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The Effectiveness of Problem-Solving Maps in Enhancing the Performance of Grade 8 Students in Factoring Polynomials

David Bowie U. Montales, M.A. Ed.
Assistant School PrincipaI II, Ramon Magsaysay Cubao High School, Philippines
Department of Education, Schools Division Office Quezon City, Philippines
davidmontales27@gmail.com
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Abstract

The primary aim of this study was to determine the effectiveness of Problem-Solving Maps as regards enhancing the performance of the grade 8 students in Factoring Polynomials. The study also aimed to test if there is no significant differences between the pretest and the posttest scores of the subjects. Adopting the experimental method, the study has involved sixty (60) students enrolled in Mathematics 8 during the 1st quarter of the school year 2021-2022 at Felipe G. Calderon High School Manila, Philippines. The researcher chose the subjects employing the purposive sampling technique based from the inclusion criteria formulated. A researcher-made test duly validated by several experts in the field of Mathematics served as the primary instrument of this study. First quarter grades and Pre-test results of the subjects were found comparable prior to conduct the experimentation. In addition, Practice Test 1, Practice Test 2 and Post-tests of the subjects were compared for both control and experimental groups after the experimentation. Results showed a slight difference in their mean score in Pre-test and Practice Test 1 in favor of the control group implying that traditional method remains to be more effective in teaching factoring polynomials. However, when the Pre-test and Post-test were administered for both control and experimental groups and compared their results separately, results yielded a very significant difference in their mean scores in favor of the experimental group. This confirms that the performance of the subjects in factoring polynomials can be further enhanced through the use of Problem-Solving Maps. In totality, the findings suggest that teachers should utilize the Problem-Solving Maps with the combination of traditional method in teaching to enhance the performance of the grade 8 students in factoring polynomials.

Keywords: problem-solving maps, factoring polynomials, effectiveness, enhancement

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1. Introduction

In the time of the pandemic, this was a challenging period of transition to all the mathematics teachers in the public schools in how to deliver the lessons in a short and limited time through online distance learning and modular distance learning. Internet connection problem is one of the concerns of the students that chose online distance learning. Meanwhile, the issue of concerns of the students that chose modular distance learning is the lack of instructions and support from the teachers and family relatives. With these instances, some of the students are losing their interest to learn that results in to increase in the number of students who are no longer participative in the learning activity. Researchers from the different schools in the Philippines observed that their students are having difficulties in following step by step procedure in solving mathematical problems. All mathematics teachers regularly come across students who are unable to comprehend mathematics concepts that have been prudently imparted to them. Mathematics teachers are trying their best to impart the most essential learning competency to the students, particularly in factoring polynomials. Factoring polynomials is a pre-requisite skill that needs to be mastered by a grade 8 student.

The researcher aims to use Problem-Solving Maps in enhancing the skills of the grade 8 students in factoring polynomials. In connected to this, there are studies that were conducted and has a common finding that with the use of problem-solving maps is an effective strategy in teaching Mathematics. According to Sirias (2013), problem-solving maps (PSM) is a new approach in Mathematics that builds three major skill concepts. These are inductive thinking, deductive thinking, and analysis. The Problem-Solving Maps (PSM) are designed to be

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applicable across multiple math topics and grade levels, allowing students to participate in a streamlined learning process that grows with them.

Problem-Solving Maps (PSM) is a learner-centered instruction that focuses on tailoring methods to target the learning needs of each student. Having the problem-solving maps in this study will be able to enhance the performance of the grade eight students in factoring polynomials and it will give a meaningful benefit to the learners in terms of learning mathematics independently.

According to Sirias, D. (2018), the PSM model proposes a set of graphic organizers, referred to as maps, to represent critical thinking processes to solve math problems. Graphic organizers are "visual displays teachers use to organize information in a manner that makes the information easier to understand and learn" (Meyen, Vergason, & Whelan, 1996, p. 132). Educational theories agree that knowledge must be organized to be retained and accessed from long-term memory (Anderson, 1995; Farnham-Diggory, 1992). Graphic organizers are one of the theoretical foundations for the PSM model.

