

Critical Thinking and Problem Solving Skills in Mathematics of Grade-7 Public Secondary Students

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Abstract –*The study aimed to assess the academic performance, critical thinking skills, and problem solving skills in mathematics of Grade-7 students in the five central public secondary schools of Area 2, Division of Batangas, Philippines. This study utilized descriptive method of research. Three hundred forty one (341) students of the public secondary schools out of the total of 2,324 Grade-7 students were selected through systematic random sampling as the subjects of the study. It was found out that the level of performance in Mathematics of the Grade-7 students is proficient. The level of critical thinking skills of students from the different schools is above average as well as their level of problem solving skills. The mathematics performance of the students is positively correlated to their level of critical thinking skills and problem solving skills. Students considered the following learning competencies in the different content areas of Grade-7 Mathematics as difficult to master: solving problems involving sets, describing the development of measurement from the primitive to the present international system of units, finding a solution of an equation or inequality involving one variable, using compass and straightedge to bisect line segments and angles, and analyzing, interpreting accurately and drawing conclusions from graphic and tabular presentations of statistical data.*

Keywords- *academic performance, critical thinking skills, Grade-7 Mathematics, learning competencies, problem solving skills*

INTRODUCTION

The enhancement of the quality of basic education in the Philippines is urgent and critical. The implemented K-12 model in the country is an educational system for elementary and secondary education patterned after the United States, Canada, and some parts of Australia. The Department of Education (DepEd) reasons out that it is high time to adopt a K-12 system, attributing the low achievement scores and poor quality of basic education to the present school setup. The DepEd appears determined to enact the program with its proposed budget catering mostly to prepare the grounds for its eventual implementation.

In the implementation of K-12 Program, the twin goals of Mathematics are critical thinking and problem solving[1]. This serves as the focal point in learning mathematics. In Mathematics, critical thinking usually comes when students ask why, rather than taking what they learn at face value. Critical thinking leads to skills that can be learned, mastered and used. It is the rational examination of ideas,

inferences, assumptions, principles, arguments, conclusions, issues, statements, beliefs and actions. In the same manner, the definition of problem solving according to Polya is finding a way around a difficulty, around an obstacle, and finding a solution to a problem that is unknown. These two goals are to be achieved with an organized and rigorous curriculum content, a well-defined set of high-level skills and processes, desirable values and attitudes, and appropriate tools, recognizing as well the different contexts of Filipino learners [1].

The definitions of critical thinking that have emerged from the cognitive psychological approach include the following: it can be regarded as the mental processes, strategies, and representations people use to solve problems, make decisions, and learn new concepts[2]. In addition, it can be considered as the use of those cognitive skills or strategies that increase the probability of a desirable outcome[3]. Facione identified six cognitive skills as central to the concept of critical thinking[4]. These skills include interpretation, analysis, explanation,

evaluation, self-regulation and inference. Critical thinking skills therefore, are skills that enable one to analyse and synthesize information to solve problems in broad range of areas.

The study of Irfaner[5] concluded that the lack of critical thinking skills utilized within the classroom greatly diminishes the students' chance for success. The study identified the gaps in the students' understanding of information, quantified their ability to compose their knowledge of the material, and for students to understand the material enough to create an insightful question showcasing their comprehension of the material. The study also determined if the teacher changed the lessons or approaches based upon the students' need for extra discussions or questions.

Marcut[6] supported that students who are trained in critical thinking skills significantly improved positively in their performance than those who were not trained. More so, Fisher [7] highlighted that the critical thinking skills training had helped in stimulating students' intellectual capability and make them engaged more in classroom activity. In addition, Bassey, Joshua and Asim [8] conducted a study on gender and Mathematics achievement in secondary schools in Calabar, Cross Rivers State. The study revealed that male and female students significantly differ on their Mathematics achievement.

The study of Chukwuyenum [9] revealed that the Mathematics performance test scores among the experimental groups were significantly different. The study also revealed no significant gender difference in Mathematics performance test. Critical thinking skills were also considered as effective means of enhancing students' understanding of concepts in Mathematics.

With the results of these previous studies regarding mathematics performance, problem solving ability, and critical thinking skills, and the concerned of the quality of mathematics instruction in the secondary schools, the researchers find it necessary to conduct the present study. It was observed that most of the students nowadays were constantly dependent on how the internet answers their questions, not knowing that their critical thinking and problem solving skills have been affected. The researchers deemed it necessary to assess the critical thinking and problem solving skills among Grade-7 students. The findings of this study will widen teacher's knowledge about students' critical thinking and problem solving skills. It can help find ways to change and develop learning strategies of

students towards improved academic performance in Mathematics.

