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RESEARCH ARTICLE

The Effectiveness of Mathematical Modeling in Developing Problem Solving Skills and Self-Efficacy in Mathematics Among Sixth Grade in Palestine

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ABSTRACT

This study aimed to investigate the effectiveness of mathematical modeling in enhancing problem-solving skills and self-efficacy in mathematics among sixth-grade students in Palestine. The study sample comprised 64 students from a school in Tulkarm Governorate under the Ministry of Education, with 30 students in the experimental group taught using mathematical modeling and 34 students in the control group taught using traditional methods. Data collection involved a test with four questions assessing problem-solving skills (comprising understanding the problem, planning the solution, implementing the solution, and verifying its correctness) and a questionnaire to gauge self-efficacy in mathematics. The results indicated statistically significant differences favoring the experimental group in problem-solving skills and self-efficacy. The findings suggest the importance of integrating mathematical modeling into the Palestinian school curriculum across different educational levels and providing teacher training on mathematical modeling for effective mathematics instruction.

INTRODUCTION

Mathematical preparing considered as one of the important and necessary sciences in various aspects of the daily life of communities; It is an essential part of communities' future as individuals and groups. Therefore, teachers must focus on preparing students by teaching them various mathematical skills, knowledge, and concepts that improves their mental abilities to help them develop Higher thinking skills as an analysis to explain creativity (The Office for Standards in Education, 2011).

The content of mathematics is concerned with basic mathematical concepts and skills Which students are expected to get as they pass through the various academic stages. The process of teaching and learning concepts and skills in mathematics and imparting them to students is a necessary task because it helps them develop problem-solving and mathematical reasoning skills, increases their familiarity with the content of the academic subject, including mathematical concepts and ideas, and strengthens their mathematical structure. On the other hand, self-esteem in learning mathematics also allows students to better direct their thinking and time to face the problems they may meet in different life situations, whether it within or outside their environments which highlight the essential need to find more efficient learning strategies that attract all students and make them more embedded in their learning (Bottge et al., 2001).

Meaningful mathematics require strategies in teaching that make students a part of their learning and make mathematics enjoyable. Moreover, these methods and strategies must be able to provide students with the necessary knowledge to keep pace with development and move forward in their professional lives. In addition, There is a need to ensure that they acquire mathematical skills that support them to find a solution in the complex situations they will encounter in their real life and to find practical solutions to their daily problems, as a fairly effective instrument that includes Features that can meet these requirements, and are highly suitable for use by mathematics teachers (Koskinen & Pitkäniemi, 2022).

Mathematical modeling represents a passage through it the learner can facilitate the teaching and learning process, and contributes to developing higher thinking skills by embodying them in the lives and reality of the learners, add to Mathematical problems and their practical applications it has become essential for learners of mathematics (Hansson, 2010).

There are many definitions of the mathematical model, as the National Council of Teachers of Mathematics (NCTM, 2000) defines it as a mathematical representation of the elements and relationships related to a phenomenon, while Pollak (2012) believes that the mathematical model is the representation of a life situation with another mathematical situation, and this representation is either in the form of pictures, drawings, equations, maps, or Graphical representations or tables.

Working on Linking mathematics to other sciences and the environment, increases the student's motivation to study mathematics by finding it suitable for his inclination’s trends, and desires, it also encourages students to use the library and obtain information from its sources, to work collaboratively and summarize ideas, all of that educate students about the environment, its characteristics, problems, and obstacles.

