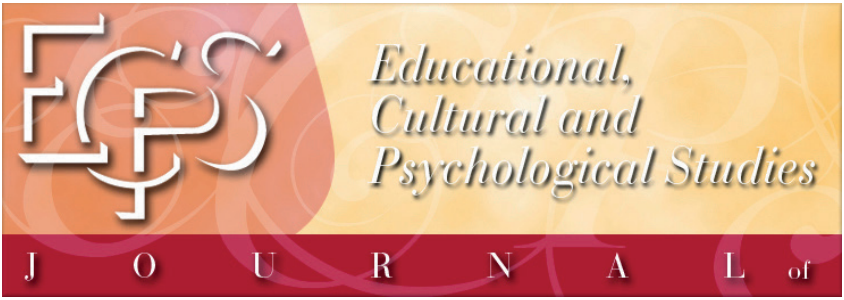

23
June 2021

ECPS Journal – 23/2021 - https://www.ledonline.it/ECPS-Journal/
Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

Recensioni
Reviews

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

The Effectiveness of a Program Based on Problem-Solving in Mathematical Problem Solving among Grade Ten Students

Ahmed Mohammed Al-Kharousi [1]
Adnan Salim Al-Abed [2]

[1] *Ministry of Education (Oman)*
[2] *The University of Jordan (Jordan)*

DOI: https://dx.doi.org/10.7358/ecps-2021-023-khab

alkharosi_555@hotmail.com
a.abed@ju.edu.jo

L'EFFICACIA DI UN PROGRAMMA DIDATTICO BASATO SUL PROBLEM-SOLVING PER PROBLEMI MATEMATICI IN STUDENTI DI TERZA MEDIA

Abstract

This study examined the impact of a program based on problem-solving in mathematical problem-solving among 10th grade students. The sample of this study consisted of (89) male and female students; Wadi Bani Kharous Basic Education School and Om Hakeem Basic Education School located in AlBatina South Governorate (Oman). The study followed the quasi-experimental research design with experimental group consisted of (48) students, and control group consisted of (41) students. The instructional materials of Polynomial and Algebraic Functions Unit and Trigonometric Functions Unit for Grade 10th were designed according to a program based on problem-solving. The problem-solving test was valid and reliable. The findings indicated that there were significant statistical differences in mathematical problem-solving test between the experimental and control group due to teaching method in favor of experimental group. The findings indicated that there were no significant statistical differences in mathematical problem-solving test between male and female students. The findings also indicated that there were statistical significance differences in mathematical problem-solving test due to the

interaction between and teaching method and gender. The study recommended organizing training workshops for mathematics teachers to introduce programs based on problem solving, training them to build educational programs based on problem solving, and urging them to adopt it due to the positive impact it has shown in teaching mathematics.

Keywords: Gender; Grade 10; Mathematical problem-solving; Quasi-experimental research; Teaching method.

1. Introduction

The process of teaching and learning has been improving since decades. In the modern era, education has taken modern trends seriously. Teaching and learning is inspired by modern advancement provided by scientific and experimental research in the field of education and psychology. This asserts the importance of the learners and their interests, the schools' connection with society, and the diversity of modern teaching methods that meets the needs of the teaching and learning process nowadays.

With accordance to the outstanding importance of the mathematics science and its pedagogy, it has been given special priority by the educational systems and the international bodies and organizations. For instance, mathematics curriculum has received a great deal of interest included the development and innovation in its content, learning objectives and teaching methods. Thus, the purpose of mathematics teaching is not only developing the learners' cognitive aspect of knowing the laws, mathematical concepts, theories, the assumptions, and the calculations, but also developing the human mind, improving students' ways of sound thinking, and preparing the individuals who are able to employ mathematical knowledge in solving various problems and in dealing with attitudes and life problems imposed by the requirements of society and the new developments of the modern era (Gad, 2009; Qassi, 2014).

Expanding the goals of mathematics to include different fields of growth requires reconsideration of the mathematics display content with indirect teaching strategies based on learner's problem-solving. This requires the teacher to select teaching strategies to enrich the learners and develop their different mental skills and to give them the right ways of thinking so that they can solve what they face in real-life situations. In addition, these selective teaching strategies should train them to innovate, produce new knowledge and develop trends towards mathematics. Therefore, the

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

mathematics teacher has to be aware of certain aspects including various teaching strategies and their role in education, the importance of listening and paying attention to students' ideas, using new methods to solve problems, and providing information and lessons on problems modality. Being ware of all of these aspects has the impact of inspiring the creative energies of students by showing their opinions and ideas to solve the problem, listen to the opinions of others, to constructively criticize them in order to reach to solutions for these problems that contribute to preparing students to face the problems in real-life situations (James, 2005).