Likewise, According to Dye (2000), "the graphic organizer has its roots in schema theory" (pg.72). When students learn something new, they must be able to retain the information for later use. Our knowledge is stored in a scaffolded hierarchy as a way of organizing information. According to Slavin (1991), people encode, store, and retrieve learned information based on this hierarchy. Information that fits into a student's existing schema is more easily

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understood learned and retained than information that does not. The teacher's task is to ensure that the student has prior knowledge related to the concept and to provide a means for helping the students make connections between prior knowledge and new concepts. Graphic organizers make it easier to link new information to existing knowledge and help students build the schema they need to understand new concepts (Guastello, Beasley, & Sinatra, 2000). If prior knowledge is activated, the schema will be able to provide a framework to which new information can be attached and learning and comprehension will be improved.

Problem-Solving Maps is a graphic organizer that visual displays organized information that makes the connections of information easier to understand and learn.

1.1 Background of the Study

Meaningful Reception Learning

According to Obilade T. (2013), that meaningful reception learning theory was developed by Ausubel who believed that people acquire knowledge primarily through reception rather than through discovery. According to Tomei (2004), The more organized and focused the presentation, the more thoroughly individual will learn. Daley B. (2010) cited that concept mapping was developed by Novak and Gowin (1984) that is based on Ausubel's meaningful reception learning principles. A concept map is a kind of visual road map showing some of the pathways we may take to connect meanings of concepts. The said article proves its relevance in the current study that the use of an advanced organizer provides scaffolding or support for the new information. It is also a conceptual bridge between new material and a student's current knowledge.

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Performance of Students in Factoring Polynomials

Brennan J. (2021), defined factoring polynomials as the opposite process of multiplying polynomials. "If you can't factor the polynomials then you won't be able to even start the problem let alone finish it" as stated by Dawkins P. (2018). The process of factoring polynomials is the reverse process of getting the product of polynomials. Wherein the result in factoring polynomials is expressed in factored form. In the study of Ogbonnaya U., Mogari D., and Machisi E. (2013), stated that factoring can be more tedious and difficult for students of low-mathematical ability especially in cases where strategies such as grouping and factoring the greatest common factor are inapplicable. In the study of Didis M. and Erbas A. (2015), observed that students employed different approaches to factorization depending on the kind of structure of the quadratic equation to be solved such as a) false guess of factors while using the cross-multiplication method; b) attempting to factorize non-factorable quadratic equation, and c) incorrect use of either difference of two squares or the greatest common factor techniques. These observations are the common mistakes that take place as the student performs factoring polynomials. Factoring polynomials is an important topic that must be learned by the students. There are many lessons in mathematics where the first procedure will be the factoring of polynomials. Students are having misconceptions and confusion from the instructions were given by their mathematics teacher. According to Elmore R. (2002), reiterated that students who do not understand the solution are regarded as beyond redemption. Naroth C. (2010) asserts that the role of a mathematics teacher is to create an environment in which students explore multiple strategies for solving mathematical problems.

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Overview of the Problem-Solving Maps

Problem-solving maps (PSMs) were developed by Dr. Danilo Sirias a professor in the College of Business and Management at Saginaw Valley State University Michigan, USA. According to Sirias D. (2018), problem-solving map models are a set of graphic organizers designed to enhance the quantitative reasoning skills, inductive thinking, deductive thinking, and analytical thinking skills of the learner.

In a mathematics class using the traditional method, Stonewater J. (2005) stated that the teacher reviews previous materials and homework, and then demonstrates low-level problem solving followed by seatwork imitating the teacher's demonstration. This pedagogical approach of placing the primary focus on the teacher as a transmitter of knowledge is representative of behaviorist theory asserts by Hackman D. (2004).

According to Weimer M. (2013), learner-centered teaching motivates students by giving them some control over learning processes. In the study of Stefaniak J. and Tracey M. (2015), they stated that students who were engaged in learner-centered activities are more actively engaged in their learning. In the study of Solis C. (2019), she stated that students can work through problems and create a collaborative learning environment.

Effectiveness of Problem-Solving Maps in Mathematics

Many studies state that using problem-solving maps in mathematics is effective in teaching and learning mathematics. Based on the study of Delino C. (2014), stated that the students who were exposed to problem-solving maps performed better than those students who were exposed to the traditional method. Based on the findings of Santos A. (2015) in her study

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that PSM is an effective strategy in teaching mathematics. Based on the study of Frilles-Mariano D. (2016), she concluded that the use of PSM embedded in a cooperative classroom environment is an effective method for improving students' achievement and attitude towards mathematics. According to Dela Vega R. and Pilapil J. (2018), that using Problem-Solving Maps in solving word problems involving polynomial functions was effective. According to Sirias D. (2018), that PSM makes students better thinkers and leads to better performance.