OBJECTIVES OF THE STUDY

The study aimed to assess the academic performance, critical thinking and problem solving skills in Mathematics among Grade-7 public secondary students. Specifically, the study sought to determine the level of performance of the students in Grade-7 Mathematics, ascertain the level of critical thinking and problem solving skills of the students, find out the significant relationships between mathematics performance and the levels of critical thinking and problem solving skills, determine the extent of difficulty the students encountered in mastering the content areas in Grade-7 mathematics, and identify which learning competencies in the content areas in Grade-7 mathematics are considered difficult.

MATERIALS AND METHODS

Research Design

This is a descriptive-correlational study seeking to determine the public secondary students' performance in mathematics and their levels of critical thinking skills and problem solving skills.

Subjects of the Study

This study involved Grade-7 students of the central public secondary schools in Area 2, Division of Batangas, Philippines. From a total of 2,324 students, 341 students are considered as the subjects of the study which were obtained by systematic random sampling using Slovin's Formula with marginal error of 0.05. Table 1 shows the distribution of the students used as subjects of the study.

Table 1. Distribution of the Students

Name of Schools	Population	Sample
Bauan Technical High School	910	134
San Pascual National High School	660	97
Anselmo A. Sandoval Memorial National High School	422	62
Masaguisit-Banayo National High School	208	30
Sta. Monica National High School	124	18
Total	2,324	341

Data Gathering Instruments

The researchers used several data gathering instruments in the study: the tests for critical thinking skills and problem solving skills adopted from that of Lopez[10], and questionnaire.

Test on Critical Thinking Skills. Critical thinking test was adopted from the test that can be found in Lopez's worktext which consists of items from the different content areas of Grade-7 Mathematics. The preliminary draft covering 65 items was presented to 3 experienced mathematics teachers to carefully identify the critical thinking skills measured in each item. Their suggestions and comments were considered. After item validation, the test was finalized and administered to some 20 selected students from Anselmo A. Sandoval Memorial National High School for dry run. The validity of the test items was determined using item analysis. The test was reduced from 65 items down to 35 items that were used as test to determine the level of critical thinking skills of the students.

Problem Solving Skills Test. A test was constructed to determine the level of performance of the respondents in problem solving. The researchers reviewed Mathematics books and considered the suggestions of Mathematics teachers concerning the mathematical attitudes manifested by the students. The test items included in the test were based on test in Lopez's worktext. The test consists of 30 problems, measuring the methods used by Polya[11] in solving problems namely: Understanding the problem, Devise a Plan, Carrying Out the Plan and Looking Back. Each problem should be solved with complete solution to determine the level of problem solving skills of the students. The draft of the problem solving test was presented to 3 experienced mathematics teachers for face validation. After the comments and suggestions were carefully integrated, a pilot study was conducted. After the pilot testing, the researchers analyse each item to determine what should be retain, revise and reject. After the item validation, the final draft of the test was administered to the subjects of the study. The responses were scored using the level of problem solving skills based on the criteria of Polya's method. It is categorized in five levels; level 1 being the most simple and level 5 as at most complex. The expectations of a student performing at each level of the mathematics problem solving component are: Level One (I) when a student finds single solution to one-step problems using number sense and operations;

Level Two (II) when a student uses limited range of algebra and uses one case to establish proof; Level Three. (III) when a student solves a problem using step-by-step procedure applying necessary and sufficient cases and uses mathematical vocabulary, imprecisely to present problem; Level Four (IV) when a student adapts one or more solutions to find the answer in the given problem and justify answers through the use of formulas; and Level Five (V) when a student creates original solution and show multi-step problems and provide full justification for each step and shows clear and precise solutions with checking at the last part of it. The students were asked to answer the questions given to them and show their solutions completely.

Questionnaire. The questionnaire was constructed to determine the extent of students' difficulty in mastering the learning competencies in the content areas of Grade-7 mathematics. Content validation of the questionnaire was done by experienced mathematics teachers. Dry run was conducted to determine the reliability of the items. The computed Cronbach's alpha of 0.87 indicates that the items of the questionnaire are of good internal consistency and are reliable. To identify the extent of students' difficulty in mastering the learning competencies in mathematics, the following scale and interpretation was utilized: 3.25 – 4.00 = No Extent, 2.50 – 3.24 = To a Least Extent, 1.75 – 2.49 = To a Moderate Extent, and 1.00 – 1.74 = To a Great Extent.

