sahib, 2012, p. 217).

**Second: Previous studies:**

1. Study (Al-Mayahi, 2018): It aimed to identify (the effectiveness of the model of stimulating mental thinking of (Adey & Shayer) in achievement and cognitive preference among students of the Department of Physics). The study sample consisted of (60) female students and distributed equally in two groups: experimental and controlling in each of them (30) female students. The researcher prepared an achievement test consisting of (30) items, and a cognitive preference test consisting of (30) items, and used statistical methods (T-test For two independent samples, Pearson correlation coefficient, Kay square). The results showed that the experimental group students

outperformed the control group students in the achievement test and the test of cognitive preference patterns (Al Mayahi, 2018, pp. 1000-1042).

2. A study by (Abdullah and Al-Azzawi, 2019): it aimed at identifying (the effectiveness of the Adi and Shire model in developing formal thinking for students of the fourth grade in science in physics); The study sample consisted of (148) male and female students who were divided into four groups: (38) students represented the experimental group (male), (30) students represented the control group (male), and (40) students represented the experimental group (female), and (40) A student represented the control group (female). The researchers prepared a test for formal thinking consisting of (18) items, verifying the validity and reliability of the test, and using the statistical method (binary variance analysis). The results showed that there is a statistically significant difference between the two average developments Formal thinking at the method variant in favor of the Adi and Shayer model for both sexes. While there are no statistically significant differences attributed to sex and interaction. (Abdullah and Al-Azzawi, 2019, pp. 852-882).
3. (Abdul Majeed, 2014) study: it aimed at identifying (the impact of using the Web Quest strategy in teaching trigonometry on developing reflective thinking skills and rapid learning among first-year high school students). The study sample consisted of (84) students, that is (41) students of the experimental group, and (43) students represented the control group. He prepared a test for reflective thinking consisting of (16) items distributed on (5) skills. The results showed that the students of the experimental group excelled students of the control group have reflective thinking skills (Abdul Majeed, 2014, pp. 47-88).
4. A study by (Al-Saray and Abbas, 2018): it aimed at identifying (the effect of teaching mathematics using the strategy of facial imagination in reflective thinking skills among second-year middle school students). The sample of the study consisted of (77) students, by (37) students representing the experimental group, and (40) students representing the control group. The two researchers prepared a test for reflective thinking, consisting of (20) items distributed among (4) skills. The results showed that the superiority of students in the experimental group on the students on the control group in the reflective thinking skills test. (The Serail and Abbas, 2018, pp. 1201-1232).

**Research methodology:**

The researcher followed the experimental research method based on fixing all the variables that affect the research problem with the exception of one specific variable whose effect is being studied in these new conditions. The researcher interferes with the studied phenomenon and influences and controls the variables in order to measure its precise impact on the problem and methodical experimental approach in which the features of the scientific

method are properly represented (Muhammad, Al-Amin, and Idris, 2017, p. 82).

**Experimental design:**

The researcher adopted the experimental design with partial control of two equal groups, as it is more suitable for the research conditions, and Figure (1) shows that:

| The group | Equivalence of the two groups | Independent Variable | Dependent Variable |
|---|---|---|---|
| Experiential | * The lifetime is calculated in months<br>* Intelligence test<br>* Test previous information in mathematics | Adey & Shayer Model | * Academic achievement<br>* Reflective Thinking |
| Control | | The traditional way of teaching | |

**Figure 1 experimental design of the research**

**Research Community and Participants:**

The research community is determined by all fourth-grade students, high schools for boys for morning studies in Ramadi - Anbar Governorate for the academic year (2018-2019). Then, the researcher randomly chose a typical high school for boys to conduct his research. It contains two divisions for the fourth academic grade; Division (b) was randomly chosen to represent the experimental group that taught in the Adey & Shayer model with the number of 34 students, and the division (a) to represent the control group that taught in the traditional way, with the number of 32 students and excluded the students who failed (statistically only) 4 students. The final total for the students of the research sample (62) has become, and Table (1) illustrates this:

**Table (1) Number of students of the two research groups, before and after the study**

| Group | Section | Total number of students | Failed students | No of students in the study |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Experiential** | **B** | **34** | **3** | **31** |
| **Control** | **A** | **32** | **1** | **31** |
| **Total** | | **66** | **4** | **62** |