Edward & Hamson (1990) demonstrates the six steps of mathematical modeling: identifying the problem, formulating a mathematical model, solving the chosen model, interpreting the mathematical solution, comparing the result with reality and finally preparing the report. In the first step students recognize the problem by asking questions to understand the target of it and to understand how to judge the outcomes. In the second step, student draw a suitable shape and list the relevant factors, then he collect information to explain the behavior of the variables. After that, he collect other information if necessary and express each change with a special symbol using a proper unit and state the hypotheses that can be used taking into consideration the relationships between the equations and the variables. In the third step, student solve the chosen model using algebraic and analytical methods, differentiation, and shapes software to solve using a computer, use simulation if necessary. In the fourth step, student interpret the mathematical solution and evaluate the results. In the fifth step, The student checks whether the results can be applied in reality and whether they have achieved the goal or need improvement. He develops a plan for improvement if necessary by going back or moving forward to the last step if there is no need for improvement. The sixth step, student prepare the report. Here he ask the following questions: To whom is the report? What does the reader want to know? How much detail is needed in the report? How to organize the report so that it is in the desired format and the results you want become clear.

Along the same line, Mason (1988) states that there are three basic steps in the mathematical modeling process: formulating the real problem in the language of mathematics by building a mathematical model consisting of variables that describe the situation in the presented problem; Then converting the real problem into a mathematical problem that is analyzed and solved, and finally interpreting the mathematical results obtained in light of the real results of the original problem.

Solving a mathematical problem is one of the standards of operations according to the National Council of Teachers of Mathematics, where the Council emphasizes that solving the problem for all different educational levels is essential for teaching mathematics so that they develop a deep understanding of the content of mathematics, and the ability to formulate multiple mathematical problems, such as life issues, which requires higher thinking skills, Applying them in different and new situations, interpreting them, and validating the solution in light of the main problem (NCTM,2000).

Creating a good mathematical problem requires a mathematical situation and a context that stimulates the student's thinking and challenges him to reach the solution, so that the student faces a new situation that does not provide a ready solution to the problem. Accordingly, Van-Gundy (2005) classified two types of structures for the mathematical problems, the first is well structured problems which has an obvious solution because there is sufficient information in its structure whereas the second type is Poorly structured problems which requires creative thinking to solve due to the lack of information about the solution .

George Polya (1957) defined the steps for solving the mathematical problem in four steps, which are as follows:

1- Understanding the problem: This step is considered the most important step in solving the problem because it helps in choosing the appropriate solution strategy. The teacher must present the problem in the language that suits the level of the students so that they can understand it before moving on to the next step.
2- Planning for the solution: In this step, student tries to search for a strategy to solve the problem, such as searching for a pattern, finding a similar problem, or through geometric representation. Here, he has to ensure the validity of the data and what is required, and to choose the procedures that will help him reach the correct solution.
3- Carrying out the plan: In this step, the student tries out the solution plan that he proposed in the previous step. The role of the teacher is crucial here as he must encourage the students to continue with the solution and instill a spirit of perseverance in the him so that he has the ability to implement the solution and modify it if necessary.
4- Looking back: the student verifies the solution in several ways, including substitution or solving the problem backward.

Using modern methods in teaching has a positive effect among students and that led to a positive change in attitudes toward teaching among teachers, which in turn affected the construction and selection of school curricula, including mathematics (Moqaddam, 2016). Accordingly, mathematics curricula have witnessed many changes to develop and raise the level of overall performance by moving from memorization to paying attention to the method of thinking that is based on understanding and logic, and is based on discussion, discovery, conclusion and evaluation, all with the aim of reaching the final solution. The document of the National Council of Teachers of Mathematics emphasized the need to enhance students' self-efficacy by adopting curricula and teaching methods that support this (NCTM, 2000).

Social psychologist Albert Bandura is considered one of the first scholars who address the concept of self-efficacy. Bandura and Wood (2007) defined the self- efficacy as the individual's guesses and opinions about his performance of behavior in situations characterized by ambiguity, and the reflection of this opinion on his selection of activities involved in performance and in the effort he makes in performing the behavior and challenging its difficulties.

In the same context, Jamaluddin et al. (2022) stated that students with low levels of self-efficacy face difficulties in performing effectively when interacting with mathematical tasks, which leads to low academic achievements and a lack of motivation toward learning. Likewise, mathematical self-efficacy works on students' preference for taking part in mathematical situations by motivating them to try several solutions for the problem.