Data Gathering Procedure

The researchers first asked the permission of Area 2 Chairman of the Division of Batangas to formally use the students of Area 2 Public Secondary Schools as the subjects of the study. After the approval, the researchers asked the permission from the school heads of the central public schools in Area 2, Division of Batangas to conduct the study. With the permission granted, the administration of the tests and questionnaire was conducted during the first quarter of the school year 2015-2016. The researchers requested the Mathematics teachers of the said schools to help in the administration of the problem solving and critical thinking tests and the questionnaire. The test papers, answer sheets, and questionnaires were retrieved by the researchers immediately after the administration. The responses were tallied, scored, and tabulated for data analysis. The academic record of the students was obtained from their respective advisers. The

researchers asked the consent of the students that they are to be used as subjects of the study. Likewise, the subjects of the study were informed that the data gathered are to be treated with utmost confidentiality.

Data Analysis

The following statistical tools are utilized in the study, frequency and percentage, weighted mean, standard deviation, and Pearson r correlation which were determined using the statistical software SPSS 19.

RESULTS AND DISCUSSION

Level of Critical Thinking Skills. Table 2 presents the level of critical thinking skills of the students in five central secondary schools. It can be seen from the table that out of 341 students, 166 of them or 48.68% got the highest score that ranges from 29 – 35.

Table 2. Level of Critical Thinking Skills of the Students

Range of Score	Level of Critical Thinking Skills	f	%
29 - 35	Superior	166	48.68
22 – 28	Above Average	91	26.67
15 – 21	Average	84	24.63
8 – 14	Below Average	0	0
0 – 7	Poor	0	0
TOTAL		341	100
<i>Mean = 27.14</i>		<i>SD = 4.48</i>	

It can be observed from the table that there were more students having superior level of critical thinking skills. Considering the result, there were 91 students who got the scores ranging from 22 – 28. This indicates that 26.67% of the students are having above average level of critical thinking skills. Moreover, there were 84 students or 24.63% who got scores ranging from 8 – 14 which indicates that their level of critical thinking skills as average. No students are considered having below average and poor performances in critical thinking skills test. The composite mean of the scores is 27.14 with the standard deviation of 4.48 indicates that the level of critical thinking skills of the students are generally above average. This simply implies that the students were able to interpret data, answers questions and statements, able to examine ideas and detecting argument working and arriving at the answers on their own thinking and able to evaluate questions to arrive

answers.

Table 3. Level of Problem Solving Skills of the Students

Range of Score	Level of Problem Solving Skills	f	%
13 – 15	Superior	30	8.80
10 – 12	Above Average	255	74.78
7 – 9	Average	56	16.42
4 – 6	Below Average	0	0
0 – 3	Poor	0	0
TOTAL		341	100
<i>Mean = 10.64</i>		<i>SD = 1.41</i>	

Level of Problem Solving Skills. Table 3 shows that 56 students or 16.42% with scores ranging from 7 – 9 out of 15 item test have an average level of problem solving skills in Mathematics.

However, there were 30 students who got the scores ranging from 13 – 15 which implies that 8.80 percent of the respondents belongs to superior level of problem solving skills in Mathematics. The data also revealed that most of the students got above average level of problem solving skills in Mathematics. The table shows that 255 of 341 respondents or 74.78% got the scores of 10 -12. No student got the scores ranging from 1 – 6 which are considered as poor and below average level of problem solving skills. The composite mean of 10.64 with standard deviation of 1.41 indicates that the students' level of problem solving skills are above average. This means that the students manifested understanding verbal description of a problem situation and able to give numerical answer to a stated question by making use of mathematical relationships between quantities.

Performance of the Students in Grade-7 Mathematics

The performance of public secondary students in Grade-7 Mathematics is measured in terms of their final grades in Mathematics during the S.Y. 2015 – 2016.

