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THE EFFECTIVENESS OF MATHEMATICAL MODELING IN MATHEMATICS ACHIEVEMENT IN INTERMEDIATE SCHOOL STUDENTS AND THEIR ENGINEERING THINKING

Lecturer. Oday Hashim Alwan
University of Maysan - College of Basic Education
odayhashim74@gmail.com

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Abstract

The current research aims to know:

1- The effectiveness of mathematical modeling in mathematics achievement among middle school students.

2- The effectiveness of mathematical modeling in engineering thinking among middle school students.

In order to achieve the goal of the research, the researcher formulated the following null hypotheses:

1- There is no statistically significant difference at the level of significance (0.05) between the mean scores of the experimental group students who study according to mathematical modeling and the average scores of the control group students who study according to the usual method in the achievement test for mathematics.
2- There is no statistically significant difference at the level of significance (0.05) between the mean scores of the experimental group students who study according to mathematical modeling and the average scores of the control group students who study according to the usual method of the dimensional engineering thinking test.

The research community was destroyed from all the schools of the first intermediate grade students in Maysan Governorate, where the researcher applied the experiment. The Intermediate School for Outstanding Students was chosen for boys, in which there are three classes, for the first intermediate grade. Two classes were chosen randomly. They were distributed into two groups, one experimental and the other control.The researcher rewarded between the two groups in some variables, and the scientific material for the experiment included the fifth and sixth chapters of the mathematics textbook for the first intermediate grade approved for the 2018-2019 academic year. The researcher has two research tools, namely the achievement test and the engineering reasoning test. The results of the research showed that there is a statistically significant difference in the achievement test and in the dimensional engineering thinking test in favor of the experimental group.

Chapter One

First. Research Problem

During the researcher's field visits to middle schools and his interviews with students, he found that they were facing simple problems in practicing engineering thinking, and he noticed students' failure to solve them. In addition, there is a tangible weakness in students 'mathematics achievement, and this was evidenced by the discussion of their teachers about their level in addition to their scores on monthly exams or from school records. Also, when the teacher represents the mathematical problem or the mathematical situation with a specific model that simulates the situation, an effect was observed on the students' motivation to solve.

In light of the above, the researcher finds that there is an urgent need for teaching strategies or models that help students to enrich their information and develop their various mental skills, as well as the necessity to use innovative teaching methods and methods that contribute to increasing achievement and engineering thinking skills in a way that helps in employing knowledge in their lives and helps to connect Mathematics in other sciences. The researcher believes that the use of mathematical modeling contributes to this, as it consists of six coherent and interrelated steps in the way the content is presented, which contributes to achieving effective learning, and it represents an attempt to describe some parts of the real world with mathematical formulas and thus employ mathematics to help understanding and make better decisions about Real-world situations, they help us explain and clarify ideas and problems.Many Arab and foreign studies have recommended the use of mathematical modeling, such as the study (2001, Wares and (Al-Rifai's study, 2006) and Abu Mazid study, 2012). As a result of the above, the researcher tried to identify the effectiveness of mathematical

modeling in the achievement of mathematics among students The middle school stage and their engineering thinking specifically through mathematical situations presented to the student as a test according to the engineering thinking skills. Accordingly, the problem can be identified in answering the question: ***"What is the effectiveness of mathematical modeling in mathematics achievement for middle school students and their engineering thinking?"***

Second. Research Significance

The importance of research lies in:

1- Curriculum designers are useful for including mathematical modeling in mathematics curricula, which helps build understanding of mathematical concepts and generalizations.
2- Aiding in acquiring engineering thinking skills and solving engineering problems, by proposing a strategy full of new ideas to solve the problem.
3- Students can relate mathematics to reality by simplifying the relationship between variables, and representing them with an understanding.
4- An introduction is provided for researchers in the use of mathematical modeling in various fields.
5- Developing the skills of teachers and students in designing mathematical models.

Third. Research objectives:

The current research aims to know:

1- The effectiveness of mathematical modeling in mathematics achievement among middle school students.
2- The effectiveness of mathematical modeling in engineering thinking among middle school students.

Fourth. Research Hypotheses:

1- There is no statistically significant difference at the level of significance (0.05) between the mean scores of the experimental group students who study through mathematical modeling and the average scores of the control group students who study in the usual way in the achievement test for mathematics.
2- There is no statistically significant difference at the level of significance (0.05) between the mean scores of the experimental group students who study through mathematical modeling and the average scores of the control group students who study in the usual way in the dimensional engineering thinking test.