Educational studies (Kohen et al., 2019; Amri & Widada, 2019; Zamnah, 2019) emphasized that students who have high self-efficacy are more present in participating in tasks, in addition to having a high degree of ambition and challenge when facing difficulties, and they perform better when they practice solving a mathematical problem than students with a low level of self-efficiency.

Purpose of the study and study questions:

Reviewing some recent studies (Da, 2023; Sinaga et al,, 2023; Byiringiro, 2024; Shongwe, 2024; Lázaro et al., 2024) that dealt with mathematics education and solving mathematical problems specifically which emphasizes the importance of using methods, strategies, and learning models within the classrooms which have a sufficient role in constructing and solving the mathematical problems. Besides the fact that the researchers work as supervisors at the educational field in universities dealing directly with students' teaching, noticed a general weakness in the subject of Mathematics, especially in solving mathematical problems, and this affects students' achievement. This can be attributed to the lack of modern methods in teaching curriculums, and the following of traditional methods of teaching within the classroom, as teachers complain that students fail to retain mathematical knowledge and that their learning does not go beyond the stage of remembering and applying. This is due to the lack of using meaningful teaching that would contribute to the acquisition, retention, and easy retrieval of mathematical concepts when the time they are needed, as they are built and preserved in long-term memory, and they are also unable to apply higher-order thinking skills to a new type of problem. Students who are taught only the problems of traditional textbooks fail to realize the importance of what they are learning. They become anxious, fearful, unwilling or demotivated to learn due to the frustration they experience and the negative feeling towards learning mathematics. Students need to be aware of what is going on around them about a subject based on to the tasks assigned to them. This explains why most students view mathematics as a set of rules or procedures for how symbols are transferred. Hence, the study came to identify the effectiveness of mathematical modeling in developing problem solving skills and self-efficacy among eighth-grade students in Palestine. Accordingly, this study answered the following research questions:

1. What is the effect of using mathematical modeling strategy on students' problem solving skills?

2. What is the effect of using mathematical modeling strategy on students' self-efficiency?

Objectives of the study:

- Developing mathematical problem solving skills among sixth-grade students in Palestine.
- Developing self-efficacy skills in mathematics among sixth-grade students in Palestine
- Comparing the effectiveness of using the mathematical modeling strategy with the traditional method in developing mathematical problem-solving among sixth-grade students.
- Comparing the effectiveness of using the mathematical modeling strategy with the traditional method in developing self-efficacy among sixth-grade students.

The significance of the study:

Theoretical significance:

The current study will provide a theoretical framework on the effectiveness of using mathematical modeling as a teaching strategy to enhance students' problem-solving skills. This information may assist curriculum developers and researchers in this field.

Practical Importance:

The practical significance of this study lies in its potential to assist mathematics teachers in enhancing their teaching methods to promote deep understanding and problem-solving skills in alignment with internationally recognized practices based on actual mathematical performance. This could pave the way for the adoption of these teaching methods in Arab schools. Furthermore, the study's value is underscored by the development of instruments that can be utilized in mathematics teaching settings, aiding researchers in creating instrument s for their studies.

Terminology And Procedural Terms:

Mathematical modeling is the process of converting real-life problems into mathematical models or mathematical problems, and then solving, interpreting, and verifying the solutions in real-life situations. Procedurally, researchers define mathematical modeling as a set of stages that teachers will teach sixth-grade students in the numbers and operations unit during the first semester using the Palestinian textbook. This is done according to the stages of the mathematical modeling strategy, which include: identifying the problem, formulating a mathematical model, solving the mathematical model, verifying the results, and interpreting the results (Maryan, 2016).