Synthesis

There are many mathematics teaching and learning that are trapped and confined to strategies that are in the prescribed textbooks. Problem-solving maps are a type of instructional material that allows a student to learn and solve problems in mathematics without having too much pressure and having the freedom to learn independently. Problem-solving maps serve as a supporting tool so students can perform mathematics problems with less supervision from the teacher. The PSM model of Dr. Sirias is a learner-centered instructional material that presents a painstaking and logical process to enhance problem-solving skills, which are valuable not only for exceedingly convoluted but also for many regular life decisions. Delino C. (2014), Santos A. (2015), Frilles-Mariano D. (2016), Dela Vega R. all agreed that problem-solving maps are effective in improving student's achievement and in teaching mathematics. On the contrary some expressed their doubt as to the effectiveness of the problem-solving maps which where highlighted by Stonewater J. (2005) and Hackman D. (2004) wherein they found that the common method of teaching mathematics is using the traditional method. It is a teacher-centered and giving the lecture is dominant.

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1.2 Objectives of the Study

The primary aim of this study is to determine the effectiveness of Problem-Solving Maps in Enhancing the Performance of Grade 8 Students in Factoring Polynomials.

Specifically, this research sought to answers to the following questions:

1. What is the participants' performance in the following:
   1.1 Pre-test
   1.2 First Quarterly Grade in Mathematics?
2. How comparable are the control and experimental groups in their Pre-test and First Quarter Grade in Mathematics?
3. What is the performance of the control and experimental group in factoring polynomials in terms of the following:
   3.1 Practice Test 1
   3.2 Practice Test 2
   3.3 Post-test?
4. How do the participants from the control and experimental groups compare concerning the following:
   4.1 Practice Test 1
   4.2 Practice Test 2
   4.3 Post-test?
5. How do the participants Pre-test and Post-test scores compare?
6. How effective are the Problem-Solving Maps (PSMs) in enhancing the performance of the subjects in factoring polynomials?

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2. Methodology

2.1 Research Method

The design that were adopted for the study is the experimental method. Sanora R. (2014) cited that experimental research is research that has the purpose to find cause-effect relationships among variables in controlled. The experimental group were taught factoring polynomials using the problem-solving maps approach while the control group were taught using the lecture approach. An experimental method is appropriate in this study to find and prove the effectiveness of the problem-solving maps approach.

2.2 Population Frame and Sampling Scheme

This study involved two groups from grade 8 students in Felipe G. Calderon Integrated School in Manila. The control group is coming from grade 8 section Bonifacio and the experimental group is coming grade 8 section Calderon. The two groups were selected with the use of purposive sampling technique. According to Crossman A. (2020), A purposive sample is a non-probability sample that is selected based on the characteristics of a population and the objective of the study. Grade 8 students will be part of this study because factoring polynomials is part of the curriculum in grade 8 mathematics. The students must have a grade of 90 and below on the 1st Quarter in Mathematics 8.

2.3 Description of the Respondents

The criteria that were used in selecting grade 8 students from the target population must be officially enrolled in Grade 8 at Felipe G. Calderon High School for the school year 2021 –

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2022. The students must have attended the regular class sessions in Mathematics 8 given by the lead proponent that was conducted during the school year 2021 – 2022. Profile of the students will be gathered through the learners' information system (LIS) with the coordination and approval of the principal.

2.4 Research Instrument

This study employed the researcher-made tests that consist of three sections (A, B, and C). Section A was designed as a pretest which consisted of 30 items to check the ability of the respondents on factoring polynomials. Section B is the mind-building portion of the process wherein the respondents will have exercises on factoring polynomials. Lastly, section C is the posttest which consisted of 30 items to test the students' remembering ability in factoring polynomials. This was developed by the researcher using a table of specifications to ensure content validity. A table of specifications is a blueprint for choosing suitable test items. The researcher decided that 30%, 30%, 20%, 13.33%, and 6.67% of the items cover factoring using the greatest common monomial factor, factoring perfect square trinomial, factoring difference of two squares, factoring quadratic trinomial, and factoring sum and difference of two cubes respectively. The percentages are derived by considering the amount of time allotted to each part of the content. Factoring polynomials are embedded in the K to 12 Curriculum in Mathematics Grade 8. It is presented to the students during the week 1 of the 1st quarter.