On the other hand, the objectives of mathematics education at the moment emphasize the need to focus on problem-solving as a major goal in teaching mathematics. National Council of Teachers of Mathematics (NCTM, 2000), the highest and largest body dealing with mathematics education, considers solving the mathematical problem as one of the main criteria in the mathematics education. It recommends the necessity to focus on problem-solving and requires the presentation of mathematics topics through problem-solving that enables the students to develop solutions and skills, to gain concepts and generalizations, or to enhance previous knowledge. This is an incentive to learn mathematics and makes it a meaningful material related to real-life situations and needs of learners.

Solving mathematical problems has a long history in the mathematics school, which has been used to achieve a variety of goals that have changed over time. The most well-known advocate of problem-solving in the early 20th century was George Pulya (1945) who stressed in his book (*How to Solve It*) the use of inference in order to develop the ability of students to solve problems (Banes, 2013).

Many studies have shown that students' weakness in using their mathematical knowledge in everyday life may be due to various reasons. One of the important reasons is the display and presentation of the mathematical problems. The second reason is the common content in most of the problem-solving activities that focuses only on the classroom environment and often have only one solution. The third reason is writing specific steps for the solution of the problem even if the problem does not enquire these steps (Bonotto, 2011; Al-Badri, 2017). Additionally, studies have emphasized the need to design the Math curriculum based on mathematical problem-solving in order to develop the level of mathematical thinking for the students and their ability to use mathematical knowledge to infer and formulate appropriate mathematical rules (Sangpom *et al.*, 2016).

The interest in solving problems in contemporary educational trends is evident in a tangible way. Various studies have pointed out the importance of using problem solving and its effectiveness as a strategy to develop

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

the curricula of mathematics. For instance, Al Badri (2017) investigated the effectiveness of an enrichment program based on solving mathematical problems and their role in the development of the ability to infer and form a sense of mathematics among high-achieving students in the 10th grade. A test has been designed in inference and mathematical sense. The study sample consisted of (63) students of high-achieving students in the 10th grade and were divided into two groups, experimental and control. The study found that the experimental group acquired inference skills and the ability to form a mathematical sense. Added to that, the findings indicated the effectiveness of the proposed program in the development of inference and the formation of mathematical sense among the students.

Al-Zoubi's study (2014a) aimed to investigate the impact of a problem-solving strategy in the development of mathematics creative thinking skills among students of a class teacher at Yarmouk University. The sample consisted of (98) students divided into two groups; experimental group with (48) students and a control group with (50) students. The study instrument was a test of creative thinking. The results of the study showed an improvement in mathematical creative thinking skills (fluency, flexibility, and originality) among students in the experimental group. The study also found statistically significant differences between the experimental and control groups in fluency, flexibility, originality and overall test scores in favor of the experimental group. The study recommended the use of problem-solving program because of its role in developing creative thinking skills.

Al-Zoubi's study (2014b) investigated the effectiveness of using a problem-solving teaching strategy in the development of numerical sense among students in the class teacher at Muta University. The study sample consisted of (87) student teachers, divided into two groups, experimental group with (45) students teachers studied using the teaching strategy and control group with (42) student teachers studied in the usual teaching method. A numerical sense test was built that included numerical perception skills, process perception and numerical relationships, computational and mental appreciation and responding logic. The results of the study showed that the students of the experimental group outperformed the control group in the test of the numerical sense and in all numerical sense skills except the skill of the perception of number.

Shubair (2011) conducted a study that aimed to find out the impact of the problem-solving strategy in treating Mathematics learning difficulties in eighth graders. The study adopted the analytical descriptive and quasi-experimental designs. The study sample consisted of (613) students divided into experimental group who studied the problem-solving strategy and the control group who studied in the usual teaching method. The study instru-

ment consisted of a test (diagnostic/achievement) on the unit of trigonometry in the eighth-grade mathematics book. The results of the study found that there is statistically significant differences at the level of significance ($\alpha < .0.01$) in the mean scores of the post-test between the two groups in favor of the experimental group. The study recommended that a problem-solving strategy should be used to teach mathematics to eighth grade.

