

Correlates of Word Problem Solving Capabilities in Algebra of the First Year Engineering Students

MELANIE D. LUGO

melanierul@yahoo.com

melllanierul@gmail.com

De La Salle Lipa, Philippines

Abstract - Word problems are topics in Algebra which are abhorred by most students. The study aimed at identifying the correlation that contribute to problem solving capabilities of freshmen college students who were enrolled in Algebra of De La Salle Lipa. It was anchored on three groups of correlates that contributed to problem solving capabilities of students; personal, cognitive, and social factors. The respondents' entrance examination result in Math; word problem solving scores were considered in the findings of the study. Results showed that respondents' attitude towards problem solving had affected their capabilities to a large extent. Study strategies have been affected to a large extent, while only one affected their capabilities to a small extent. There is a significant relationship between the problem solving capabilities of the students in the three factors. The common problems exhibited were wrong representation, wrong computation, and use of trial and error method, misinterpretation, forgotten formulas, and forgotten concepts. The cognitive and the social factors had a

significant effect on the problem solving capabilities of the students.

Keywords: correlation, algebra, word problem solving, personal factor, cognitive factors, social factors

INTRODUCTION

Algebra is the first mathematics subject taken by the first year college students. The same subject is also part of the secondary education curriculum. Despite the commonality of topics being discussed in the course, it has been observed that students still dislike the subject. The cognitive factors include the type of language, comprehension, and conceptual, computational, process skills of the students. The social factors of the students also include the interaction of the student with peers and with the teachers. Their social integration includes informal friendships, supports groups, and contact with the faculty.

FRAMEWORK

Algebra is a branch of mathematics using symbols to explore relationships between numbers and the operations used to work with them. As a language of higher mathematics, algebra is a gateway to future study and mathematically significant ideas, but is it often a wall that blocks the paths of many (Chick, n.d.). Verschaffel, et.al. (2000) defined word problems as verbal descriptions of problem situations wherein one or more questions are raised, the answer to which can be obtained by the application of mathematical operations to numerical data available in the problem statement. In their most typical form, word problems take the form of brief texts describing. The student himself plays a greater part in his academic performance. Personal factors that influence problem solving capabilities are those that are personally relevant and therefore vary with the individual. These include interest, personalization, and familiarity (Wiest, 2002). Students in the study expressed strong feelings and specific ideas about what did and did not interest them.

Jitendra (2002) said that most models for understanding and assessing student's solution of problems are derived from cognitive psychology, and that problem solving instruction emphasizes conceptual understanding (Xin & Jitendra, 1999 in Jitendra, 2002).

Academic adjustment is also a factor considered in the student's performance not only in Mathematics but in all other subject areas. The degree to which the student was socially integrated into the college community is an interaction factor. Social integration includes informal friendships, support groups, participation in extracurricular activities, contact with faculty, and social networks formed during the college experience. Interaction with faculty also appears to be an important factor in academic adjustment and student performance (Boulter, 2002).

The study was based on the concept of Kroll and Millers (1993) as regards problem-solving. According to them, problem solving capabilities in middle-grade students are influenced by several major factors. They are knowledge factors, affective factors, and socio-cultural factors.

Problem-solving capability and difficulty is influenced by three major factors. They are personal factors, cognitive factors, and social integration factors.

The social factors include the interaction of the student with peers and with the teacher. Social integration includes informal friendships, supports groups, and contact with faculty (Boutler, 2002). The interaction with the faculty was found to be an important factor in the student's academic adjustment and performance (Boutler, 2002).

OBJECTIVES OF THE STUDY

The study aimed to identify the correlation that affect the problem solving capabilities of first year engineering students of De La Salle Lipa. The data analyzed were the responses given by 176 first year students enrolled in the Engineering Programs of De La Salle Lipa during the first semester of school year 2008-2009.

MATERIALS AND METHODS

This study used the descriptive research design. The study was conducted at De La Salle Lipa, The data were obtained from the students enrolled in the Engineering programs. The survey was administered during the second semester of school year 2008-2009. The researcher adopted the questionnaire from the study of Lugo 2005 on the factors that contribute to the students' problem solving capabilities in Algebra. The researcher distributed the copies of the questionnaire. The respondents were all first year engineering students enrolled at De La Salle Lipa AY 2008-2009. The questionnaires were retrieved and the responses were summarized and analyzed.

Data were summarized and tabulated using frequency counts, percentage and weighted means.