Fifth. Research limits:

The current research is limited to:

1- Intermediate first grade students in the middle school (Outstanding Students) in the Directorate of Education in Maysan Governorate.
2- Study subjects (geometry, measurement - areas and volumes) included in the fifth and sixth chapters of the mathematics textbook scheduled for the first intermediate grade.
3- The second semester of the academic year (2018-2019).

Sixth. Defining terms:

1- The Effectiveness

- Defined byZeitoun, (2001): as "the extent to which the outputs of the system coincide with its objectives"(Zeitoun2001:17).
- Procedural: The extent of the success of the teaching model in achieving the set teaching objectives.

2- Mathematical Modeling

- Define it (Lahmar, 2007): as "the application of mathematics in dealing with real life problems, problems in mathematics itself, or problems in other sciences, by converting the life problem into a mathematical problem, then dealing with this issue and solving it, and choosing a better one." Solutions that are commensurate with the nature of the issue we are addressing, and then generalize and predict if possible(Lahmer, 2007: 14).
- Procedural: It is to redesign the unit lessons (geometry, measurement / areas and volumes) according to the mathematical modeling represented by the steps (understanding and defining the problem, developing the necessary assumptions to build the mathematical model, building the mathematical model, solving the mathematical model, interpreting the mathematical solution, ensuring the correctness of the solution).

3- Achievement

- He defined it (Hussein, 2011): It is the knowledge that the student acquires through a curriculum for a course intended to be adapted to the educational milieu, and this concept is limited to the information obtained by the student according to a prepared program that aims to make the student more adaptive to the medium to which he belongs, as well as preparing it to adapt to the academic environment in general (Hussain, 2011: 176).
- Procedural: It is the amount of the acquisition, comprehension and remembrance of students of the experimental and control groups of all

engineering concepts and laws and how to apply them. This is measured by the degree they obtain in the achievement test.

4- Geometrical Thinking

Arifah (Ibrahim and Nassour, 2011): It is a form of thinking represented in the student's ability to perform a set of activities and mental processes and achieve a certain level of thinking, when confronted with a problem related to engineering (Ibrahim and Nassour, 2011: 117).

- Procedural: It is the mental and behavioral activity that the student performs when he faces an engineering problem that he cannot easily solve, which forces him to analyze the problem and study its basic components, and is measured by the degree that he obtains in the engineering thinking test prepared for that.

Chapter Two

The First Axis: Theoretical Background:

First .Mathematical Modeling:

Science develops and its modernity becomes greater whenever it is processed mathematically and whenever possible the process of modeling its theories and laws in the form of mathematical models that help interpret results and predict through them, and through these models the world has become something understandable in many phenomena.As students need more useful mathematics in their daily lives and its learning contributes to preparing them to face the large and accelerating challenges in the future, and mathematical modeling in its essence represents a bridge between basic mathematical knowledge and non-mathematical situations, as students themselves know the relationship between mathematics and the real world, and that the problems they face They can be represented by mathematical models and their solutions, and by discussing possible solutions, new mathematical predictions and concepts can be drawn up (Abu Mazyad, 2012: 27).

- **Objectives of Mathematical Modeling:**

Mathematical modeling in a classroom environment aims to achieve the following:

1- Providing the learner with thinking models by dealing with the logic of the mind and its justifications, as this helps to activate the left side of the brain by

responding to logic, organizing thinking paths, and moving in the learning process from the part to the whole, especially in the formation of a comprehensive picture or model of a pattern Solve the problem.

2- It provides the opportunity for the learner to express his thoughts in thoughtful steps in solving the problem, and try to try other people's solutions, and treat them on objective and scientific grounds, as well as distinguish the learner between different thinking styles.

3- - The learner develops the ability to solve specific educational problems in several areas, in the sense that the effect of learning a certain thinking pattern through the use of mathematical modeling is transmitted to areas other than the educational material, and therefore the learner tries to model this behavior from thinking and apply it to different situations (Afaneh and Al-Jaish, 2009, 171).

- **The Importance of Mathematical Modeling in Mathematics:**

Mathematical modeling has significance that can be summarized as follows:

1- Mathematical modeling with its multiple skills should become an essential component of mathematics curricula at all stages, according to several levels.

2- Mathematical modeling helps in developing students 'thinking skills, and enhances their scientific method in solving problems and developing students' critical competence.