Table 4. Students' Performance in Mathematics

Range of Grade	Level of Performance	f	%
90 and above	Advanced	73	21.41
85 – 89	Proficient	151	44.28
80 – 84	Approaching Proficiency	115	33.72
75 – 79	Developing	2	0.59
74 and below	Beginning	0	0
TOTAL		341	100
<i>Mean = 86.21</i>		<i>SD = 3.76</i>	

Table 4 presents the level of performance of the students in Grade-7 Mathematics. It can be noted that 151 students or 44.48% got grades ranging from 85 – 89 which are considered as Proficient. Furthermore, there were 73 students got the grades of 90 and above that correspond to Advance level of performance. There were 115 students or 33.72% got grades ranging from 80 – 84 indicating approaching proficiency while only 2 students got grades ranging from 75 – 79 indicating developing level of performance in mathematics. No one got grades of below 75. Generally, the mean of 86.21 with a standard deviation of 3.76 indicates that most of the students in the different schools in Area 2, Division of Batangas performed proficiently in Grade-7 Mathematics.

Table 5. Correlation Between the Students' Mathematics Performance and Critical Thinking Skills

Variables	Computed r	p-value	Decision on Ho
Performance Critical Thinking Skills	0.265*	0.000	Reject

*Significant

Based on Table 5, the computed r of 0.265 with a p-value of 0.000 (<0.05) indicates that the null hypothesis is rejected. This means that the mathematics performance of the students is significantly related to their level of the critical thinking skills. A positive r-value indicates that there is a positive weak correlation between mathematics performance of the students and their level of critical thinking skills. Students with better critical thinking skills are more likely to have better mathematics performance.

The results imply that educators and Mathematics teachers need to upgrade scheme on different teaching strategies in order to enhance the critical thinking skills of the students. In addition to this, the study of Irfaner identified gaps in the student's understanding of information, quantify their ability to compose knowledge which are the component of critical thinking in relation to mathematics performance of the students.

Based on Table 6, the computed r of 0.137 with a p-value of 0.011 (<0.05) indicates that the null hypothesis is rejected. This means that there is a significant relationship between the mathematics performance of the students and their level of problem solving skills.

Table 6. Correlation Between the Students' Mathematics Performance and Problem Solving Skills

Variables	Computed r	p-value	Decision on Ho
Performance Problem Solving Skills	0.137*	0.011	Reject

*Significant

A positive r-value indicates that there is a positive weak correlation between mathematics performance of the students and their level problem solving skills. Students with higher level of problem solving skills are more likely to perform better in mathematics. It can be inferred that students' performance in Mathematics improved and enhanced through their problem solving skills.

Students' Extent of Difficulty in Mastering the Mathematics Competencies in the different content areas

The students were given a list of the learning competencies expected of them in studying Grade-7 Mathematics and were asked to indicate the extent of difficulty they encountered in mastering these competencies. Among the learning competencies in Numbers and Number Sense, solving problems involving sets got the lowest mean of 2.04 which indicates that students find such competency moderately difficult to master. However, the competency of describing the absolute value and illustrate it on a number line got the highest mean 3.30 indicating that students find it easy. In general, the composite mean of 3.10 indicates that the students find mastering the competencies in Number and Number Sense with least extent of difficulty.

Among the learning competencies in Measurement, describing the development of measurement from the primitive to the present international system of units is considered by the students as moderately difficult to master with the mean of 2.48. Meanwhile, students find it with a least extent of difficulty to master the conversion of measurements from one unit to another for each type of measurement including the English system with the mean of 3.24. In general, the composite mean of 3.02 indicates that the students find mastering the competencies in Measurement with least extent of difficulty.

In terms of the learning competencies in Algebra, students find it no extent of difficulty to master the concepts about constants and variables in a given algebraic expression. With the same mean of 3.26, students also regarded the competency of how to find algebraically the (a) product of two binomials; (b) product of a sum and difference of two terms; (c) square of a binomial; (d) cube of a binomial; (e) product of a binomial and a trinomial as easy as the other one. On the other hand, they find it with moderate difficulty to master the competency of finding the solution of an equation or inequality involving one variable, including one that involves absolute value (a) from a given replacement; (b) intuitively by guess and check; (c) by algebraic procedures (applying the properties of equalities and inequalities); (d) graphing. In general, the composite mean of 3.01 indicates that the students find mastering the competencies in Algebra with least extent of difficulty.

In the content area about Geometry, most of the competencies acquired by the students were regarded as mastered to a least extent of difficulty. The first competency of representing a point, line and plane using concrete and pictorial models got the highest mean 3.25 which indicates that students mastered it with no extent of difficulty. However, the competency of using a compass and straightedge to bisect line segments and angles and construct perpendiculars and parallels got a lowest mean of 2.49 which indicates that students regarded it as moderately difficult to master. In general, the composite mean of 3.04 indicates that the students find mastering the competencies in Geometry with least extent of difficulty.