The skill of solving mathematical problems involves tackling mathematical situations or problems that demand a solution based on the student's prior knowledge and experiences. To arrive at the correct solution, students must follow a set of regular, sequential, and predetermined steps. Issues that necessitate higher-order thinking skills like analysis, synthesis, evaluation, and creativity are considered more challenging (Naveris & Pehkonen, Laine, 2013).

The researchers defines procedural knowledge as the student's ability to explain and understand the mental operations required for the unit of measurement, which involves the steps for solving a mathematical problem (understanding the problem, planning the solution, implementing the solution, and verifying the solution). This study assesses the students' skills through the scores obtained by eighth-grade students in a problem-solving test specifically designed by the researcher.

Self-efficacy:
Woolfolk (2010) asserts that self-efficacy is the students' ability to perform challenging activities and tasks and strive to achieve goals, either individually or collectively.

The researchers define mathematical proficiency procedurally as the student's ability to complete mathematical tasks accurately and efficiently. It is assessed through the score obtained by the student in a self-efficacy questionnaire specifically designed for this purpose by the researchers.

LITERATURE REVIEW

Betanga (2018) conducted a study on the effects of teaching mathematical modeling on students' pre-test performance in mental problem exams and their attitudes. The study included 54 students selected in a major city in the southern United States. Interviews and a questionnaire were used as research instruments. The results indicated a significant difference in posttest scores between the experimental and comparison groups, favoring the experimental group. Students showed positive attitudes towards mental problems and mathematics in an educational modeling context. Teaching mathematical modeling aimed to help students understand real-world situations, enhancing critical thinking and conceptual understanding. It also positively impacted students' learning, understanding of concepts, and attitudes towards learning.

Suh et al. (2017) studied the impact of teachers' mathematical modeling practices on enhancing critical thinking, cooperation, and communication skills in primary and cooperative stages. The study involved two out of 24 teachers and used various research instruments, including interviews, observations, notes, lesson plans, reflections, and student feedback. The findings showed that teachers effectively utilized these instruments to engage students in mathematical modeling and improve their skills.

The study of Beingemait & Hein (2010) explored the impact of modeling in teaching mathematics and the challenges teachers encounter when using this method. The study involved 105 teachers and found that teachers lack experience in modeling tasks, affecting both practical application and teaching. The study suggested that incorporating mathematical modeling and models in teaching can enhance outcomes for teachers and students, serving as a key element for improving the learning and teaching of mathematics.

Fulton (2017) studied how female math teachers engage with math while teaching modeling to elementary students. The research involved four female teachers at Jefferson Elementary Schools in Rocky Mountain. The study used interviews, pre- and post-observations. Results showed positive interactions between teachers and students during modeling lessons, leading to increased student motivation and improvement in math modeling. Students' involvement in tasks generated various math ideas, challenging teachers to effectively present concepts.

Along the same line, Been (2016) aimed to identify teachers' views on mathematical modeling in U.S. middle schools, analyze how these views influence teaching, and explore the meaning of modeling based on existing definitions. The study included four middle school teachers and used structured interviews. Key findings included the various meanings of modeling, such as applying math to real-world examples, the importance of teachers adapting their roles to facilitate modeling, and the benefits of modeling in developing critical thinking skills and aligning math concepts with real-world phenomena.

Huson's (2016) research sought to investigate the viewpoints of educators regarding mathematical modeling and its instructional resources within the educational system of the United States. The comprehension of teachers' perspectives on mathematical modeling within the educational environment can assist writers and publishers in enhancing the incorporation of modeling into school curricula, thereby improving the quality of student learning. Through interviews, the study engaged six high school mathematics instructors from diverse educational settings in the United States. The findings indicated that teachers align their instructional practices with the modeling cycle framework but require additional assistance, particularly during the initial stages of problem comprehension and model development. The provision of specific modeling challenges is deemed essential; however, it currently lacks sufficient guidance and support.