3- Teaching through applications and mathematical modeling may help to make mathematics meaningful to the student, and modeling helps to reduce the gap between theory and practice, and also helps to remove the prevailing idea about mathematics as a subject that has nothing to do with reality.

4- Highlighting the role of mathematics in teaching other subjects, as learning mathematical concepts and generalizations by applying them in other subjects such as natural sciences, astronomy, computers, economics and others, all this makes the student feel the role of mathematics in other sciences and help in learning them.

5- Mathematical modeling helps in employing computer technology, and the emergence of enormous statistical programs helped in the use of mathematical modeling in conditional prediction and orientation of the future.

6- The applications of mathematics, mathematical modeling and problem solving are an appropriate way to develop general understanding, trends and problem-solving ability (Lahmar, 2007: 32), (1991: 37, Niss & Blum).

- **The Mathematical Modeling Process Takes Place in The Following Steps:**

1) Understanding and defining the problem 2) Developing the necessary assumptions to build the mathematical model 2) Building the mathematical

model 4) Solving the mathematical model 5) Interpreting the mathematical solution. 6) Ensure the correctness of the solution(Abu Mazyed, 2012: 40).

Second. Geometric thinking:

- Van Heel's theory of engineering thinking:

The research of the duo (Bermari van Hale) and his wife (Diana van Hale Geldof) focused on teaching and thinking about engineering, levels of thinking in it and the role of education in improving those levels of learners. At the end of the 1950s, this duo developed a distinct theory regarding levels of engineering thinking, based on the idea that the learning process is not continuous, but rather that there are jumps in the learning curve. In the seventies, educators in the United States interested in this theory, and it gained acceptance. (Safety, 1995: 219).

Research was presented in the United States on verifying this theory and studying the levels of engineering thinking, whether they exist, and their compatibility with students in all levels of education, Van Hill's theory included three main sections, namely, insight - levels of thinking - stages of transition in levels.Several notions of insight in Van Hill's theory are taken from the Gestalt theory. Van Hill says that insight exists when a person assumes a sufficiently new position and adds that he and Gestalt scholars say the same thing but with different words (1986 Van Hicle).

As for levels of thinking, the two partners saw the necessity of having different levels of characteristics in engineering thinking. These levels were numbered by many sources from (0 - 4), and another section numbered from (1 - 5) Hoover called these levels:

- The first level - perceptual (recognition) or visual (Vistlization): this level is determined by observing the image or geometric figure without realizing its properties, and is characterized by the ability to notice geometric shapes, name them and distinguish the shape from among a group of shapes that appear similar.
- The second level - analytical or descriptive: is defined by a conscious analysis of the properties of the geometric figure and is characterized by observing and describing the properties of shapes without relating to each other, whether on the level of the properties of the same shape or the properties of different shapes.
- The third level - ordinal (ordering) or relational (Relationship): or intonation deduction, which includes the learner’s awareness of the relationships between the different geometric shapes and is characterized by the ability to

give a definition of the geometric shape and find relationships between the properties of one shape and different shapes.

- The fourth level - deduction or formal deduction: is determined by the ability to use assumptions and postulates to demonstrate some relationships without realizing these assumptions and axioms, and it is characterized by the ability to deduce through building simple mathematical proofs, understanding the role of the axiom, definition, theory and the ability to analyze Within the steps of proof.
- The fifth level - abstract (Rigor) or axiomatic: This level is based on logic in understanding the origins of constructive relationships, postulates and engineering theories and is characterized by the ability to use formal logic in proof, understand the role of indirect proof, and compare different geometries (Hoffer, 1981: 22-26 &Khasawneh, 2007: 11-12).
- The learner cannot move from one of these five more distant levels to be able to the previous levels and move from the level to the next one depends largely on educational experiences and not on chronological age or level of genius as each level has its own language, terminology, relationships and engineering concepts appropriate to it (Al-Mashhadani, 2011: 277).

Van Hill says that moving from one level to the next is a learning that takes place by the learners themselves, and teachers can give directions to their pupils during complex exercises and this transition between a natural process takes place through a successive educational - learning program. Van Hiele, 1986: 50-62.

Van Heil believes that this transition takes place through five stages:

1) Information: Teaching must begin with materials that provide the learner and lead him to discover specific structures.
2) Direct orientation: the learners' tasks should be evaluated in a way that makes the learned structures familiar to them.
3) Explanation (explication): the teacher introduces engineering terms and encourages learners to extract them in their writings and discussions in engineering lessons.
4) Free regimentation: The teacher presents tasks that can be completed in different ways, and learners gain experience in solving requirements on their own, depending on what they have previously studied.
5) Integration: gives learners an opportunity to synthesize what they had previously studied, who were designing their own activities(Van Hiele, 1999: 315-316).