The content of the problem-solving maps module as the research materials and the research instrument were validated by a professor from Saginaw Valley State University

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Michigan, USA. Together with licensed professional teachers from the Mathematics Department of Ramon Magsaysay High School.

A dry run was administered through google forms with the permission of the school principal and with the coordination of the Master Teachers in the Mathematics Department of Felipe G. Calderon High School. The targeted respondents were the top two sections in grade 8 level that resembles the attributes to the target respondents. The dry run was commenced during their mathematics class. Item analysis was performed through the responses of the grade students in google forms. The checking and item analysis were done in the google forms at the same time as the grade 8 students answer the questionnaire. The participation of the two top sections will not be part of the actual administration. Revisions was made based from the suggestions during the validation and the results of the item analysis during the dry run. After having found valid and reliable, the actual experimentation was conducted.

2.5 Data Gathering Procedures

The data of this study was collected with the aid of researcher-made tests. The instrument was administered by the researcher online with the use of Google Forms. In doing this, the school administrators were informed in advance through a request letter to approve administering the instrument to respondents. As the school principal approved the request, the researcher informed the other school administrators that the research instrument will be given to the targeted respondents and to make a necessary adjustment to their class schedule. The researcher allotted a ten (10) day sessions through online using the google meet platform. On the first day of

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the intervention, the researcher gave the pre-test and assessed the result. The results of the pre-test was the basis of comparison on the performance of the control and experimental group. Problem-solving maps approach was used in the experimental group while the traditional method of teaching was used in the control group.

The researcher discussed the following topics for every session:

a) factoring using the greatest common factor

b) factoring perfect square trinomial

c) factoring difference of two squares

d) factoring quadratic trinomial

e) factoring sum and difference of two cubes.

As the researcher finished discussing the topics under the factoring polynomials, two practice tests and a posttest through google forms was given to the respondents. The experimentation was done during the 1st Quarter of the school year 2021-2022. Interested students who volunteer to participate was given a consent form to be signed by their parent or guardian and returned to the primary researcher at the beginning process of the intervention. The results of the pretest and posttest was pooled for the thesis project and individual results of this study were remain confidential and anonymous. No costs will be incurred by your school or the individual participants.

3. Results and Discussion

The study yielded the following findings:

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3.1 Performance of the Students in the Pre-test and First Periodic Grade

Table 1
Performance of the Subjects in the Pre-test and First Periodic Grade

Areas	Control		Experimental	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Pre-test	18.500	3.674	18.433	4.141
First Periodic Grade	88.900	4.155	90.800	3.458

The grades of the subjects are based on the grading system below adopted by the school involved in the study:

No.	Descriptive Interpretation	Range of Scores in Pretest and Posttest	Range of Scores in Practice Test	Range of 1st Periodic Grades in Mathematics
1	Outstanding	25 – 30	9 – 10	90 – 100
2	Very Satisfactory	19 – 24	7 – 8	85 – 89.99
3	Satisfactory	13 – 18	5 – 6	80 – 84.99
4	Fairly Satisfactory	7 – 12	3 – 4	75 – 79.99
5	Did Not Meet Expectations	0 – 6	0 – 2	70 – 74.99

Based on the data in Table 1, the mean score of students in the control group was 18.500 with a standard deviation of 3.67423 while the experimental group obtained a means score of 18.433 with a standard deviation of 4.141. With regards to the first periodic grade, the control group recorded a mean grade of 88.900 with a standard deviation of 4.155. Finally, the

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experimental group obtained a mean grade of 90.800 and a standard deviation 3.458. Analyzing the figures, it could be observed that the mean scores of the control group is slightly higher compared to the experimental group. Consequently, the mean grade of the experimental group is slightly higher than the mean grade of the control group. The grades and scores were then compared.

Thus, the performance of the subjects in the Pre-test and First Periodic Grade was above average.