The study conducted by Al-Yaseen and Khasawneh (2018) aimed to investigate the perceptions of mathematics teachers regarding mathematical modeling, their self-efficacy levels in mathematical modeling skills, and the relationship between these two factors. The research sample included 143 male and female secondary school teachers in Jordan during the academic year 2016-2017. The study utilized instruments to assess teachers' perceptions of mathematical modeling and a self-efficacy scale for modeling skills. The findings indicated a significant and direct correlation at a 0.05 level between teachers' perceptions of mathematical modeling and their self-efficacy in mathematical modeling skills. Based on these results, the study recommended the implementation of in-service training programs for mathematics teachers to enhance their knowledge and beliefs, which could positively impact their teaching practices, particularly in the area of mathematical modeling.

Helmy (2016) conducted a study in Egypt to explore the relationship between educational scaffolding, levels of critical thinking, and their influence on academic achievement and mathematical self-efficacy among students enrolled in the College of Education, specializing in the first grades. The study involved the development of a teaching guide for selected topics in the Basics of Algebra course, utilizing an educational scaffolding approach, in conjunction with an achievement test and a measure of mathematical self-efficacy. The research was carried out with a sample of 58 students from the College of Education, specializing in the first grades, with 30 students assigned to the control group and 28 to the experimental group. A two-group design was employed, and students were initially categorized based on their critical thinking levels (high or low) determined by their scores on the Watson-Glaser Critical Thinking Test. The findings indicated the effectiveness of educational scaffolding in enhancing academic achievement and increasing mathematical self-efficacy. Moreover, the study revealed the impact of students' critical thinking levels on academic achievement and mathematical self-efficacy, favoring those with higher levels of critical thinking. Additionally, a statistically significant interaction was observed between the educational scaffolding strategy and the levels of critical thinking (high or low) in relation to academic achievement and mathematical self-efficacy.

STUDY METHODOLOGY AND DESIGN

Considering the nature and objectives of the present study, the quasi-experimental method was employed. This method was deemed appropriate for attaining the study's goal, which is to investigate the effectiveness of mathematical modeling in enhancing problem-solving skills and self-efficacy in mathematics among sixth-grade students in basic classes in Palestine. The diagram below illustrates the study's design:

EG O1O2

CG O1O2 - O1 O

EG: The experimental group that studied using mathematical modeling

CG: The control group that studied using the traditional way

X Experimental treatment (mathematical modeling)

O1: Mathematical problem-solving test.

O2: Self-efficacy scale in mathematics.

Study variables:

This study has two variables. The first is the independent variable represented by the teaching method, which was at two levels: teaching using mathematical modeling and teaching using the traditional method. The second variable is the dependent variable, where the study had two dependent variables: mathematical problem-solving skills and self-efficacy in mathematics.

The study sample:

A sample of 66 students from the sixth grade in Tulkarm Governorate was selected from Martyr Faiq Kanaan School using the purposive method. Two classes were chosen from the school and divided into two groups. One group, consisting of 32 students, was taught using the mathematical modeling method as an experimental group. The other group, with 34 students, served as the control group and was taught using the traditional method.

To ensure the equality of the study groups before commencing treatment, the scores of the students in both the experimental and control groups on a pre-test were collected. Subsequently, the means and standard deviations for the scores of each group were calculated. The results are presented in Table 1.

Table (1): means and standard deviations, and t-test for the two groups in the pre-test

	Group	Number of students	SMA	Standard deviation	value (t)	Significance level
Pre-test	Experimental group	30	3.5667	1.71572	.209	.835
	Control group	34	3.4706	1.92646		

It is clear from Table (1) that the value of (t) is not statistically significant at the significance level (α= 0.05), and this shows the equality of the experimental and control groups before starting to implement the study. So, the students of the experimental group were taught the unit of numbers and operations according to the Mathematical modeling strategy, The control group taught the same unit traditionally.

The analysis presented in Table 1 indicates that the value of (t) does not exhibit statistical significance at the significance level (α= 0.05). This suggests that there was an equivalence between the experimental and control groups prior to the commencement of the study. Subsequently, the experimental group received instruction on the unit of numbers and operations based on the Mathematical modeling strategy, while the control group followed a traditional approach in studying the same unit.