The Second Axis: Previous Studies :

Abu Mazyid's study (2012): It aimed to know the effect of using mathematical modeling on developing creative thinking skills among sixth-grade students in the governorates of Gaza, through the use of mathematical modeling in reformulating the second unit (decimal fractions) from the sixth-grade mathematics book in developing skills Thinking and creativity (fluency - flexibility - originality), and the study sample consisted of (83) sixth-grade students in Deir Al-Balah Boys Primary School - A- divided into two groups: (control and experimental), and the study tool is a test of creative thinking.

1- The results showed the positive effect of mathematical modeling on developing creative thinking skills for the benefit of the experimental group that studied the unit using mathematical modeling. Therefore, the researcher recommended the necessity of using modeling in the educational curricula, to show the role of mathematical knowledge in solving real problems from real life.
2- Ahmed's study (2008): It aimed to use mathematical modeling in solving applied problems in mathematics among students of the second cycle of basic education, and the researcher used the one-group experimental design, and the study sample consisted of (38) students of the seventh grade of basic education. Preparation of two proposed units: (Mathematics and Life unit and Life Applications unit).
3- A teacher's guide was prepared for each unit and an applied problem-solving test was prepared, as the applied problem-solving test, pre and post, was applied, and the study showed that there was a significant improvement in students 'level after teaching the two units, which had a great impact on developing students' ability to use mathematical modeling. In solving applied problems. The study recommended the necessity of introducing new units taught using mathematical modeling in mathematics curricula for the second cycle of basic education.

- **Beneficial aspects of previous studies:**

1- Knowing the foundations and concepts on which mathematical modeling is built.

2- Choosing the appropriate teaching strategies for the mathematics curriculum.

3- Choose the experimental approach which is the most suitable for research.

4- Determining the appropriate statistical method for analyzing and interpreting results.

4- Comparison between the research results and the results of previous studies.

Chapter Three

Research Methodology and Procedures

First: - Experimental design: The researcher used a design with partial control, and this design depends on two groups, one experimental and the other control, and Table (1) illustrates this:

Table (1) the experimental design of the research

Group	Parity	Independent Variable	Dependent Variable
Experimental	1- Chronological age in months	Mathematical modeling	1- The dimensional engineering thinking test
Control	2- Examining previous knowledge 3- Intelligence 4- Pre-engineering thinking test	Normal Modeling	2.Achievement Test

Second. Research community:

The research community consisted of students of the first intermediate grade in middle schools affiliated to the General Directorate of Education in Maysan Governorate for the academic year (2018-2019).

Third. The research sample: The research sample was intentionally chosen from intermediate students of superior students for boys for the following considerations:

1- The school administration's willingness to cooperate with the researcher.
2- The full readiness of the first intermediate grade mathematics teacher to apply the experience, noting that his teaching experience in teaching this subject is 12 years.
3- The proximity of the school site to the researcher's residence allowed the researcher to sit with the teacher at additional times to give him instructions and clarify some matters related to the teaching plans before and during the experiment.
4- Convergence and parity of students in terms of social, economic and cultural levels.
5- Division (C) was chosen randomly to represent the experimental group, while Division (B) represented the control group out of three divisions for the first intermediate grade.

Fourth. Control Procedures:

1- Conducting parity between the two groups: Some variables that may affect the search results have been controlled, including:

- Chronological age calculated in months: the ages of students were obtained from their school cards.

Intelligence: Raven matrix was applied to intelligence, and the mean and standard deviation of both groups were calculated to test the difference between them.

- Previous knowledge test: where a test consisting of (20 multiple choice items) was prepared from the mathematics curriculum for the sixth grade of primary school from some semesters that included engineering subjects and it was presented to a group of specialized professors and arbitrators, and some of its paragraphs were modified.
- Pre-engineering thinking test: where the engineering thinking test prepared by the researcher was applied previously to the experimental and control groups to find out the extent of their equivalence in this variable before applying the experiment.