RESULTS AND DISCUSSION

The Math entrance examination results showed that majority of the students (37.0%) have Math entrance scores 32 to 37. It is followed by students getting a range of scores of 26 to 31 (30.1%) and a range of scores of 38 to 43 (21.2%). There are a very small percentage of students getting a range of scores of 44 to 50 (2.7%). There are varied capabilities of students in terms of their mathematical ability. The results were in consonance with the study made by Weist (2002) who reported that individual responses to mathematics varies according to community type, geographical location, individual personality and academic ability. Students coming from varied types of secondary schools had carried with them the same abilities they manifested during their high school.

The Level of Problem Solving Capabilities of the Respondents shows the scores obtained by the students in the word problem examination administered to them. The scores ranged from zero to 100, indicating a similar finding in the entrance examination results. There are 30 or 17.1% of the students who performed very poorly in solving the word problems. This further shows that the students have difficulty in problem solving. However, there are 26 (14.9%) who performed excellently in solving the word problems. There are also students who

got perfect scores in the given word problems. Those respondents may be regarded as possessing excellent problem solving capability. Most of the respondents (66 or 37.5%) had scores from 60 to 79. The students were characterized as possessing high problem solving capabilities. The average score of the respondents is 50.48. The respondents who got a high score were able to solve the problems using the following: step-by-step process; they easily determine the goal of the problem correctly and able to find the correct relationships among the pieces of information given in the problem; and they were able to make a correct representation of the problem situation. The respondents who got a low score did not use the step-by-step process; showed poor comprehension of the problem by not being able to determine the problem goal correctly; and did not know what formulas to be used.

The Students perceived problem: Personal Factors; Attitude towards Problem Solving shows that the students perceived problem solving as helping them to develop the mind and teaching them to think to a large extent (4.11). Students recognize the importance or the use of mathematics and problem solving in their lives. Mathematics is a work of the mind and requires a lot of thinking process. The students perceived that they see it that they understand their classmate's solution to a problem before they agree with it (mean of 4.02). Results show that they don't just agree with their classmates' solution unless they see how they came up with the answers. Two items of the ten attitude scale had affected the students' problem solving capabilities to a small extent with a mean of 3.35 to 3.42. The students perceived that they never give up on a problem (mean of 3.42), and to a small extent (3.35), they don't skip parts that require them to do problem solving. Results revealed that persistence and patience in solving problems is manifested in the students to a lesser degree. Most students would like to do problem solving haphazardly such that when they have the answers, they would not redo it or try other ways of solving them.

Taking notes in class affected their problem solving capabilities to a large extent (3.91). They also believed that copying notes during lecture helps them to be familiar with different kinds of formulas. They said their notes gave them something to read when they study their lessons at home. The students reported that reviewing word problems that they have solved has affected their problem solving capabilities

(3.82). Results show that some of the students reviewed their solutions to check the correctness of their solutions (3.82). It will be noted that the students worked out solutions to problems with the instructor only to a very small extent (3.31).

In nine of the ten criteria on the language used shows that this helped the students in their problem solving capabilities to a large extent (3.49 to 3.78). Only one affected their capabilities to a small extent (3.49), which was on the use of reference terms. This further showed that students feel strongly that mathematical word problems should be presented in the simple and direct terminologies. This was affirmed by the highest mean in the use of words that are easy to understand (3.72). Because of such difficulty, it is advised that the teacher use familiar names and problem contexts which students could relate well to help them in problem solving. Word and sentence length should be considered to determine the difficulty level of the text.

The Comprehension result shows the respondents' comprehension of the problem greatly affects the students' problem solving capabilities. Word problems that easily to comprehend and well stated are needed for comprehension. This will help to a large extent the problem solving capabilities of students. That the problem will help remembering ideas presented will help in better comprehension (3.85) and will contribute to the problem solving capabilities the highest extent (3.79) are great helps in problem solving. To allow better comprehension, students should be presented real life often-relational ideas about numbers to influence them in better assessment of word problems. Teachers should create or choose story concepts that are familiar and that used key terminologies and ideas within the students grasping level. As reported by Hembree (1992 in Weist, 2002), students perform better on problems that include some measure of action.

The Conceptual skills as perceived by the students seven of the ten items affected their problem solving capabilities to a large extent, with mean scores ranging from 3.5 to 3.64. The highest perception was on the recognition of different approaches to problem to a large extent (3.64). However three of the ten items had affected their problem solving capabilities to a small extent only. The students reported that they had analyzed the word problems easily (item 1) and that conceptual problems arose when a student does not clearly understand the idea

behind the problem. The findings are in relation to the student's language and comprehension skills. If a student does not grasp the idea presented in the problem, further analysis is not possible. Students do not want to spend time thinking. This may be due to the fact that they have been used to spoon feeding technique. The mathematical problem solving instruction should emphasize conceptual knowledge of the operations and a highly integrated understanding of the fundamental operations. In solving word problems, teachers should teach their students to make a models or diagrams that can be used to represent the information in a problem and to figure out what operation is needed to solve the problem. Mathematical problem solving requires the ability to organize problems by structural similarity.