Al-Khatib and Ababna's Study (2011) aimed to investigate the impact of a problem-solving strategy on mathematics thinking and attitudes towards mathematics in seventh grade in Jordan. The study sample consisted of (104) students divided into two random groups; an experimental group studied using a problem-solving strategy and control studied in the usual way. The results on mathematical thinking showed that the students of the experimental group outperformed those of the control group. It also found that there were no statistically significant differences in mathematical thinking due to the interaction between the teaching strategy and the achievement level. The attitudes of the students in the experimental group were better than those of their peers in the control group. Additionally, there were no statistically significant differences in students' attitudes towards mathematics attributed the interaction between the teaching strategy and the achievement level.

According to the importance of researchers using strategies to solve mathematical problems, this study aimed to examine the effectiveness of a problem-solving program among students in the tenth grade based on their gender.

2. Problem statement and research questions

Mathematics problem-solving is on the top 10 basic skills of Math curriculum included in the National Council of Teachers of Mathematics in United States of America (NCTM) which indicated that Mathematics problem-solving is one of the major skills of Math Curriculum. Thus, developing these skills among students has received attention by educators (Abu Zeina, 2010).

The results of Omani students in the international study (TIMSS) for the academic years 2011, 2015 and 2019 revealed a decline and low achievement of students in Mathematics subject. The results of the Sultanate of Oman are still far from the global average (IEA, 2017; National Report of the International Study in Math and Science, 2013). This decline may be due to students' weakness and inability to solve Mathematic prob-

lems as students of all levels of achievement spend most of their time and effort sorting and extracting data and linking them each other to identify the problem and create a solution plan, which in turn, confirms that a deep understanding of the mathematics problem is the a focal point to solve.

In light of that, there is a need to provide a problem-solving educational program which can contribute to the development of the mathematical problem-solving skills. Therefore, this study aimed to answer the following questions:

- Question 1 – What is the effectiveness of a program based on problem-solving in solving the mathematical problem among grade 10 students?
- Question 2 – Does the mathematical problem solving of grade 10 students differ according to gender?
- Question 3 – Is there any effect in the mathematics problem-solving due to the interaction between the teaching method and gender among grade 10 students?

3. Study hypotheses

The null hypotheses were formulated as following:

- Hypothesis 1 – There is no statistically significant difference at the level of significance ($\alpha = 0.05$) between the average grades of the experimental group that studied according to a program based on problem-solving and the average score of the control group that studied in the usual way in the Mathematical problem solving test.
- Hypothesis 2 – There is no statistically significant difference at the level of significance ($\alpha = 0.05$) in the Mathematical problem solving test of grade 10 students due their gender.
- Hypothesis 3 – There is no statistically significant difference at the level of significance ($\alpha = 0.05$) in the Mathematical problem solving test due to the interaction between mathematical problem solving and gender.

3.1. *Definition of terms*

The following terms were commonly used in this study:

- *Usual teaching method* – Al Badi *et al.* (2020) defined it as the usual way of teaching using the paper and pencil to convey knowledge to the students without technology interference. In this study, it referred to the teaching Math for grade 10 students without a program based on

mathematical problem-solving.

- *Problem solving* – Abu Zeina (2010, 308) defined problem solving as «A new situation confronts the learner and they not have a ready-made solution, so they need the learner to think about it and analyze it and then use what they previously learned to be able to solve it». In this study, it referred to the degree that the student gets in the mathematical problem-solving test prepared by the researcher.

3.2. *Study objectives*

The main objective of this study is to examine the effectiveness of a program based on problem-solving in students' mathematics problem solving skills among male and female grade ten students.

4. Research methodology

The study followed the quasi-experimental design based on two groups; experimental group and control group. The experimental group studied the two units of Polynomial and Algebraic functions (Unit 5) and Trigonometric functions (Unit 6) using a program based on mathematical problem-solving designed by the researcher. The control group studied the same two units in the usual way without a program based on mathematical problem-solving. After the treatment, the two groups took a mathematical problem-solving test.

4.1. *Sample of the study*

Table 1 shows the study sample based on gender variable.