After testing the significance of the difference between the two groups for each of the above variables using the T-test for two independent samples (T-test), the results showed that the difference was not statistically significant as the values calculated for each of them were less than the tabular value of (2.000) at the level of significance (0.05) Which indicates the equivalence of the experimental and control groups in these variables, and as shown in Table (2):

Table (2) T-test for the two groups of research in equivalence variables

Variables Parity	Group	Number	Mean	Dev. Std.	Freedom Degree	T-Value		Statistical Value
						Calculated	Tabulated	
Age in Month	Experimental	30	145.5	3.406	58	0.733	2.000	Unsignificant
	Control	30	152.4	4.989				
Raven IQ Test	Experimental	30	22.35	1.470	58	1.012	2.000	Unsignificant
	Control	30	21.60	1.155				
Test of prior knowledge	Experimental	30	18.42	8.929	58	0.723	2.000	Unsignificant
	Control	30	17.25	9.167				
Pre-engineering thinking test	Experimental	30	18.46	5.42	58	1.201	2.000	Unsignificant
	Control	30	145.5	3.406	58	0.733	2.000	

2- The experimental and control groups taught the same mathematics teacher in the school in order to avoid the difference that may result from the difference of the subject teacher in his ability and personal characteristics and the extent of his knowledge of the nature of the experimental variable.
3- The number of teaching sessions for the experimental and control groups was equal.

4- The experimental and control groups were assigned the same homework.
5- The experiment took the same period of time for the two groups, and this was done in the second semester, as the experiment began on 24/2/2019 and ended on 11/4/2019.
6- Controlling some extraneous variables that may affect the accuracy of the results, and despite the statistical parity between the two groups of research in some variables, the researcher tried as much as possible to control some extraneous variables, because experimental research is exposed to extraneous factors that may affect internal validity and the external design of the experimental, and the following are these variables and how to adjust them:

- Confidentiality of the research: The researcher agreed with the school administration and the subject teacher to maintain the confidentiality of the experiment because of its effect on the accuracy of the experiment results.
- The classroom environment: The experiment was applied in one school, and in two adjacent classes, and the classroom space and the number of windows and seats are equal in both classes.

7- Measurement tools: The researcher controlled this variable using the same standard tools with the students of the two research groups, as two tools were used, one of which was an achievement test and the other an engineering thinking test.

Fifthly. ResearchRequirements

1- Determining the scientific subject: The course included the fifth and sixth chapters (geometry, measurement - areas and volumes) of the mathematics textbook for the first intermediate grade approved for the academic year (2018-2019).
2- Defining objectives and formulating them behaviorally: In light of the general objectives of teaching mathematics for the first intermediate grade and the content of the two chapters to be taught, the behavioral objectives were formulated and presented to a group of subject experts and teachers in order to demonstrate their views on formulating these behavioral objectives and the extent to which they achieve the goals of teaching. From 80% of the experts' agreement, and the paragraphs that did not obtain this percentage of the agreement were amended, the final number of behavioral objectives became (35) a behavioral objective.

The regularity and time required for its implementation, and the second for the experimental group that was studied according to mathematical modeling. The plans were presented to a group of experts

and referees in the field of mathematics and methods of teaching it to benefit from their opinions and suggestions, and adjustments were made to the plans accordingly.

Sixth. Two search tools

1- Achievement test: The achievement test was prepared, where the objective of the test was determined, the content of the material was analyzed, then a table of specifications was prepared (the test map). Its preparation can be summarized in a two-dimensional list, one of the two dimensions shows the content and the proportions specified for its weights, and the second dimension shows the goals and their weights as indicated The number of paragraphs in each cell.

The test consisted of 24 items of a multiple-choice type, as in Table (3). (Al-Dulaimi et al., 2005: 28).

Table (3) Testing Map

Content	**Class weight**	**Behavioral goals**				**Total**
Chapter One	43%	4	3	3	4	10
Chapter Two	57%	6	4	4	6	14
Total	100 %	10	7	7	10	24

- Drafting of the test paragraphs: The test paragraphs were written and its instructions prepared. Explain with an example. The student is given one score for the correct answer for each of the test items, and zero for the wrong or abandoned answer.
- Validity of the test: Types of validity have been achieved, including:

A- Face Validity: presenting the achievement test and the behavioral purposes to a group of arbitrators in the field of mathematics and methods of teaching mathematics, in order to benefit from their opinions and directions. And its relevance to the level of students and the behavioral objectives specified for it, and therefore the test counted as a true checker to measure the final achievement of students.

B- Content Validity: The content truthfully intends that the test measures the goals established in the subject, meaning that the test items are comprehensive for all the subject studied by the student. The specification table is considered one of the content validity indicators, which indicates the number of paragraphs in each cell, as well as the goals and content to be covered through these paragraphs, that is, it requires an appropriate distribution of the paragraphs that represent the content covered by the goals (Al-Manzel and Atoum, 2010).

