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The Effectiveness of Problem Solving Maps (PSM) on Learning Linear Equation of Grade 8 Students

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Abstract: This study aimed to determine the effectiveness of problem solving maps (PSM) on the academic achievement of Grade 8 students in learning linear equation. The study used an experimental design. The researchers' population consisted of all Grade 8 students of Antonio J. Villegas Vocational High School. The sample size consisted of 98 selected Grade 8 students divided into two groups. Two groups were taught the same lesson for three weeks. The control group was taught using the traditional teaching with similar activities approach while the experimental group was taught using Problem Solving Maps with three sets of activities and three sets of evaluation and facilitation for three weeks duration. The scores of both the pretest and posttest were taken and these data were statistically treated using mean, standard deviation, and t-test for significant difference. Through results and discussion, we concluded that there is significant improvement in student's learning outcomes as well as their classification after PSM implementation. Finally, findings of the study revealed that there is an improvement in the groupings of students both in the control and experimental group but significant improvement was shown for the students taught using PSM.

KEYWORDS: problem solving maps; effectiveness, students

I. Introduction

Since time immemorial, there is a consensus that the concept of "numbers" is the foundation of an orderly society and organized life, and is one of the important concepts of Mathematics. Man and mathematics have been co-existing and partners since the dawn of civilization, working in synergy in the advancement of human civilization. Crude mathematics had its beginnings when man learned to count with his fingers. We can therefore perceive the importance, indispensability, and relevance of Mathematics in the animate and inanimate worlds; it is the science of numbers in man's everyday life. However, we should be aware that Mathematics is a field of study that is relatively easy to teach, but, for the students, difficult to learn, appreciate and comprehend, much less like. Raising learners' achievement in mathematics has become a matter of increased focus in recent years. Improving the quality of teaching mathematics may likely raise students' achievement in mathematics. Studies seem to agreeably suggest those learners who receive high quality instruction in mathematics experience greater and more persistent achievement gains than their peers who receive lower-quality instruction in mathematics (Rivkin, 2005). "The Mathematics teachers should have complete awareness of the difficulties proven as potent factor that hinder students' intellectual growth. Unless these difficulties are solved, the teacher could not expect them to show satisfaction and enjoyment in studying the subject, according to (Songco, 1991). (Doefer, 1965), states that it is the obligation of the school to provide the best possible education in Mathematics. Responding to these several studies and research on how to make Mathematics interesting and appealing to students and to avoid failures have been conducted, but these are not enough. Intervention or Remedial Program should be made. Thus, Problem Solving Maps, a book by Danilo Sirias, Ph. D., which recommends the use of Mathematics to improve critical thinking skills, was used in this research.

`The project aims to evaluate the effectiveness of Problem Solving Maps in learning linear equation of Grade 8 students of Antonio J. Villegas Vocational High School.

II. Statement of the Purpose

This study aims to determine the effectiveness of problem solving maps (PSM) on learning linear equation of the Grade 8 students of Antonio J. Villegas Vocational High school. Specifically, this study aims to:

1. What is the pre-test performance of the control and experimental group?
2. What is the posttest performance of the control and experimental group?
3. Is there a significant difference between pre-test scores of the control and experimental group?

4. Is there a significant difference between post-test scores of the control and experimental group?
5. Is there a significant difference between pre-test and posttest performance of the control group and experimental group?
6. What recommendations can be given to further improve PSM as an innovative/intervention approach?

III. Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference between the pretest result of the control and experimental group.
2. There is no significant difference between the posttest result of the control and experimental group.
3. There is no significant difference between the pretest and posttest result of the experimental and control group.

IV. Related Literature

To improve critical thinking skills a teaching strategy or approach in teaching and learning will be used. The proposed model is not very complicated. It does not require purchasing fancy software or taking a long training program. It is not a new curriculum which you currently used to teach your classes. In fact, the process only requires viewing the purpose of learning math in different light. It is not about what to teach but "how" to teach math. The first part includes a reflection of the problems associated with traditional approach. Thus, the philosophy for teaching is proposed. The final product is the set of tools called Problem Solving Maps. These maps are generic which can be used to teach a variety of math topics.