Table 1. – Sample of the study.

Group	Experimental	Control	Total
Male	24	25	49
Female	24	16	40
Total	48	41	89

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

5. Problem-solving program

First: The objectives of the educational program

The overall objectives of the educational program can be determined as follows:

1. To develop students' ability to solve and interpret Math problems.
2. To develop students' ability to accurately organize and arrange information.
3. To enhance the student's self-confidence and self-realization by encouraging them to have dialogues and discussions and listen to others' opinion.

Second: Content of the educational program

After reviewing theoretical literature and previous studies on the solution of Mathematical problems, and after setting the general objectives of the program, the content of the program, which consists of the fifth and sixth units (Polynomial and Algebraic Functions Unit and Trigonometric Functions Unit) were selected from the Math curriculum of semester 2 for grade 10. The content is organized in a way that suits students' preferences and takes into account the integration of educational experiences and a variety of activities.

Third: Identifying the teaching strategies and methods of the educational program

Several strategies were used to implement this program including:

- Modeling.
- Start with a simpler problem.
- Revers solution.
- Open mathematical sentence strategy (organizing equations or inequalities).
- Logical justification strategy.

Fourth: Identify activities and instructional materials associated with the educational program

The educational activities and instructional materials associated with the program are an important element in designing the educational program.

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

This is because they are directly linked to achieving the objectives of the program. Various activities were prepared to increase the effectiveness of the proposed educational program and instructional materials including laws and geometric shapes, models of shapes and figures, and classroom worksheets. In addition, activities book containing a summary of lessons and exercises supporting the educational program was prepared. The educational program emphasized strategies such as group discussions and reinforcement of individual participation. The researcher followed some criteria in order to identify the educational activities and materials associated with the program such as:

- Educational activities and materials should be suitable for the content and objectives of the program.
- Educational activities and materials should be consider differences the level of the students and should motivate students to accomplish the required tasks.
- Educational activities and materials should enhance students' ability to solve Math problem.
- Educational activities and materials should stimulate students' thinking.
- Educational activities and materials should be achievable in light of the possibilities available.

Fifth: The technology used in the program

Technology has become widely spread in the educational context. Educators used various technological tools; projectors, interactive whiteboard, and some computerized software such as GeoGbra, Graphmatica to name but a few.

Sixth: Determining the time and spatial limit of the educational program

The program targeted students in grade 10 in the second semester of the 2018/19 academic year. The program was implemented in an eight-week period at the rate of seven classes per week, and the duration of each class was 45 minutes.

Seventh: Identify the evaluation methods used in the educational program

The evaluation process aims to determine the extent to which the objectives of the program as a whole have been achieved, and the following evaluation methods have been used in the program:

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

- Pre-assessment – The goal is to determine the extent to which students are able to develop the skills that the program seeks to develop. The pre-assessment included mathematics problem-solving test.
- Formative assessment – This assessment was implemented during the implementation of the program through a range of activities associated with the skills to be developed and the feedback of any student who has a weakness in any skill.
- Post-assessment – This was implemented at the end of the program through the re-implementation of the mathematics problem-solving test in order to measure the difference between the pre-assessment and the post assessment and to monitor the impact of the implementation of the program on mathematics problem solving.

5.1. *Research instruments*

To achieve the objectives of the study, a Mathematics problem-solving test was developed. The aim of the Mathematics problem-solving test is to measure the ability of the 10th grade students to solve the mathematical problem associated with the mathematics subject in the 10th grade in the two units that mentioned earlier. The test was initially constructed and included 15 questions, 10 of which were in the form of multiple choice and 5 in the form of essay questions. In order to ensure the validity of the test, it was presented to specialists in the fields of Math curricula, teaching methods, measurement and evaluation. The group of referees, included members of academic bodies at universities, educational supervisors and teachers, express their opinions and suggestions on the test. Some minor adjustments were made including on the language of some vocabulary and one of the multiple-choice questions was deleted. The test ended in its final form with (9) multiple choice and (5) essay questions. The test was applied to a pilot sample to verify the appropriate time for the test, to calculate the coefficients of difficulty, and to extract the stability coefficient. The appropriate time for the test was found to be 50 minutes. Difficulty coefficients ranged from (0.37-0.70) which means that the test items are suitable to be used in the study. The researcher piloted the test to measure its reliability which was found (87.0) which is an acceptable value for the study purposes.