- **The exploratory application for the test: It was divided into two phases:**

A- The first exploratory application: to ensure the clarity of the items of the achievement test, its validity, and understanding of its paragraphs, as well as to know the time taken to answer the test. The test was clear and the average response time was (45) minutes.

B- The second exploratory application: to analyze the test items, where the test was applied again to a sample consisting of (110) students by three classes in Al-Razi Intermediate School for Boys without the original research sample. The answers of the exploratory sample students were corrected, then the scores were arranged in descending order, then the highest 27% and 27% lowest as a ratio for comparison between two contrasting groups for test analysis.

- Difficulty and ease factor for paragraphs:

The difficulty equation has been applied to each of the test items and found it ranges between (0.35-0.71). The test items are acceptable if the range of difficulty ranges between (0.20 - 0.75) (Melhem, 2012).

- The discriminatory power of paragraphs:

When calculating the discriminatory strength of each of the test paragraphs using the paragraph discrimination strength equation, it was found that the strength of paragraph discrimination ranged between (0.32 - 0.65), and the paragraph could be considered acceptable if its discriminatory ability was (0.20) and above, but in the case of groups 27% higher and 27 The minimum% is preferable for the distinction to be (0.30) or more, so all test items are considered acceptable in terms of their ability to discriminate (Hussain, 2011).

- **Effectiveness of false substitutes:**

After applying the effectiveness of alternatives equation, it appeared that the alternatives had attracted a number of students of the lower group compared to the students of the higher group, and thus it was decided to keep the alternatives as they are without change.

- Stability of the test: the stability factor obtained by the Alpha-Cronbach method reached (0.85), and after this procedure the test was ready for final application.

- **Achievement Test Application:**

After completing the exam numbers and its instructions, the test was applied in its final form on Wednesday 10/4/2019 after informing students of the research sample of the test date a week before its application. The wrong answer is zero. As for the left-out paragraphs, in which the indication of the alternatives is unclear, the answer was considered wrong, and this is why the highest score that the student attained was (24) and the lowest that the student could obtain was zero, and the average time spent in answering the test ranged between (35-45)Accurate.

Geometric Reasoning Test:

The researcher developed the Van Heel test for engineering thinking that was used in the study of Titi (2000), where this test aimed to measure the levels of Van Hill for engineering thinking among the students. Pre-Commission for the Development of Mindfulness and Achievement in Engineering in Secondary Schools (CDASSG),The researcher developed this test to fit the Iraqi curriculum, as the concepts and terminology were chosen from the curriculum taught in the intermediate stage, especially the first intermediate grade (the research sample). (20 paragraphs) were formulated of a multiple-choice type covering the five levels of Van Hill, and through the presentation of the test For professors and specialized referees, to know its validity and clarity of its paragraphs, some paragraphs have been amended to make the test in its final form.

- **Exploratory experience:**

The researcher applied the test on a random pilot sample of (40) students in Al-Razi Intermediate School for Boys affiliated to the Directorate of Education in the Maysian Governorate to find out the validity of the test and the clarity of its paragraphs. The exploratory sample between the lowest time (35) minutes and the highest time (45) minutes, with an average time of (40) minutes.

- Correcting the answer sheets: -

The researcher corrected the answer sheets for the survey sample, as one score was given for the correct answer and 0 for the incorrect answer for each test paragraph of the multiple choice type. The left paragraphs were treated as the incorrect paragraph.

- Statistical analysis: It included both of the following:

A. Difficulty of the paragraphs: - After students' answers were corrected, their scores were ranked in descending order, and higher and lower (50%) were chosen to represent the upper and lower classes. As the difficulty coefficients ranged (0.34 - 0.63), they were found to fall within the acceptable range (Bloom, 1971, p.96).
B. Discriminatory strength of paragraphs: - Discrimination coefficients for paragraphs ranged between (0.26 - 0.68).
C. Stability of the test: - Where the researcher calculated the coefficient of stability using the (Alpha - Cronbach) equation, as its reliability coefficient reached (0.84), which indicates that the stability is high and positive.

- The application of the dimensional engineering thinking test: -

After completing the experiment, the researcher applied the dimensional engineering thinking test on Thursday 11/4/2019 according to the instructions mentioned previously.