"With the maps, it is very easy to find out the gaps students have in their knowledge", "Karyna Lopez, teacher at Colegio Greenwich, Mexico

"The math tools enable us to organize our thougt by pattern. Learning a thinking pattern makes life much easier, not only in studying math, but also in various aspect of everyday life." Motoi Tobita, Ph. D, Secretary General , TOCFE, Japan

"The way we learned the exponent properties was very interesting…I think this will stick in my head because it was not boring way to understand things or remember things. We should do this often. I like it very much." High school student,USA

Problem solving is defined by Schoenfeld as "a task (a) in which the student is interested and engaged and for which he wishes to obtain a resolution, and (b) for which the student does not have a readily accessible mathematical means by which to achieve that resolution" (Schoenfeld, 1989) as cited in (Bottge, 2004), p. 81). Some of the challenges for students in problem solving are poor reading comprehension, lack of confidence in their ability to solve problems, lack of interest in the problem at hand, and little experience solving non-routine problems (Bottge, 2004). Providing students with direct instruction on specific problem-solving strategies such as make a diagram, guess and check, consider a simpler case, and look for patterns has benefited some students. Higgens (1997) compared three classes of middle school students who received five weeks of direct instruction on problem-solving strategies with three other classes that received more traditional instruction. Additionally, the students experiencing problem-solving strategy instruction were given weekly challenge problems for the remainder of the year following the initial five-week strategy instruction. Each weekly challenge problem had no obvious way to arrive at a solution and was geared toward the interests of sixth and seventh graders. Throughout the week, these students would share their strategies for the problem with one another. Problems requiring laboratory work, manipulatives, cooperative learning, and guided discovery also were incorporated throughout the year. The three classes that received the more traditional instruction did not receive any direct problem-solving instruction or specific exposure to solving non-routine problems. At the end of the school year, students were interviewed and given problems to solve. In general, the students receiving direct strategy instruction and weekly challenge problems faired better at solving non-routine problems.

Bottge (1999) is concerned about teaching practices that withhold complex content from below average students until easier material is mastered. Bottge recommends engaging students in "challenging and meaningful problems" using contextualized or

anchored instruction (p. 82). Anchored instruction is instruction that places students in a scenario students might encounter and allows them to explore the mathematics that occurs in that situation. It also allows the students to create some of the mathematical questions they would like to investigate in that context. In Bottge's study, some remedial eighth-grade students received contextualized instruction and others did not. The contextualized, or anchored, instruction began with a series of video vignettes. These 15-minute segments provided stimulating and meaningful contexts and served as a springboard for more exploration. Just as in life, the problems were not explicitly stated, so the students determined what they were trying to solve. The descriptions of the discussion and interaction that took place as the students investigated these scenarios made it apparent that students were invested in the project. The final problem was to design and build two skateboard ramps within certain constraints. Bottage concluded that many of the students who were given complex, contextualized problems showed improvement in their problem solving.

V. Methodology

This action research utilized the experimental design since its main purpose was to determine the effectiveness of Problem Solving Maps and its possible effect to the mean gain scores on achievement of pupils on a three weeks lesson in Grade 8 Mathematics.

Two groups were taught the same lessons for three weeks. The control group was taught using the single teaching with similar activities approach while the experimental group was taught using Problem Solving Maps with three sets of activities and three sets of evaluation and facilitation for the three groupings of pupils for the three weeks duration. Two regular sections were included in the study out of the twelve Grade 8 sections that the school have.

Both groups were given the diagnostic test to identify the classification of pupils whether they belong to the above average group, average group, and below average group. The achievement test was administered after three weeks using parallel teacher-made tests. The number of students was again identified to know whether there was change in their classification. The results of the pretest and the posttest were compared to determine whether using PSM change the performance of the students.

VI. Data Gathering

After seeking the approval from the principal, the teacher-researchers started the experiment.

The scores of both the pretest and the posttest were taken and these data were coded, tallied, and were statistically treated using the mean, standard deviation, and t-test of significant difference.

The mean and the standard deviation were used to determine the level of performance of control and experimental groups and the classification of pupils, while the t-test was employed to determine the significant difference of the mean scores on pretest and posttest of both groups.

VII. Results and Discussions

The following are the results and the analysis done from the data.

A. Performance of the Two Groups of Respondents in the Diagnostic Test (Pretest).

The result of the pretest and posttest of the two class groups is presented in Table 1.

Diagnostic scores reveal that the control group has a mean of 14.08 [Sd=3.11] while the experimental group reported a mean score of 15.40 [Sd= 3.15] which is a little higher.