6. Results and discussion

6.1. *Statistical processing*

The quantitative data collected via the test scores were statistically analyzed using SPSS (Statistical Package for the Social Sciences) software. For statistical analysis, the researcher employed SPSS for data processing including descriptive statistics of means and standard deviations. the researcher also used the 2×2-designed (Two-Way ANCOVA) analysis to adjust the differences between the mean scores of two groups in the pre-test and post-test. ETA square (η^2) was also calculated to measure the size effect of the proposed mathematics problem-solving program.

6.2. *Results and discussion*

To answer the study questions and test the associated hypotheses, the mean scores and the standard deviations of test scores in the experimental and control groups were calculated as shown in *Table 2*.

Table 2. – Mean scores, standard deviations and averages adjusted of the pre-test and post-test scores.

Group	Gender	Number	Pre-test		Post-test		Adjusted average
			Mean	*Standard deviation*	*Mean*	*Standard deviation*	
	Male	24	4.66	1.99	16.88	5.26	17.78
Experimental	Female	24	7.79	2.55	17.63	6.25	15.34
	Total	48	6.23	2.76	17.25	5.73	16.56
Control	Male	25	4.52	2.18	9.84	5.63	10.89
	Female	16	5.13	2.78	14.87	7.31	15.31
	Total	41	4.76	2.42	11.80	6.73	13.10
Total	Male	49	4.59	2.07	13.29	6.46	14.33
	Female	40	6.73	2.93	16.53	6.5974	15.33
	Total	89	5.55	2.70	14.74	6.75	14.83

Table 2 shows that there are significant differences between the mean scores of students of the experimental and the control groups. The results indicate that the mean score of the experimental group test scores was (6.23) and the standard deviation (2.78), while the mean score of the control

group was (4.76) and standard deviation (2.42). This shows that there was a difference in the mean score indicated by (1.47) between the two groups before the treatment.

The results also indicate that there are significant differences between the mean scores of the experimental group and the control group in the post-test scores with a mean score of (17.25) and standard deviation of (5.73) for the experimental group and mean score of (11.80) and standard deviation of (6.73) for the control group. This indicates that there is a difference in the mean scores of the two groups (M = 5.45).

Table 2 also shows that there are significant differences between the mean scores of male and female students in the pre-test (1.51). The mean score of male students is (4.59) and the standard deviation is (2.07) whereas the mean score of female students is (6.73) with a standard deviation of (2.93).

It is also noted that there is a difference between the mean scores of the male students and female students in the post-test (M = 3.24) as the mean score of the male student was (13.29) with standard deviation (6.46) and the mean score of the female students was (16.53) with standard deviation of (6.59).

To find out whether the there is any statistical differences ($\alpha = 0.05$) in the mean scores of the students of the experimental and control groups in the post-test and in order to isolate the differences between the two groups in the pre-test, Two-Way ANCOVA analysis with the 2×2 design was used. The ETA (η^2) was also measured to identify the size effect of using the educational program test and the results were as in *Table 3*.

Table 3. – The results of Two-Way ANCOVA analysis.

Source of variance	Sum of squares	Degree of freedom	Mean squares	F value	Significance level	ETA square
Pre-test	489.807	1	489.807	15.767	0.009	0.158
Teaching method	236.116	1	236.116	7.600	0.000	0.083
Gender	18.248	1	18.248	0.587	0.446	0.007
Interaction	235.706	1	235.706	7.587	0.007	0.083
Error	2609.553	84				
Total	23350	89				

The results in *Table 3* indicate statistically significant differences between the mean scores of the two groups on the post-test. The value of (F) was (7.60) and this value is statistically significant at ($\alpha = 0.05$) between the

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

mean score of the students who were taught using the educational program based on mathematical problem-problems, and the average score of those who were taught in the usual way. This leads to the rejection of the first hypothesis: there is no statistically significant difference at the level of significance ($\alpha = 0.05$) between the mean scores of the experimental group students who studied according to the problem-solving program and the mean score with students of the control group who studied in the usual way. Thus, the educational program improved the mathematical problem solving ability of the students of the experimental group, compared to the students in the control group.

The ETA square (η^2) was calculated and found to be (0.083). It can be said that approximately 8.3% of the variation in the mathematical problem-solving between the experimental and control groups is due to the educational program.