Seventh: Statistical Means:

According to the research requirements, the researcher used the statistical program (SPSS) in addition to some statistical laws as follows:

1- The t-test for two independent samples (t-test): It was used in the equivalence of the two groups (experimental and control) in some variables and in the analysis of the research results.
2- Paragraph difficulty equation: Calculating the difficulty factor for the achievement test items and engineering reasoning.
3- Paragraph Distinction Equation: Calculation of the coefficient of discrimination of achievement test items and engineering reasoning.
4- The alpha-Cronbach equation: used to find the reliability of the achievement test and the engineering reasoning test.

Chapter Four

First: Presentation of results

- **Results related to the first hypothesis**: for the purpose of verifying the first hypothesis, which is “There are no statistically significant differences at a level of significance (0.05) between the average scores of the experimental group students studying according to mathematical modeling and the average scores of the control group students who study according to the usual method in the achievement test in the math.

The researcher conducted a (t-test) test for the experimental and control groups in the achievement test, as shown in Table (4):

Table (4) Results of the first hypothesis

Group	Number	Mean	Standard Deviation	T-Value		Statistical Value
				Calculated	Tabulated	
Experimental	2.786	23.48	30	2.000	4.827	Sig.
Control	3.878	18.96	30			

It appears from the table that the calculated T value (4.827) is greater than the tabular T value (2.000) at a level of significance (0.05) and a degree of freedom (58), which means that there is a statistically significant difference in favor of the experimental group in the achievement test, and this means rejecting the null hypothesis and accepting the hypothesis The alternative, which indicates the superiority of the experimental group that was studied according to mathematical modeling over the control group that was studied according to the usual method.

Results related to the second hypothesis: For the purpose of verifying the second hypothesis, which is "There is no statistically significant difference at a level of significance (0.05) between the average scores of the students of the experimental group that are taught according to mathematical modeling and the average scores of the students of the control group in the dimensional engineering thinking test." The researcher conducted the t-test for the experimental and control group in the dimensional engineering thinking test, as shown in Table (5):

Table No. (5) The results of the second hypothesis

Group	Number	Mean	Standard Deviation	T-Value		Statistical Value
				Calculated	Tabulated	
Experimental	2.960	19.22	30	2.000	5.743	Sig.
Control	2.958	16.96	30			

It is evident from the table that the calculated T value (5.743) is greater than the tabular T value (2.000) at the level of significance (0.05) and the degree of freedom (58). This means that there is a difference of statistical significance in favor of the experimental group in the dimensional engineering thinking test. This means rejecting the null hypothesis and accepting the alternative hypothesis that indicates the superiority of the experimental group that was studied according to mathematical modeling over the control group that was studied according to the usual method in the dimensional engineering thinking test.

Second: Interpretation of the results

1- Mathematical modeling allowed students to walk in organized steps, which greatly contributed to the development of their ability of expression and effective participation, which led to the development of their understanding of concepts and their ability to solve mathematical problems.
2- The use of mathematical modeling worked to give the mathematics lesson a vital character, by accustoming students to formulating the mathematical problem in their own language, making a suitable illustration for it, and explaining it with a model or sensory method, and the diversity in the means of displaying things, life situations, natural and the use of symbols, Work to increase the level of students' achievement.
3- Mathematical modeling was concerned with students' understanding of the topics and the problems that were posed, which positively affected their engineering thinking, and made them more capable and skilled in dealing with engineering problems.
4- Using mathematical modeling, to make students of the experimental group able to solve unfamiliar problems, and more complex, compared to the control group students.
5- Mathematical modeling helped to transfer concepts from their abstract nature to the physical character, which enabled students to deal with them more easily, and this allowed students to employ concepts in life, thus developing their understanding of them, thus developing their engineering thinking and directing them towards learning mathematics.
6- Mathematical modeling enabled students to deal with mathematical problems formulated in an easy realistic way, and increased their ability to solve them in specific steps, and increased their ability to formulate realistic problems in their own language, and illustrate them with figures, or illustrations, within realistic life situations, thus increasing the linkage of mathematics Indeed, the development of their participation and activity in the classroom, which formed a positive trend towards learning mathematics, and the development of their ability to solve more accurate and complex problems.

Third: Conclusions

Based on the results of the current research, the following conclusions were reached:

1- There was a clear effect of mathematical modeling in raising the academic achievement of the first intermediate grade students in mathematics.
2- here was a clear effect of mathematical modeling in raising the level of engineering thinking for the first intermediate grade in mathematics.