**Equivalence of the two research groups:**

The researcher equalize statistically between the students of the two research groups in variables: (life time calculated in months, intelligence test, and a test background level in mathematics), and table (2) shows that:

**Table (2) Results of the T-test for two independent samples of the three variables for students of the two research groups**

| **Group** | **Experiential group (31)** | | **The control group (31)** | | **Degree of freedom** | **T-Value** | | **Significance level 0.05** |
|---|---|---|---|---|---|---|---|---|
| **Variables** | Mean | Standard deviation | Mean | Standard deviation | | Calculated | P. value | |
| **lifetime calculated in months** | **185.41** | **9.8** | **184.36** | **10.2** | **60** | **0.413** | **2000** | Not significant |
| ***Intelligence test** | **39.25** | **4.74** | **38.70** | **6.15** | | **0.394** | | Not significant |
| **Pre-Test of mathematics level** | **6.19** | **2.3** | **5.82** | **2.8** | | **0.476** | | Not significant |

Scientific Subject Determination: The scientific subject is defined in Chapter Two (Equations and Variants), Chapter Three (Fundamentals and Roots), and Chapter Four (Calculating Triangles) from Mathematics textbook for the Fourth Scientific Grade in the high school.

**Formulating behavioral goals**: The researcher formulated the behavioral goals according to Bloom's classification of cognitive goals at its six levels and presented it with the content of the scientific material to a group of specialists to show their views on the soundness of its formulation and its suitability to cognitive levels, where they all agreed on them.

**Preparing teaching plans:** The researcher prepared teaching plans to teach mathematics classes to be taught in the first academic course for fourth-grade students according to the Adey & Shayer model for experimental group students, and traditionally to the students of the control group the researcher presented it to a group of specialists made slight adjustments according to what they suggested.

**1. Preparing the achievement test**: The researcher prepared a table of specifications in which the subjects of the three chapters from the book of mathematics were represented. The levels of behavioral goals within the cognitive domain of Bloom's classification. The number of the test items in its initial form reached (40) objective test items of a multiple choice type with four alternatives. One correct alternative, then verify its apparent sincerity after presenting it to a group of specialists, specialized in the methods of teaching mathematics. To make sure of the clarity of the items and the time taken to answer it, the researcher applied the test to a preliminary exploratory sample consisting of (25) students in the fourth academic grade. It was found that the items are clear and the average time specified for the answer was (40) minutes. To analyze the items statistically, he applied it for the second time to another exploratory sample consisting of (140) students. Their answers were corrected in descending. Then, the upper and lower extreme samples were selected (27%) as two separate groups to represent the whole sample. The researcher took higher answer sheets ((27% and lower) ((27%, so their number became (38) students in the higher group, and (38) students in the lower group.After that according to the level of difficulty, it ranged between (0.30-0.63)). While the discrimination factor ranged between (0.42-0.69), and the effectiveness alternatives, where all wrong alternatives with negative values. That is, theymistaken a number of students with weak levels, which indicates their effectiveness.

Reliability of the test: It was calculated using the Koder-Richardson method K-R20 because the test items are objective of a multiple choice type, that is, the student's answer to the specific item is either correct or wrong (Melhem 2020, p. 311). The reliability of the test extracted by this method reached (0.82), which is a good reliability coefficient. Thus, the test became finalized from (40) items, and a score of (1) was given for the correct answer and (0) for the wrong answer.

2. The Reflective Thinking Test: After the researcher examined the literature and previous studies on reflective thinking, he prepared a test of (30) objective items of a multiple choice type distributed on five skills, namely, (observation and meditation, the detection of fallacies, reaching conclusions, and giving convincing explanations, To develop suggested solutions), with (6) items for each skill. It was presented to a group of specialists in the methods of teaching

mathematics, and they agreed (90%) and more on all of its items, with minor modifications to some of its items. Then, the researcher applied it to a sample of (25) students, and it became clear that the test items and instructions were clear, and that the time taken to answer it was (35-40) minutes, with an average of (35) minutes. Then, applied it to the statistical analysis sample (the same as the achievement test sample), as the researcher took higher answer sheets ((27% and lower ((27%), so their number became (38) students in the higher group, and (38) students in the lower group. Then according to the difficulty level it ranged between (0.41-0.66). While the coefficient of discrimination ranged between (0.44-0.70). As for the effectiveness of the alternatives, all the values of the wrong alternatives appeared negative, meaning that they mistake a number of students with weak levels, which indicates their effectiveness.