Table 1:Pretest Results of the Control and the Experimental Group

Groups	N	Mean	SD
Control	48	14.08	3.11
Experimental	50	15.40	3.15

The variance results of 3.11 and 3.15 are not that big which signify that both classes are heterogeneous; meaning the students were of different level of intelligence. This is indeed a good baseline since the results suggest that the two sections included in the study are almost the same in the manner that the scores are scattered. This means that the student's grouping are mixed as to their abilities.

Tomlinson (2009) claimed that pupil's differences should be addressed and the two groups became an ideal grouping for which the experiment was conducted.

B. Performance of the Two Groups of Respon-dents in the Achievement Test (Posttest).

Table 2: Posttest Results of the Control and the Experimental Group

Groups	N	Mean	SD
Control	48	16.63	2.20
Experimenta	50	22.08	2.86

The level of performance of the two groups in the posttest is presented in Table 2.

The experimental group of pupils who were exposed to PSM obtains a mean score of 22.08 [Sd=2.86] while the control group who were taught using the traditional method obtain a mean score of 16.63 [Sd=2.20].

The result showed that the posttest scores of the experimental groups taught with PSM is remarkably better as compared to those which were taught the traditional approach. Looking at the standard deviation scores, it implies that the variance of both the control and experimental groups were smaller which suggests that the students' intellectual ability were not scattered unlike in the pretest result.

C. Classification of Students in the Control and Experimental Group Based on the Pretest and Posttest Scores Results

Table 3: Classification of Students Before the Problem Solving Maps (PSM)

Table 3 presents the grouping of the students both in the control and in the experimental group.

Score Range	Classification	Diagnostic (Pretest)				
		Control (Mean = 14.08)		Score Range	Experimental (Mean =15.40)	
		f	%		F	%
17.19 above (+1 Sd)	Above Average	12	25	18.55 Above (+1Sd)	14	28
11 - 16	Average	29	60.42	13-17 Average	26	52
10.97below (-1 Sd)	Below Average	7	14.58	12.25 Below (-1 Sd)	10	20
	Total	48	100		50	100

As per classification of students based on the mean and standard deviation results, a majority of the students were on the average group for the control and experimental group prior to the treatment. However, after the experiment, there was a big increase in number of students for the average group for the experimental group and a larger number now belongs to the above average group. There were few students reported to be in the below average group for both the control and the experimental group.

Data suggest that both approach in teaching increased the achievement but remarkable increase was noted in the group taught with PSM.

C. Classification of Pupils in the Control and Experimental Group Based on the Pretest and Posttest Scores Results

Score Ran	Classificati	Achievement (Posttest)				
		Control (Mean = 16.63		Score Ran	Experimental (Mean = 22.08	
		f	%		F	%
18.8above (+1 Sd)	Above Average	20	41.66	24.9Above (+1Sd)	23	46
15-17	Average	23	47.92	2023 Average	20	40
14.4Below (-1 Sd)	Below Average	5	10.42	19.4Below (-1 Sd)	7	14
	Total	48	100		50	100

Table 3.1:(Above) Classification of Students After Problem Solving Maps (PSM)

Table 3.1 presents that after the experiment, there was a big increase in number of students for the average group for the experimental group and a larger number now belongs to the above average group.

Data suggest that both approach in teaching increased the achievement but remarkable increase was noted in the group taught with PSM. This improvement in the classification or grouping of pupils in both groups assumes the principle that both groups who are taught by the same teacher with the same lesson could normally have a change in aptitude especially if the teacher has addressed the differences as averred by Anderson (2007). However, the notable change in the experimental group is surely brought about by the PSM exposed to them as supported by Stravroula (2011), Subban (2006), and Stronge (2004). With the PSM, the teacher's approach to the teaching and the activities may have affected very well the acquisition of the learning competencies as was mentioned by Wilson (2009). Specifically however, in English, the contentions of Sevillano (cited by Robinson et al, 2014) directly supports the result.

D. Results of Significant Difference Between the Pretest Scores of the Control and Experimental Group

Table 4: Significant Difference Between the Pretest Scores of the Control and Experimental Group

Table 4 presents the significant difference in the pretest scores of the two groups.