STUDY INSTRUMENTS

Teaching materials:

Lessons have been developed for the first unit of the sixth-grade textbook, focusing on numbers and operations according to the Mathematical Modeling strategy. A content analysis process was conducted for the unit, which involved a review of relevant theoretical literature on the stages and steps of mathematical modeling. Subsequently, the educational unit was presented to a panel of eight educational experts, comprising professors specializing in mathematics curricula and teaching methods at Palestinian universities. These experts were tasked with providing feedback and insights on various aspects of the educational material, including the appropriateness of the learning outcomes, the allocation of class time, and the lesson design structure based on different stages of the Mathematical Modeling strategy. Their opinions and suggestions were duly taken into consideration.

Mathematical problem-solving test:

The test comprised four questions designed to assess the ability to solve mathematical problems, including understanding the problem, planning the solution, implementing the solution, and verifying its correctness. The test duration was set at 45 minutes. It was developed with the specific aim of evaluating mathematical problem-solving skills. Prior to its creation, a review of relevant theoretical literature and previous studies, such as those conducted by Al-Wahaibi (2019) and Al-Ghosoun (2019), was undertaken.

The validity of problem-solving tests

The validity of the problem-solving test was verified by presenting it to a group of experienced and specialized arbitrators from the faculty of Palestinian universities, and after reviewing it and giving their comments about its content, clarity of expressions, and comprehensibility of the language used, the fifth question was removed due to its level of difficulty. The students reached a consensus on the validity of the remaining test items.

Reliability of Problem-Solving Test:

To assess the reliability of the problem-solving test, the test was applied to a sample of participants outside the study sample but from the study population. The sample included ten sixth-grade students from Tulkarm Governorate. The test-retest method was employed to evaluate the reliability coefficient, which was found to be 0.78. This value is considered acceptable for the study (Awda, 2010).feedback on the

Problem-solving test correction procedure:

The problem-solving test consists of four questions, each designed to evaluate four specific skills: understanding the problem, planning the solution, implementing the solution, and verifying the solution. Each skill is allocated one mark, resulting in a total score of 16 marks for the test.

Self-efficacy scale:

The self-efficacy scale was developed by drawing upon theoretical literature and previous relevant research. It comprised 18 items designed to assess self-efficacy in mathematics among sixth-grade students. Responses were rated on a five-point Likert scale, ranging from a very great extent = 5, a great extent = 4, a moderate degree = 3, a weak degree = 2, to a very weak degree = 1. The self-efficacy scale in mathematics included three negative items, specifically items 3, 9, and 17, while the remaining items were positive.

The Validity of the Self-Efficacy Scale in Mathematics:

The scale's validity was confirmed by presenting it to a panel of eight arbitrators consisting of faculty members specializing in mathematics and science curricula, teaching methods, measurement, evaluation, and educational psychology at Palestinian universities. The feedback provided by the arbitrators regarding linguistic clarity was taken into consideration, and adjustments were made accordingly. Items that contributed significantly to the overall score of the scale, demonstrated validity in measuring self-efficacy in mathematics, and received a consensus agreement of 95% from the arbitrators were retained. As a result, paragraph 18 was removed and replaced with other paragraphs to finalize the questionnaire items.

Reliability of the Self-Efficacy Scale:

The self-efficacy scale's reliability was assessed by computing the Cronbach's alpha coefficient (α) as indicated in table 3.6.

Table (2): Cronbach alpha reliability values the Self-Efficacy Scale items:

Topic	Cronbach-alpha values	Number of items
Mathematical language and its uses	0.77	6
Mathematical ideas in the mathematical task	0.85	6
Solve the mathematical task	0.81	6

This indicates the reliability of the scale, making it suitable for use in the present study as per the Nunnally scale, which established a minimum reliability of 0.70 (Nunnally & Bernstein, 1994).