Among the learning competencies in Statistics and Probability, analyzing, interpreting accurately and drawing conclusions from graphic and tabular presentations of statistical data got a mean of 2.47 which indicates that the students find the mastery of that topic with moderate extent of difficulty. The competency of explaining the basic concepts, uses and importance of Statistics got a weighted mean of 3.06 indicating least extent of difficulty. In general, the composite mean of 2.81 indicates that the students find the mastery of competencies in Statistics and Probability with least extent of difficulty.

CONCLUSION AND RECOMMENDATION

The level of critical thinking skills of students from the different schools in Area 2, Division of

Batangas is above average. The level of problem solving skills of students from the different schools in Area 2, Division of Batangas is above average. The level of performance in Grade-7 Mathematics of the students is proficient. The mathematics performance of the students is positively correlated to their level of critical thinking skills and to their level of problem solving skills. The following competencies in the different content areas of Grade-7 Mathematics were considered as moderately difficult to master: solving problems involving sets, describing the development of measurement from the primitive to the present international system of units, finding a solution of an equation or inequality involving one variable, using compass and straightedge to bisect line segments and angles, and analyses, interprets accurately and drawing conclusions from graphic and tabular presentations of statistical data.

Results of the study regarding the extent of difficulty in mastering the mathematics competencies in the different content areas can be of great help to the teachers in preparing learning intervention activities to enhance such learning competencies.

The following are hereby recommended: (1) training in critical thinking skills need to be conducted to enhance student's achievement in Mathematics; (2) prototype lessons in Grade-7 Mathematics were recommended to be prepared integrating critical thinking skills and problem solving skills towards enhancement of academic performance; (3) Mathematics teachers should utilize the prototype lessons enhancing the critical thinking and problem solving skills of the students. Efforts need to be undertaken by teachers to stimulate critical thinking and problem solving skills of the students toward an improved academic performance in Mathematics; (4) a similar study be conducted on areas where students show weakness in mathematics as basis of determining ways on how to assist them in the learning of mathematics; (5) since the study is limited to the students of area 2, Division of Batangas, a similar study can be conducted to cover the students in other areas of the Division of Batangas Province.

REFERENCES

- [1] K to 12 Curriculum Guide MATHEMATICS (Grade 1 to Grade 10). Retrieved from goo.gl/3Qxsj5 on January 2, 2016.
- [2] Sternberg, R. J. (1986). *Critical thinking: Its nature, measurement, and improvement* National Institute of Education. Retrieved from

<http://eric.ed.gov/PDFS/ED272882.pdf>. on January 2, 2016.

- [3] Halpern, D. F. (2001) Assessing the effectiveness of critical thinking instruction. *The Journal of General Education*, 50(4), 270–286.
- [4] Facione, P. A. (1990). *Critical Thinking: A statement of expert consensus for purposes of Educational Assessment and Instruction: Research Findings and Recommendations*. American Philosophical Association. Retrieved from ERIC Document Reproduction Service No. ED 315423 on January 2, 2016.
- [5] Irfaner, S.(2006). Enhancing Thinking Skills in the Classroom. *Humanity and Social Sciences Journal*.
- [6] M̃arcut, I ,(2005).Critical Thinking - applied to the methodology of teaching mathematics, *Educatia Matematic̃al*, 1, 57–66.
- [7] Fisher, R.(2003).Teaching thinking: Philosophical enquiry in the classroom. London, continuum. 4, (1), 153-160.
- [8] Bassey, S.W., Joshua, M.T, & Asim, A.E (2008). Gender differences and mathematics performance of rural senior secondary students in Rivers State, Nigeria. *Proceedings of International Conference to Review Research in Science, Technology and Mathematics Education*. Munba, India, 2 (3), 12-18.
- [9] Chukwuyenum, A. N. (2013). Impact of Critical thinking on Performance in Mathematics among Senior Secondary School Students in Lagos State, Nigeria. *IOSR Journal of Research & Method in Education* Volume 3, Issue 5 (Nov. –Dec. 2013), pp.18-25
- [10] Lopez, E. (2010). *New Mathematics for Grade-7 Worktext*.
- [11] Polya, G. (1980). 'On solving mathematical problems in high school'. In S. Krulik (Ed). *Problem Solving in School Mathematics*, (pp.1-2). Reston, Virginia: NCTM.

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