3- The use of mathematical modeling in the educational process that enhances social relations between students and develops for them a love of cooperation with each other in the learning process and behavioral aspects such as organization, arrangement and commitment.
4- Mathematical modeling helps to understand mathematical concepts and grasp the relationships between them, which helps meaningful learning to occur.

Fourth: Recommendations

Through the research results, the researcher recommends the following:

1- Working on teaching student teachers in colleges of basic education on how to use mathematical modeling in solving life problems, and a serious approach to holding training courses for current teachers, to train them in using the mathematical modeling strategy, to teach mathematics in general.
2- Paying attention to diversity in strategies and methods of teaching mathematics, moving away from deaf learning common in our schools in general, and paying attention to students building knowledge on their own and not presenting it to them in its final form so that their learning is meaningful.
3- The necessity of strengthening mathematics curricula with a mathematical modeling strategy, and directing teachers 'attention to the importance of mathematical modeling, to increase students' motivation to study mathematics.
4- Focusing on using physical models to teach mathematics in a way that suits students ’abilities and enables them to deal positively with it.

Fifth. Suggestions

In continuation of the current research, the researcher suggests:

1- Conducting a study similar to the current study in other subjects.
2- Conducting a study similar to the current study in other stages and classes.
3- Study the effect of using this strategy on other aspects, such as developing critical thinking, developing scientific direction, or acquiring skills.

References

1- Ibrahim, Hashem and Nassour, Raghda (2011): The distribution of Van Hill's levels of engineering thinking among the eighth grade students (field study in Lattakia governorate), Tishreen University Journal for Research and Scientific Studies, Issue 3 (33), 113-129.
2- Abu Mazyad, Mubarak (2012): The effect of using mathematical modeling on developing creative thinking skills among sixth grade students in Gaza

governorates, unpublished master's thesis, Al-Azhar University, Gaza - Palestine.

3- Ahmed, Karima (2008): The use of mathematical modeling in solving applied problems in mathematics among students of the second cycle of basic education, an unpublished master's thesis, Faculty of Education, Ain Shams University, Egypt.
4- Hussein, Abdel Moneim Khairy (2011): Measurement and Evaluation, Academic Book Center, 1st Edition, Amman, Jordan.
5- Khasawneh, Amal Abdullah (1994): Levels of Thinking in Engineering among Student Teachers, Yarmouk Research Journal, Volume (10), Issue (1), 439 -481
6- Al-Rifai, Ahmed (2009): The impact of a program in mathematical modeling on the development of metacognition strategies, problem-solving behavior and creative teaching skills of the student teacher, Mathematics Division, unpublished PhD thesis, Faculty of Education - Tanta University, Egypt.
7- Zaitoun, Hassan Hussein (2001): Teaching Design a Systems Vision, The World of Books, Cairo.
8- Salama, Hassan Ali (1995): Methods of Teaching Mathematics between Theory and Practice, 1st Edition, Dar Al Tarbiah, Cairo.
9- Al-Mashhad Al-Ani, Abbas Naji (2011): Teaching Methods and Models in Teaching Mathematics, Al-Yazuri House for Publishing and Distribution, Jordan.
10- Al-Titi, Nayef, (2000): The degree of the tenth grade students 'acquisition of levels of engineering thinking and its relationship to their abilities to write engineering proofs, an unpublished master's thesis, Al-Quds University, Palestine.
11- Afaneh, Ezzou and Al-Jaish, Yusef (2009): Teaching and Learning with the Two Sided Brain, Dar Al Thaqafa for Publishing and Distribution, Amman, Jordan.
12- Lahmar, Saleh (2007): Effectiveness of a proposed program in developing mathematical modeling skills for student teachers, Mathematics Division, Faculty of Education, University of Aden, unpublished Master Thesis, College of Education, University of Aden, Yemen.
13- Bloom , B.S. and others , Hand book on for motive and summative evaluation of student learning , Mc Graw Hill Book Company , New York (1971) .
14- Blum, W. & Niss, M. (1991). Applied Mathematical problem solving modeling Application and Links to the subject state Trends and Issues in Math. Educational Studies in Math. No.22, 37 - 68.
15- Hoffer, A. (1981): "Geometry is more than Proof, Mathematics Teacher" Vol., 74.
16- Wares, A. (2001) Middle school student's construction of mathematical models, Illinois State University.
17- Van Hiele, PierrM.(1986) : Structure and Insight a theory of Mathematics Education, New York, Academic Press.
18- Van Hiele, PierrM .(1999): Developing geometric Thinking Through activities that begin with paly, Teaching Children Mathematics, (6) February, pp. 310-316.