3.2 Test of Comparability of Control and Experimental Groups in their Pre-test and First Periodic Grade in Mathematics

Table 2
Comparison of the Subjects' Pre-test and First Periodic Grade

Areas	Mean	S.D.	t-value	p-value	Sig.
Pre-test – Control	18.500	3.674	0.066	P = 0.948 > 0.05	**NS**
Pre-test – Experimental	18.433	4.141			
First Periodic Grade – Control	88.900	4.155	-1.925	P = 0.59 > 0.05	**NS**
First Periodic Grade – Experimental	90.800	3.458			

Before the conduct of experimentation, the first periodic grades of the subjects in Mathematics 8 and pre-test results in factoring polynomials for both control and experimental groups were equated using t-test. As revealed in Table 2, both control and experimental groups were primarily comparable as specified by the t-test results. In specific, the control and experimental groups for the pre-test results gathered a t-value of 0.066 with a P-value of 0.948 which is greater than the

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alpha level of significance of 0.05 yielding no significant differences in their pre-test results. Hence, primarily both groups are truly comparable statistically.

As regards to their first periodic grade in mathematics, the grades of both control and experimental groups are similarly comparable as specified by the t-value of -1.925 and a P-value of 0.59 which is also greater than the alpha level of significance of 0.05 interpreted as no significant difference.

Due to the no significant differences recorded in their pre-test scores and first periodic grade in mathematics, it could be said that both groups consequently have recognized comparability before the experimentation. This means that there is no relationship existing between the pre-test scores and first periodic grade in mathematics of the subjects from the control and experimental group. This implies that subjects do perform uniformly in Mathematics 8.

3.3 Performance of the Control and Experimental Groups in Practice Test 1, Practice Test 2 and Post-test

Table 3
Control and Experimental Groups Scores in Practice Test 1, Practice Test 2 and Posttest

Areas	Control		Experimental	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Practice Test 1	7.233	2.254	7.000	2.491
Practice test 2	8.200	1.584	9.066	1.507
Posttest	22.766	3.645	26.533	2.300

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As viewed in Table 3, the control group obtained a not higher than the experimental group using the problem-solving maps in Practice Test 1 after the several activities conducted during the virtual enhancement lesson. This was verified by the mean score of 7.233 with a standard deviation of 2.254 by the control group. Apparently, the experimental group garnered a mean score of 7.000 and a standard deviation of 2.491. Nevertheless, according to the school's grading system, both the control and experimental groups have earned a "Very Satisfactory" performance in their Practice Test 1.

With regard to the subjects' Practice Test 2 scores, the control group showed a slight difference in terms of performance compared to the experimental group in the Practice Test 2 using the problem-solving maps. The experimental group garnered a mean score of 9.066 and a standard deviation of 1.507. This is extremely higher compared to the mean score obtained by the control group which is 8.200 and a standard deviation of 1.507. Based from the grading system of the school, the score of the control group in the Practice Test 2 was considered "Very Satisfactory" while the mean score of experimental was marked "Outstanding".

On the other hand, in terms of Post-test results, an extremely high difference in the scores obtained by the two groups was also recorded. The control group obtained only a mean score of 22.766 and a standard deviation of 3.645 while the experimental group obtained a mean score of 26.533 and a standard deviation of 2.300.

In Practice Test 1 suggests that the control group cannot advance entirely from the tradition method of teaching as most of the respondents are still dependent on the direct instruction given by the teacher in the classroom. Since factoring polynomials is a tedious and difficult for students of low-mathematical ability especially in cases where strategies such as

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grouping and factoring the greatest common factor are inapplicable (Didis M. and Erbas A., 2015), the role of a mathematics teacher is to create an environment in which students explore multiple strategies for solving mathematical problems (Naroth C., 2010).

With regards to the subjects' score in the Practice Test 2 and Posttest, there is a high difference recorded in their mean score. It can be concluded that using problem-solving maps made an impact in the subjects' performance in factoring polynomials.

Thus, it can be concluded that with the use of the problem-solving maps in addition to the traditional method of teaching can support to facilitate in enhancing the grade 8 students' performance in factoring polynomials.

3.4 Comparison of the Performance of the Subjects from the Control and Experimental Groups Practice Test 1, Practice Test 2 and Post-test

Table 4
Comparison of the Control and Experimental Groups in Practice Test 1, Practice Test 2 and Posttest

Areas	Mean	S.D.	t-value	p-value	Sig.
Practice Test 1 – Control	7.233	2.254	0.380	P = 0.705 > 0.05	**NS**
Practice Test 1 – Experimental	7.000	2.491			
Practice Test 2 – Control	8.200	1.584	-2.171	P = 0.034 < 0.05	**S**
Practice Test 2 – Experimental	9.066	1.507			
Posttest – Control	22.766	3.645	-4.786	P = 0.000012 < 0.05	**VS**
Posttest – Experimental	26.533	2.300			

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Table 4 shows the comparison of the control and experimental group in Practice Test 1, Practice Test 2 and posttest after the experiment using t-test.