The researcher also verified the validity of the internal consistency of the test items by finding a correlation for each item with the total score of the test using the Pearson correlation coefficient. It ranged between (0.39-0.62) and it appeared that all calculated correlation coefficients are statistically significant when compared to the tabular value of the correlation coefficient (0.195) at significance level (0.05) and with a degree of freedom (138).

Thus, the test consisted of (30) objective items divided into five skills (meditation and observation, detection of fallacies, reaching conclusions, giving convincing interpretations, and developing proposed solutions), with (6) items for each skill, and (1) degree was given for each correct answer, and (0) for the item with the wrong answer, or it is left or that contains more than one answer.

The researcher relied on analyzing the results of his research on the statistical bag of social sciences (SPSS).

**Presenting and Discussing the Results:**

To verify the first zero hypothesis which states that: There is no statistically significant difference at the significance level (0,05) between the average score of the experimental group students who studied the Adey & Shayer model and the mean score of the control group students who studied traditionally in the achievement test. The researcher applied the test to the students of the two research groups, then calculating the arithmetic mean and the standard deviation of their grades on the test:

**Table (3) the calculated T value in the post achievement test for the two research groups**

| Group | No. of students | Mean | Standard deviation | Degree of freedom | T value | | Significance level 0.05 |
|---|---|---|---|---|---|---|---|
| | | | | | Calculated | P. value | |
| Experiential | **31** | **31.25** | **6.51** | **60** | **4.277** | **2.000** | Significant |
| Control | **31** | **23.72** | **7.33** | | | | |

It is clear from the table that there is a statistically significant difference between the average scores of students of both groups on the achievement test for the benefit of the experimental group students. Therefore, the first zero hypothesis is rejected and the alternative hypothesis is accepted. This finding was consistent with (Al-Mayahi, 2018) study regarding the effect of the Adey & Shayer model on achievement. The researcher attributes this result to the teaching of mathematics according to the Adey & Shayer model that helped introduce mathematical topics in a sequential and step-by-step manner and its association with application in daily life within the bridging step, which made the student more accommodating and difficult to forget. Besides, the transfer of students from the usual pattern in which the student is often a recipient of information with active participation with colleagues and teacher.During answering each step of this model, it is easy for students to link their previous information with the current information, which led to expanding their experience and generating new information more deeply. Moreover, it strengthened their academic achievement, and allowed students to work on the opportunity to think again about what they think about themselves. Thus, it led to an increase in their knowledge of accurate mathematics and the consolidated their understanding by applying it more accurately. It also helped to make the student able to familiarize himself with the components of mathematical content and reach it through the exposure to cognitive conflict, which leads to the imbalance of his information with his knowledge stock.

To calculate the effect size of the independent variable, the Adey & Shayer model on the dependent variable "achievement", the researcher applied the following Ita $^2\eta$ square equation for the T-test:

$$^2\eta = \frac{t^2}{t^2 + df}$$

T is : The calculated t-test value

df: degree of freedom

The value has reached (0.234), and it has a large impact size according to the criterion (Afaneh, 2000) of the effect size, and Table (4) shows that:

**Table (4): The effect size and its magnitude according to the value of ETA square**

| **Statistical medium type** | **The value of the effects** | | |
|---|---|---|---|
| **ETA square $\eta^2$** | **0.06 – 0.01** | **0.06- 0.14** | **0.14** |
| | **Zero** | **Medium** | **Big** |

**2. The Results related to the Reflective thinking variable:**

Results related to the second zero hypothesis which states that: There is no statistically significant difference at the level of significance (0.05) between the average scores of students of the experimental group that were studied in the Adey & Shayer model and the average scores of students of the control group that studied traditionally in the reflective thinking test. The researcher applied the test to the students of the two research groups, then calculated the arithmetic mean and the standard deviation of their scores on the test. The T-test for two independent samples was usedto verify the significance of the difference between their mean scores. Table (5) shows that:

**Table (5) the calculated T value in Reflective thinking post-test for the two research groups**

| Group | No. of students | Mean | Standard deviation | Degree of freedom | T value | | Significance level 0.05 |
|---|---|---|---|---|---|---|---|
| | | | | | Calculated | P. value | |
| Experiential | **31** | **28.68** | **5.81** | **60** | **3.139** | **2.000** | **Significance** |
| Control | **31** | **23.84** | **6.32** | | | | |

It is clear from the table that there is a statistically significant difference between the average scores of students of both groups on the achievement test for the benefit of the experimental group students. Therefore, the second zero hypothesis is rejected and the alternative hypothesis is accepted. The researcher attributes this result to the teaching of mathematics according to the Adey & Shayer model. It helped to prepare mathematics for students to study through sequential mental processes according to their educational abilities and preparations. Moreover, it gave them many opportunities to think with various types of thinking, including reflective thinking. Also, the questions raised by the teacher and the solutions posed by the student motivate other students to think about more than one solution and develop them with reflective thinking skills. The model also helped to accelerate the cognitive and mental development of students who studied through the activities and tasks contained in the mathematical content to solve the intellectual and cognitive contradiction in order to reach the highest level of thinking and then to the stage of cognitive equilibrium and then self-reliance in \ learning in reaching illogical solution. Also, it requires a new vision of the problem presented by the educational task, which has led to the practice of reflective thinking skills. It also helped to organize the mathematical knowledge that a student obtains by helping the teacher connect the previous information with the new information, then presenting a position or problem to them. Moreover, thinking about the problem and awareness of what they are thinking about, and finally linking what they reached with their previous experiences in practical life or other subjects. Consequently,this led to the practice of reflective thinking skills and their superiority over the students of the control group.+

To find out the amount of the effect size of the Adey & Shayer model on reflective thinking, the researcher applied the equation of "ETA square ،", and it reached (0,141), which is of large size according to the criterion (Afaneh, 2000) of the effect size shown in Table (5).

**Conclusions:**

In light of the results of the current research, we can come to the following conclusions:

1. Teaching mathematics with the Adey & Shayer model had a greater impact on the achievement of students of the experimental group than on the achievement of students of the control group that studied with the same topic traditionally.

2. The experimental group students were more interactive in the classroom learning environment because the Adey & Shayer model involved in

introducing tasks, activities and provoking cognitive contradiction in their thinking, and then in harmony to return to equilibrium again.

3. Students of the experimental group are in harmony with the Adey & Shayer model in the classroom to ensure the bridging stage by linking what the student learns to the environment and performing their duties with more pleasure.

4. Teaching with the Adey & Shayer model helped revitalize historical information, generate excitement, suspense for the lesson, positive collaboration, and reduce student fatigue.

5. The magnitude of the effect of the Adey & Shayer model on the "achievement and reflective" variables is significant.

**Fourth: Recommendations:**

In light of the above results, the researcher recommends the following matters:

1. Adey & Shayer's model of mathematics teaching is adopted for its effect on achievement and reflective thinking.

2. Training teachers of mathematics and teachers on how to employ the Adey & Shayer model in their teaching of the subject through the annual training programs for male and female teachers conducted by the Department of Training in the General Directorates of Education in all governorates.

3. Qualification of students of the Department of Mathematics in stages (third and fourth) on how to teach with the Adey & Shayer model, by including it within the curriculum of mathematics teaching methods.

4. The necessity of organizing workshops for mathematics supervisors and teachers under the supervision of qualified trainers from university teaching, and training them to employ the Adey & Shayer model.

5. Develop students' ability to reflect through thinking about teaching mathematics.

**Fifth: Suggestions for further research:**

In light of the above and to complete the current research, the researcher suggests the following:

1. Conduct studies using the Adey & Shayer model in other subjects or stages.

2. Conducting a similar study to compare the Adey & Shayer model with other teaching models in the same variables.

3. Conducting a study similar to the current study in other dependent variables other than achievement and contemplative thinking.

4. Conducting a study of the impact of the Adey & Shayer model on the achievement of fifth-grade students in mathematics and developing their mathematical thinking.

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