There was a difference between the mean sores of the post-test for the control and experimental groups in the post test in favor of the experimental group with adjusted mean score of (16.56) compared to the adjusted mean score of the control group which was (13.10).

This positive result can be attributed to the impact of using the program based on problem-solving in math problem-solving to the following factors:

- The way lessons are carried out in accordance with problem-solving learning has helped students to acquire skills and knowledge through the systematic presentation of lesson content in a variety of ways.
- Presenting various problems that simulate real-life situations during the problem-solving program may have a positive role in providing students with the skills to solve the mathematical problem by applying them in multiple and similar situations.
- The positive effect of students' learning with real problems in overcoming the dislike of math learning, due to the abstract nature that overcomes the subject, consequently; increases their interest in learning, increases their ability to solve math problems.
- The problem-solving program provides a variety of opportunities and multiple sources of knowledge for students by focusing on discussion, dialogue and working in groups, and urging them to exchange ideas, support them with justifications and verify their validity, which has played a role in creating an appropriate and encouraging learning environment.
- The organized steps of problem-solving, that linked students' past experience to new experience in order to create meaningful learning, may play a role in helping them to solve math problems more accurately.

Referring to the analysis of the Two-Way ANCOVA analysis in *Table 3*, the results indicate there is no statistically significant difference at the level of significance (α = 0.05) between the mean scores of students according to their gender in the post-test. The value of (F) was (0.587) indicates that there are no differences attributed to the gender variable. Thus, the second null hypothesis, which states that «There is no statistically significant difference at the level of significance (α = 0.05) in the test to solve the mathematical problem of grade 10 students due their gender», is accepted.

By referring to the results of two-way ANCOVA analysis in *Table 3*, it is evident that there are statistically significant differences at the level of significance (α = 0.05) between the mean scores of students in the control and experimental groups due to the gender variable. (F) value calculated for the difference was (7.587), which is considered statistically significant. Thus, the third hypothesis, which states that «There is no statistically significant difference at the level of significance (α = 0.05) in the mathematical problem-solving test due to the interaction between mathematical problem solving and gender», is not accepted.

The impact factor of ETA (η^2) was 8.3%. The *Figure 1* shows the interaction between the teaching method and the gender of the students.

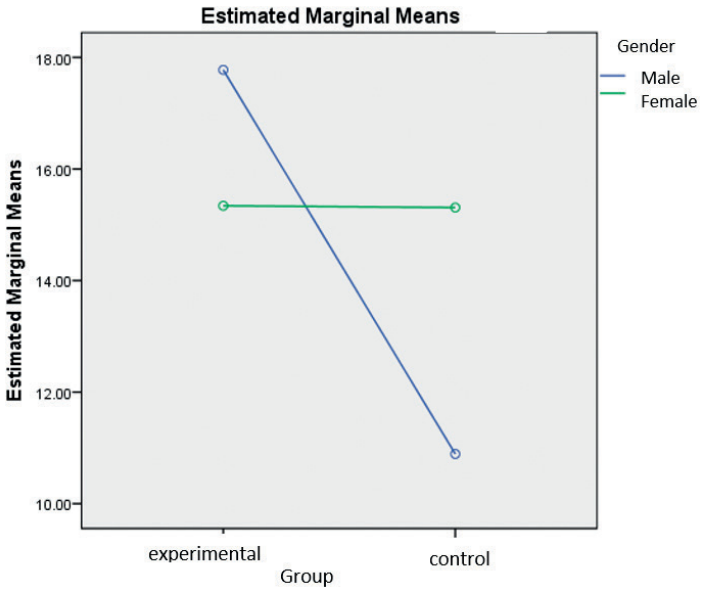

Figure 1. – Interaction between the teaching method and the gender of the students.

Online ISSN 2037-7924 - Print ISSN 2037-7932 - ISBN 978-88-7916-976-9

The statistically significant difference of the interaction between the teaching method and the gender of the students may be attributed to the initiative, enthusiasm, desire and confidence of those Female have positively reflected in their ability to solve math problems.