As compared statistically, the results showed that the there was no significant difference in the Practice Test 1 of both groups indicated by t-value of 0.380 and a P-value of 0.705 which is greater than 0.05. It implies that the subjects are still adapting in the learning process with the application of traditional method and problem-solving maps in enhancing their skills in factoring polynomials.

On the other hand, there was a significant difference recorded in the scores of the subjects in their Practice Test 2. As shown in the table, the t-value garnered -2.171 with a P-value of 0.034 which is less than 0.05. It is clearly depicted that there is an improvement in the performance of the subjects in factoring polynomials whether traditional approach or problem-solving maps is being applied. In particular, the finding implies that the subjects find the problem-solving maps approach is more favorable than traditional approach as indicated by the mean score of 9.066 with a standard deviation of 1.507 of the experimental group which is slightly higher than of the control group that obtained a mean score of 8.200 and a standard deviation of 2.491.

Finally, in terms of the Post-test scores, it was distinguished that there was a very significant difference in both the experimental and control group in their score. The both garnered a t-value of -4.786 and a P-value of 0.000012 which is less than 0.01. It means that a change truly exists upon the conduct of the experimentation involving traditional approach and the use of problem-solving maps. In specific, the result shows that the subjects treasure the problem-solving maps approach more favorable than traditional approach as indicated by the

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mean Posttest of 26.533 with a standard deviation of 2.300 of the experimental group which is extremely higher than that of the control group that obtained a mean score of 22.766 and a standard deviation of 3.465

As a whole problem-solving maps approach appears to be more favorable than the use of traditional approach in factoring polynomials as shown in subjects' Practice Test 2 and Post-Test results. Problem-solving maps approach which includes graphic organizer that visualizes the connection of one procedure to another. As related with the Novak and Gowin (1984), in showing some pathways we may take to connect meanings of concepts. The students have already an idea in performing the next procedure due to the advanced organizers that provide scaffolding or support that served as a bridge between the previous and present procedure it is related to Sirias D. (2018), problem-solving maps models are designed to enhance the quantitative reasoning skills, inductive thinking, deductive thinking, and analytical thinking skills of the learner.

3.5 Comparison of the Subjects' Pre-test and Post-test Scores

Table 5: Comparison of the Subjects' Pretest and Posttest Scores

Areas	Mean	S.D.	t-value	p-value	Sig.
Pretest – Control	18.500	3.674	0.066	P = 0.948 > 0.05	**NS**
Pretest – Experimental	18.433	4.141			
Posttest – Control	22.766	3.645	-4.786	P = 0.000012 < 0.05	**VS**
Posttest – Experimental	26.533	2.300			

Table 5 shows the results of comparison of the subjects' pre-test and post-test scores. In terms of Pre-test results, it was noted that there is "No Significant Difference" that exists in both

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experimental and control group in their scores, they both yielded a t-value of 0.066 and a P-value of 0.948 which is less than 0.05. It indicates that the subjects are having difficulties in performing factoring polynomials whether they use the traditional approach or the problem-solving maps approach. However, based from the data gathered in Pre-test, the control group obtained a mean score of 18.500 which is slightly higher than the the experimental group with a mean score of 18.433. It implies that traditional teaching has an impact in the performance of the subject in factoring polynomials before the conduct of the experimentation.

Correspondingly, there was a "Very Significant" difference in the Post-test scores of the control and experimental group. The data vividly revealed that the both groups yielded a t-value -4.786 and a P-value of 0.000012 which is less than 0.01. The results clearly suggest as well that using problem-solving maps contributed to the differences in their scores obtained in their Post-tests as supported by the increase of mean grade. From the Pre-test of 18.433 and a standard deviation of 4.141, the experimental group obtained a mean score of 26.533 and a standard deviation of 2.300 in the Post-test.