Statistical methods:

To test the research questions and hypotheses, the researcher employed the Statistical Package for the Social Sciences program (SPSS). Subsequently, statistical methods were applied.

1. Utilizing the reliability equation, specifically Cronbach's alpha, to calculate the reliability of the resolution.
2. The study questions were answered by extracting means and standard deviations, and analysis of covariance (ANCOVA), which includes the extraction of the effect size coefficient.

Study results and discussion:

The study results were obtained following the application of instruments and instruction to two groups of sixth-grade students in the Numbers and Operations unit. The traditional method was applied to the control group, while mathematical modeling was implemented with the experimental group. The findings were presented as follows:

First, the results related to the first question: "What is the effect of using mathematical modeling strategy on students' problem solving skills?".

To answer this question, means and standard deviations of the performance of sixth-grade students were calculated on the pre-and post-problem solving test according to the teaching method (problem-solving, traditional).

Table (3): Means and standard deviations for the performance of sixth-grade students on the pre-and post-problem solving test according to (the teaching method)

Skills	group	Number of students	Post-test		Pre-test	
			Standard deviation	Mean	Standard deviation	Mean
Understanding the problem	Experimental	30	.68145	3.5333	1.430778	2.56667
	Control	34	1.08793	3.7059	1.709781	2.47059
Planning for the solution	Experimental	30	.68229	3.5000	1.37339	.9000
	Control	34	1.05169	3.5000	1.05803	.8235
Carrying out the plan	Experimental	30	1.03335	3.0333	.25371	.0667
	Control	34	1.11384	2.1765	.28790	.0882
Looking back	Experimental	30	1.16264	2.4000	.18257	.0333
	Control	34	1.04830	1.1471	.28790	.0882
Total marks	Experimental	30	2.03673	12.7000	1.71572	3.5667
	Control	34	2.78732	10.4412	1.92646	3.4706

It is evident from Table 3 that apparent differences exist in the average scores of students on the total score of the problem-solving test based on the study variable (group), with higher averages observed in the experimental group compared to the control group in the post-test. To investigate the impact of teaching methods and achievement levels on these differences, an analysis of covariance (ANCOVA) was performed. The results are presented in Table 4.

Table (4): Analysis of covariance related to the performance of sixth-grade students on the post-problem-solving test based on the teaching method variable.

Source of Variance	Sum of squares	D.f.	Mean of squares	F	Sig. level	Effect size
Pre problem solving test	14.576	1	14.576	2.456	0.122	0.039
Teaching method	79.440	1	79.106	13.382	0.001	0.18
Error	360.106	61	5.936			
Total	8922,000	64				

The analysis presented in Table 4 indicates statistically significant differences at the level of significance (0.05) between the mean performance scores of sixth-grade students on the post-measurement of the problem-solving test, attributed to the teaching method. These differences favor the experimental group.

The findings indicated that the impact of the instructional approach utilizing mathematical modeling yielded an effect size of 18%. This suggests that the mathematical modeling-based teaching method enhanced the problem-solving test performance of sixth-grade students in the post-assessment. This observation aligns with Cohen's (1988) framework, where a percentage of 14% or higher is deemed significant in explaining variance.

The current findings are attributed by the researcher to the instructional approach focused on mathematical modeling. This method has been found to improve students' mathematical skills, aid in recognizing connections between concepts, and foster thinking patterns that support problem-solving and comprehension. Mathematical modeling serves as both a pedagogical tool and an application strategy that hinges on research, inquiry, and experimentation. The conclusions drawn are supported by practical applications, enabling students to understand mathematical concepts in a more comprehensive, systematic, and organized manner. This process helps internalize the concepts and incorporate them into the cognitive frameworks of students, particularly female students. Consequently, this integration assists students in addressing the issues identified in the study results. The findings of the current study are consistent with previous research (Betanga, 2018; Fulton, 2017; Been, 2016; & Huson, 2016).