Recommendations

In the light of the results of this study, the following recommendations can be made:

- Take advantage of the proposed educational program based on solving mathematical problems presented by the researcher by including it in the content of mathematics textbooks.
- Organize training workshops for mathematics teachers to introduce programs based on problem solving, training them to build educational programs based on problem solving, and urging them to adopt it due to the positive impact it has shown in teaching mathematics.
- Conduct similar studies to reveal the effectiveness of programs based on problem-based on other variables and different stages in teaching mathematics.
- Study the effectiveness of the proposed educational program based on solving mathematical problems in enhancing mathematical skills and thinking styles.

References

Abdelkader, Khaled (2013). Difficulties in resolving the verbal problems in math in the sixth grade in Gaza governorate point of view. *Al-Aqsa University Journal*, *17*(3), 77-106. https://platform.almanhal.com/Details/Article/63555

Abu Zeina, Farid Kamel (2010). *Develop and learn school Math curricula*. Amman: Wael Publishing House.

Al-Abed, Adnan, & AL-Shara, Ibrahim (2014). The learning aspects of math in students and their influence on the of their mathematical self-concept and their relationship to their achievement in math. *Al-Najah University Research Journal (Humanities)*, *26*(9), 2065-2104.

Al Badi, A. A., Osman, M. E. T., & Abdo, M. (2020). The impact of virtual writing tutor on writing skills and attitudes of Omani College students. *Journal of Education and Development*, *4*(3), 101. https://doi.org/10.20849/jed.v4i3.828

Al-Badri, Salama Bint Saeed Bin Mohammed (2017). *The effectiveness of a program based on the formation and resolution of mathematical problems in the*

development of the ability to infer, form a mathematical sense and solve math problems and their composition among high-achieving students in the tenth grade according of their mathematical strength. Unpublished PhD Thesis, Sultan Qaboos University (Oman), Faculty of Education.

Al-Badri, Samira Musa (2005). *Educational and psychological terms*. Amman: Culture House for Publishing and Distribution.

Al-Khatib, Mohammed, & Al-Bbnah, Abdullah (2011). The impact of using a problem-solving teaching strategy on math thinking and attitudes towards math in Jordan's seventh grade. *Journal of Educational Sciences*, *38*(1), 189-205.

Almajllawoi, Hamza Mohammed, & Al-Abed, Adnan (2016). The impact of the use of selective models on the achievement of sixth grades in math and their mathematical self-concept. *Al-Manara Journal of Research and Studies*, *22*(3), 378-416.

Al-Zoubi, Ali Mohammed Ali (2014a). The impact of a problem-solving teaching strategy in the development of math creative thinking skills among students of a class teacher. *Jordanian Journal of Educational Sciences*, *10*(3), 305-320.

Al-Zoubi, Ali Mohammed Ali (2014b). The effectiveness of a teaching strategy based on mathematical problem solving in developing the numerical sense of elementary math student-teachers in Jordan. *Mutah for Research and Studies: Humanities and Social Sciences*, *29*(2), 167-204.

Banes, B. C. (2013). *A study of preservice elementary teachers learning mathematics through problem-based learning and problem solving*. Unpublished Doctorate Dissertation, Middle Tennessee State University.

Bonotto, C. (2011). Engaging students in mathematical modelling and problem posing activities. *Journal of Mathematical Modelling and Application*, *1*(3), 18-32.

Bruun, F. (2013). Elementary teachers perspectives of mathematics problem solving strategies. *Mathematics Educator*, *1*(23), EJ1020068, 45-59.

Chapman, O. (2005). Constructing pedagogical knowledge of problems solving: Preservice mathematics teachers. In H. L. Chick & J. L. Vincent (Eds.), *Proceedings of the 29th Meeting of the International Group for the Psychology of Mathematics Education*. Vol. 2 (pp. 225-232). University of Melbourne: Design and Print Centre.

Dickha, O. (2005). Teachers' inferences about students' self-concept in the role of dimensional comparison. *Learning and Instruction*, *15*, 225-235.

Dixon, R., & Brown, R. (2012). Transfer of learning: Connecting concepts during problem solving. *Journal of Technology*, *1*(23), EJ991236, 2-17.

IEA – International Association for Evaluation of Educational Achievement (2017). *TIMMS 2015 and TIMSS advanced 2015 international results*. http://www.iea.nl/timss

Jad, Nabil Salah Al-Masilahi (2009). The effectiveness of a proposed unit according of the structural model in the development of math strength in middle school students. *Journal of Math Education*, *12*, 69-130.