3.6 Effectiveness of the Problem-Solving Maps (PSMs) in Enhancing the Performance of the Subjects in Factoring Polynomials

In totality, the findings revealed that the null hypothesis was rejected. Hence, problem-solving maps are effective in enhancing the performance of the subjects in factoring polynomials. As evidenced by the performance of the students from experimental groups during their Pre-test and Post-test. It was referred to the previous studies that focus on using problem-solving maps. The first previous study was written by Delino C. (2014) conducted in

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experimental design in form of one group pretest-posttest in using problem-solving maps in teaching geometry at Canumay East National High School Division of Valenzuela City Philippines. The second one is a thesis written by Frilles-Mariano D. (2016) in experimental design in embedding problem-solving maps in a cooperative classroom environment at Philippine Normal University. They stated that the use of problem-solving maps is an effective method for improving students' achievement and attitude towards mathematics.

In having the enhancement lesson to the subjects of this study, it has shown that there is a great development and progress in the performance of the subjects in factoring polynomials. It is also a validation that problem-solving maps approach is a learner-centered activity that must be employed to the learning process of the students. As stated by Weimer M. (2013), learner-centered teaching motivates students by giving them some control over learning process.

4. Conclusions

Based from the findings of the researcher, the following conclusions were drawn:

1. The performance of the subjects in factoring polynomials prior to the experimentation was satisfactory and above average.
2. The subjects from the control and experimental groups employed in the study have the same performance in factoring polynomials prior to the experimentation.
3. The level of performance of the subjects in the practice tests and posttest has a notable improvement as they undergo the treatment.

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4. Blended approach of teaching (a combination of traditional method and the use of problem-solving maps) can contribute significantly in the enhancement of skills of grade 8 students in factoring polynomials.
5. The use of the problem-solving maps can scaffold the ambiguity among the grade 8 students in factoring polynomials that will contribute to the development of their quantitative reasoning skills, inductive thinking, deductive thinking, and analytical thinking skills.
6. Problem-solving maps approach is an effective means of teaching factoring polynomials among the grade 8 students when used as a supplement to the traditional method.

5. Recommendations

With the findings and conclusions, the researcher hereby presents the following recommendations:

1. The teachers should assimilate and combine Problem-Solving Maps into their face to face classes to uphold quality education for the students and support them build an interactive understanding of the mathematics.
2. The conduct of seminars, trainings or workshops about pioneering teaching strategies concerning the use of Problem-Solving Maps may be planned in various schools to aid support the teachers who are dealing with different types of students in the 21st century.
3. More materials (e.g. worksheets or modules) on Mathematics with an integration of Problem-Solving Maps should be considered, advanced and corroborated from time to time.

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4. Future researchers may conduct studies including more subjects from various courses along this line to explore further probable of Problem-Solving Maps Approach in other learning areas especially those that are measured complicated.

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ISSN 2960-3986
GEO Academic Journal Vol. 4 No. 1 – 2023 series

7. References:

Brennan J. (2021). Understanding algebra. Retrieved May 21, 2021, fromhttps://jamesbrennan.org/algebra/polynomials/ factoring_ polynomials.htm

Crossman A. (2020). Understanding purposive sampling. Retrieved May 23, 2021 from https://www.thoughtco.com/purposive-sampling

Daley B. (2010). Concept maps: Practice applications in adult education and human resource development. New Horizons in Adult Education and Human Resource Development. Retrieved May 23, 2021, from https://files.eric.ed.gov/fulltext/EJ969502. pdf

Dawkins P. (2018). Paul's online notes. Retrieved May 21, 2021, from https://tutorial.math.lamar.edu/classes/alg/factoring. aspx

Delino C. (2014). The effect of problem-solving maps in teaching geometry on the academic performance of third year high school students at Canumay East National High School Division of Valenzuela City

Didis M. and Erbas A. (2015). Performance and difficulties of students in formulating and solving quadratic equations with one unknown. educational sciences: Theories and Practices. 2015 August. Retrieved May 23, 2021, from https://files.eric.ed.gov/fulltext/EJ1100800.pdf

Effectiveness. 2021. In https://dictionary.cambridge.org Retrieved May 23, 2021, from https://dictionary.cambridge.org/us/dictionary/english/ effectiveness

Dye, G. A. (2000). Graphic organizers to the rescue! helping students link and remember information. Teaching Exceptional Children, 32(3), 72-76.

Elmore, R.F., 2002. The limits of change. Retrieved 23 May 2021, from https://theywilllearn.files.wordpress.com/2010/02/ limit s_change11. pdf

Enhancement. 2021. In https://dictionary.cambridge.org Retrieved May 23, 2021, from https://dictionary.cambridge. org/dictionary/english/enhancement

Frilles-Mariano D. (2016). Problem solving maps (PSM) Embedded in a cooperative classroom environment: Effect on students' achievement and attitude towards mathematics. Philippine Normal University

Guastello, E. F., Beasley, T. M. & Sinatra, R. C. (2000). Concept mapping effects on science content comprehension of low-achieving inner-city seventh graders. Remedial and Special Education, 20(6), 356-364.