Groups	Mean	Standard Deviation	Computed t	P value	Decision
Control	14.08	3.11	2.08	0.20	Accept Ho
Experimental	15.40	3.15			

df = 96

The computed p value (p = 0.20) is greater than 0.05 level of significance at 96 degrees of freedom. Hence the hypothesis of no significant difference is accepted. There is no significant difference in the pretest scores of the class groups.

This result is good since the baseline data prior to the use of PSM suggest that the students have similar intellectual abilities which will be very crucial for trying out the experiment in the teaching approach. The data suggest that the groups are very ideal for the experiment since they possess similarities prior to the experiment.

E. Results of Significant Difference Between the Posttest Scores of the Control and Experimental Group

Table 5: Significant Difference Between the Posttest Scores of the Control and Experimental Group

Table 5 also presents the significant difference of the posttest scores between the control and the experimental group.

Groups	Mean	Standard Deviation	Computed t	P value	Decision
Control	16.63	2.20	10.56	0.000	Reject Ho
Experimental	22.08	2.86			

From the data, it is very clear that the difference in scores in the achievement favor the experimental group which was taught using PSM. Hence, it is safe to say that PSM is effective based on the data generated.

F. Significant Difference Between the Pre-test and Post-test Scores of the Control and Experimental Group

Table 6: Significant Difference Between the Pretest and Posttest Scores of the Control and Experimental Group

Table 6 presents the comparison of the pretest and post test scores of the control and the experimental groups.

Groups	Mean	Standard Deviation	Computed t	P value	Decision
Pretest versus Posttest			9.05	0.000	Reject Ho
control	14.08	3.11			
control	16.63	2.20			
Pretest versus Posttest			16.19	0.000	Reject Ho
experimental	15.40	3.15			
experimental	22.08	2.86			

Clearly, for the control, there is strong evidence ($t = 9.05$, $p = 0.000$) that the teaching intervention improves marks. Moreover, for the experimental group, the t statistics, $t = 16.19$, and $p = 0.000$; is very small probability of this result occurring by chance, under the null hypothesis of no difference. The null hypothesis is rejected, since $p < 0.05$ (in fact $p = 0.000$). Hence, the hypothesis of no significant difference between the pretest and posttest scores for the control and experimental group are rejected.

The results are very significant since both groups exposed with treatment report difference in score. Also, in the group taught using PSM showed very significant difference in mean score. This then makes it safe to conclude that PSM is effective on teaching Linear Equation of Grade 8 students.

VIII. Findings

The following are the findings of this action research.

1. The mean scores of both control [14.08; Sd=3.11] and the experimental [15.40; Sd=3.15] groups do not significantly differ based on the p value result of 0.20 greater than the alpha set at 0.05 at 98 degrees of freedom.
2. The mean scores of the control [16.63; Sd=2.20] and the experimental [22.08; Sd=2.86] significantly differ which favor the use of PSM from the p value of 0.000 is less than the alpha set at 0.05 using 98 degrees of freedom.
3. During the pretest, majority of the pupils are average (control group, 29 or 60.42 % and 26 or 52 %). After the treatment, however, majority of the pupils in both the control and experimental groups became above average (20 or 46.66%) and (23 or 46%) respectively.
4. There is no significant difference between the control and experimental group's pretest scores based on the p value of 0.20 which is greater than the alpha value of 0.05 using 96 degrees of freedom but significant difference exists for both the experimental and control groups as signified by the posttest results.

IX. Conclusions

Based on the findings, the following are the conclusions.

1. The pretest scores of the control and the experimental group do not differ significantly.
2. The posttest scores of the groups significantly differ resulting to higher scores for the experimental group.
3. There is significant difference exists in the pretest and posttest scores of the control and experimental group.
4. There is an improvement in the groupings of students both in the control and experimental group but significant improvement was shown for the pupils taught using PSM.
5. Use of PSM is effective considering the higher scores of the experimental group compared to the control group.

X. Recommendation

Based on the above findings and conclusions, the following recommendations are suggested.

1. PSM should be used in teaching students in Mathematics especially in heterogeneous classes because it improved their classroom performance.
2. Teachers should be given in-service trainings

on PSM for them to gain more knowledge and clear understanding of the approach.

3. Although it may seems tedious on the part of the teachers, they should be encouraged to prepare and use PSM to motivate pupils to participate in class discussions.

4. This action research should be continued.

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