Second, results related to the second question: " What is the effect of using mathematical modeling strategy on students’ self-efficiency?”

To answer this question, mean and standard deviation of the responses of sixth-grade female students on the pre- and post-self-efficacy scale were calculated.

Table (5): Means and standard deviations for the performance of sixth-grade students on the pre-and post-self-efficiency scale according to (the teaching method)

Group	Number of students	Pre-test		Post-test	
		SMA	S. D.	SMA	S. D.
Experimental	30	2.56667	1.430778	3.5333	.68145
Control group	34	2.0786	0.28867	2.0	0.3333
Experimental	30	.9000	1.37339	3.5000	.68229
Control group	34	.8235	1.05803	3.5000	1.05169
Experimental	30	.0667	.25371	3.0333	1.03335
Control group	34	.0882	.28790	2.1765	1.11384
Experimental	30	.0333	.18257	2.4000	1.16264
Control group	34	.0882	.28790	1.1471	1.04830
Experimental	30	3.5667	1.71572	12.7000	2.03673
Control group	34	3.4706	1.92646	10.4412	2.78732

Table 5 indicates that there is an apparent difference between the averages of the experimental and control groups in the post-test of self-efficacy in mathematics attributed to the teaching method employed (mathematical modeling versus traditional). The analysis of covariance was conducted on the post-test scores of students on the self-efficacy scale in mathematics, accounting for their pre-test scores. The table below presents the results of the analysis of covariance associated with the students' post-test and pre-test scores of students in the respective study groups.

Table (6): Analysis of covariance associated with the performance of sixth grade students on the pre- and post-test of the self-efficacy scale in mathematics according to the teaching method

Source of variance	**Sum of squares**	**D.F.**	**Mean of squares**	**The calculated F**	**Significance level**	**Effect size**
Pre-test of the Mathematics Self-Efficacy Scale	1.120	1	1.120	8.448	0.005	0.122

Teaching method	28.818	1	28.818	217.448	0.000	0.781
Error	8.084	61	133			
Total	545.130	64				

Table 6 illustrates statistically significant variances in the mean scores of students on the self-efficacy scale in mathematics at a significance level of 0.05. This is evident as the value of F was 217.448, which is statistically significant at the 0.05 significance level. The results indicate a substantial difference in favor of the experimental group over their counterparts in the control group. This suggests that the self-efficacy levels of sixth-grade students in mathematics vary based on the instructional approach they are exposed to. The impact of the teaching method is substantial, with an effect size of 78.1%, signifying a significant influence above the average for the mathematical modeling-based teaching method on the sixth-grade students' performance in the post-test of the self-efficacy scale in mathematics (Cohen, 1988).

The current findings are attributed by the researchers to the proficiency acquired by sixth-grade students through the teaching method of mathematical modeling. This proficiency has had a significant impact on their mental and mathematical cognitive structures, enhancing their way of thinking and bolstering their self-beliefs. As a result, students have demonstrated increased effectiveness and self-efficacy in their problem-solving approaches and overall engagement in various educational scenarios. These outcomes underscore the positive and substantial influence of the mathematical modeling teaching method on the cognitive processes, learning strategies, and teaching practices of sixth-grade students. Moreover, this approach has been instrumental in elevating the students' higher-order thinking skills in a coherent and integrated manner, ultimately leading to improved problem-solving abilities and a deeper understanding and comprehension of mathematical concepts compared to traditional methods of instruction.

Recommendations:

1- Enhancing the Palestinian school curriculum by incorporating strategies for solving mathematical modeling problems across different educational levels.

2- Conducting training sessions for educators focused on mathematical modeling and its application in the instruction of mathematics.

3- Emphasizing the themes of mathematical problem-solving and students' self-efficacy in mathematics due to its influence on the enhancement and ongoing development of the field of mathematics.

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