James, E. (2005). Constructing a math applications, curriculum-based assessment: An analysis of the relationship between application problems, computation problems and criterion-referenced assessments. *DAI-B*, *66*(7), 3933.

McMoach, B., & Siegle, D. (2003). The structure and function of academic self-concept in gifted and general education students. *Roeper Review*, *25*(2), 61-65.

Ministry of Education (2013). *National report of the international study in mathematics and sciences for eighth grade, TIMSS (2011)*. Muscat: Ministry of Education.

Mr. Walaa Abdul Fattah Ahmed (2017). The effectiveness of the project-based learning strategy in teaching the assessment and diagnosis course in special education on the academic self-concept and academic achievement among the students of the Special Education Department Prince Sattam Bin Abdulaziz University. *Arab Studies in Education and Psychology – Saudi Arabia*, *88*, 23-44.

NCTM – National Council of Teacher of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teacher of Mathematics.

Qasi, Salima (2014). The extent to which students in the fifth grade of primary school acquire the mathematical thinking skills contained in the new math curriculum. *Journal of Humanities and Social Sciences*, *14*, 170-182.

Sangpom, W., Suthisung, N., Kongthip, Y., & Inprasitha, M. (2016). Advanced mathematical thinking and students' mathematical learning: Reflection from students' problem-solving in mathematics classroom. *Journal of Education and Learning*, *5*(3), 72-82.

Shabir, Imad Ramadan Mohammed (2011). *The impact of the problem-solving strategy on treating math learning difficulties in eighth grade*. Unpublished Master's Thesis, Al-Azhar University (Gaza).

Shoihi, Hasser Bin Hassan Bin Mohammed (2016). *A proposed enrichment program based on the model of creative problem solving in the teaching of math and its impact on the development of the thinking skills of divergence and mental motivation in talented students in the first grade of secondary school*. Unpublished PhD Thesis, King Khalid University (Saudi Arabia), Faculty of Education, .

Siobhan, H. (2007). *Improving basic math skills using technology*. ED512698.

Trna, J. (2014). IBSE and gifted students. *Science Education International*, *25*(1), 19-28.

Riassunto

Questo studio ha esaminato l'impatto di un programma basato sulla risoluzione dei problemi per problemi matematici in studenti di terza media. Il campione di questo studio era costituito da (89) studenti, maschi e femmine; frequentanti la Wadi Bani Kharous Basic Education School e la Om Hakeem Basic Education School, situate in AlBatina South Governorate (Oman). Lo studio ha seguito il disegno di ricerca quasi sperimentale con il gruppo sperimentale composto da 48 studenti e il gruppo di controllo composto da 41 studenti. I materiali didattici dell'Unità delle funzioni polinomiali e algebriche e dell'Unità delle funzioni trigonometriche per il grado di istruzione pari alla terza media, sono stati progettati secondo un programma basato sulla risoluzione dei problemi. Il test di risoluzione dei problemi è risultato valido e affidabile. I dati hanno indicato che c'erano differenze statistiche significative nel test di risoluzione dei problemi matematici tra il gruppo sperimentale e il gruppo di controllo a causa del metodo di insegnamento a favore del gruppo sperimentale. I risultati hanno anche indicato che non c'erano differenze statistiche significative nel test di risoluzione dei problemi matematici tra studenti maschi e femmine, mentre sono state registrate differenze significative nel test matematico di risoluzione dei problemi dovute nell'interazione tra metodo di insegnamento e genere. Lo studio ha comportato l'organizzazione di seminari di formazione per insegnanti di matematica per allestire programmi basati sulla risoluzione dei problemi, visto l'impatto positivo mostrato da questa strategia didattica nell'insegnamento della matematica.

Parole chiave: Genere; Metodo di insegnamento; Problem solving matematico; Ricerca quasi-sperimentale; Terza media.

How to cite this Paper: Al-Kharousi, A. M., & Al-Abed, A. S. (2021). The effectiveness of a program based on problem solving in mathematical problem-solving among grade ten students [L'efficacia di un programma didattico basato sul problem-solving per problemi matematici in studenti di terza media]. *Journal of Educational, Cultural and Psychological Studies*, *23*, 71-88. doi: https://dx.doi.org/10.7358/ecps-2021-023-khab