DOI: https://doi.org/10.56738/issn29603986.geo2023.4.28
ISSN 2960-3986
GEO Academic Journal Vol. 4 No. 1 – 2023 series

Hackman D. (2004). Constructivism and block scheduling: Making the connection. Phi Delta Kappan, 85(9): 697-702. Retrieved May 23, 2021, from https://www.researchgate.net/publication/274999287_Constructivism_and_Block_Scheduling_Making_the_Connection

Love C. (2014). 5 Reasons to use Google forms with your students. Retrieved May 23, 2021, from https://www.technokids.com /blog/apps

Marshall SP. *Schemas in problem solving*. New York, NY: Cambridge University Press; 1995.

Naroth, C. 2010. Constructive teacher feedback for enhancing learner performance in mathematics. Unpublished Masters Dissertation. University of the Free State, Bloemfontein South Africa

Obilade T. (2013). The use of meaningful reception learning in lesson on classification. international journal of home economics. Retrieved May 18, 2021, from https://vtechworks.lib.vt.edu/bitstream/handle/10919/51588/2013ObiladeUseOfMeaningfulReception.pdf?sequence=1&isAllowed=y

Ogbonnaya U., Mogari D., and Machisi E. (2013). A comparison of low performing students' achievement in factoring cubic polynomials using three different strategies. International conference on educational technologies. Retrieved May 23, 2021, from https://files.eric.ed.gov/fulltext/ED557182.pdf

Sanora R. (2014). Chapter III: Research method. Retrieved May 23, 2021, from http://repo.iain-tulungagung.ac.id/519/7/CHAPTER% 20III.pdf

Santos A. (2015). The effect of problem-solving maps in academic performance of grade 7 students in mathematics. Mapulang Lupa National High School, Division of Valenzuela City.

Sirias D. (2018). A proposed model to improve quantitative reasoning: the problem-solving maps. Northeast Decision Sciences Institute 2018 Annual conference, Providence, Rhode Island, USA

Sirias D. (2013). Managing Math with problem solving maps. Retrieved May 18, 2021, from https://www.tocforeducation. com/maps.pdf

Slavin R.E. (1991). Educational psychology (3rd ed.). Needham Heights, MA: Allyn & Bacon

Smith G. (2017). What is learner-centered? how to teach 100% better with a Learner-Centered Approach. Retrieved May 23, 2021 from https://thisisgraeme.me/2017/03/06/approaches-what-is-learner-centred/

DOI: https://doi.org/10.56738/issn29603986.geo2023.4.28
ISSN 2960-3986
GEO Academic Journal Vol. 4 No. 1 – 2023 series

Stefaniak J. and Tracey M. (2015). An exploration of student experiences with learner-centered instructional strategies. Contemporary educational technology. Retrieved May 23, 2021 from https://www.cedtech.net/download/an-exploration-of-student-experiences-with-learner-centered-instructional-strategies-6142.pdf

Solis C. (2019). Correlating students' academic performance and attitude towards mathematics through problem-solving maps (PSM): Inputs for teacher training development plan

Stonewater J. (2005). Inquiry teaching and learning: The best math class study. School Science and Mathematics. Retrieved May 23, 2021, from https://www.researchgate.net/publication/250948257_Inquiry_Teaching_and_Learning_The_Best_Math_Class_Study

Tomei L (2004). Reception learning and David Ausubel, October 20, 2004. Retrieved May 18, 2021, from http://faculty.rmu.edu/~tomei/ed711psy/c_ausub.htm

Weimer M. (2013). A summary learner-centered teaching: Five keys changes to practice. Retrieved May 23, 2021 from https://cte.tamu.edu/getattachment/Faculty-Teaching-Resource/Program-ReDesign/Orientation-and-Team-Formation/Book-Summary-Learner-Centered-Teaching-by-Maryellen-Weimer.pdf.aspx#:~:text=Learner%2Dcentered%20teaching%20encourages%20students,how%20they%20are%20learning%20it.&text=Learner%2Dcentered%20teaching%20motivates%20students,some%20control%20over%20learning%20processes.