The teachers should provide quality instruction that emphasizes both problem representation and problem solution. Mathematical problem solving instruction should emphasize conceptual knowledge of the operations and should also facilitate a highly integrated understanding of the operations and the many different but related meanings.

The Computational skills result shows that mastery of the fundamental operations is a big help in the problem solving process (mean of 3.91). Making manual computations and making mental computations on fundamental operations affects the problem solving capabilities to a large extent. In addition, familiarity in the use of the calculator (mean of 3.71) is also contributing to the problem solving process to a large extent.

It was also found that students depended much on the calculator for their computations. However, they still lacked the skills in doing computations, either manually or with the use of a gadget. Students were always in a hurry to get a value as the final solution without making reviews as to whether the answer they got was correct. Many students never checked their answers.

The component perceived to have the least effect was item 8. They reported that they were able to finish the computations easily (mean of 3.24) and that they had arrived at a solution with the use of the calculator (mean of 3.31). It was a common observation that students seemed to be working on a race pace every time something is asked of them to do. They believe that if they submitted their papers ahead of

the others, they are more intellectually capable, irrespective of whether they had done it correctly. They would always rely on the calculator and when confronted for having a wrong answer, would blame the calculator for doing so. Teachers should emphasize the checking of the students' answers by reversing the process. The best way to teach checking is to require students to do it.

The Process skills result shows that six of the ten criteria on the respondents' process skills affect their problem solving capabilities to a large extent, with the highest mean score of 3.72 for reviewing solutions. The next highest rating was on the use of different approaches to problem solving (3.67), and the use of a definite step-by-step process (3.61). Students were found to be lazy in reviewing their solutions. Getting to an answer, whether it is correct or not, makes them feel that they had already achieved something.

The two process skills that contributed to a small extent to the problem solving capabilities of students are performing the mathematical process well (3.38), and the in drawing diagrams and models (3.41). In most cases, students had the belief that they are fully equipped and are highly capable of solving problems. They also had the feeling that whenever they draw diagrams for a problem, their illustrations were correct.

The problem should be read first to analyze what is given and what is required. Pictures can be used to simplify the problem. Calculations can be done using the calculator and should be reviewed twice. When an answer is arrived at, results should be checked and if possible, the problem could be solved using another method.

Teachers should be able to teach students how to make illustrations and diagrams that represent the problem. Sample problems provided by the teacher should emphasize drawing of models. More exercises on how to draw diagrams and models and the formulation of equation from therein should be given to facilitate the student's problem solving skills.

Peer interaction results show that peer interaction could also affect the capabilities of students in problem solving. The students felt that getting help from classmates makes problem solving easier. Student's turned to their classmates and peers in identifying the formula as well as the techniques to use. The students likewise make comparisons and

confirmations of the solution and the answers. Other criteria involving peer interaction affects the problem solving capabilities of the students to a small extent.

For the teacher interaction the students' responses revealed that teacher interaction helps the students' problem solving process. The students reported that they are greatly helped when the teacher gives examples as guides, and when she/he gives the step-by-step process. Likewise, when the teacher gives comments to students' solutions and when the teacher finds ways to help the students, problem solving could be made easier. Asking the teacher for classifications when confused in a particular problem affects their problem solving capabilities only to a small extent (3.30).

It is a teacher's responsibility to focus on every student's learning and present the material clearly so that students should pass the subject. Both the student and the teacher should have a proactive attitude towards mathematics education. Adequate assistance from the teacher is necessary to alleviate the student's fear of solving word problems. The students learn best when they are active rather than passive learners.

Planning and organizational skills and attention factors can impact math skills. It is important for students to understand the nature of their math difficulties and the reasons underlying them, so they can explain their needs to their instructors. It shows that the correlation analysis between the problem solving capabilities and the personal, cognitive, and social factors were all found to be direct. As a result on the Pearson r all are not significant for the three factors. Correlation analysis between the problem solving capabilities and the personal factors were found to be direct. This means that as the perception on the personal factors increases, the problem solving capabilities also increases. When students viewed mathematical word problems as something that challenges the mind and makes them think, it allowed them to do better. The use of varied strategies in studying also resulted in higher performance. Taking down notes and making regular reviews of the lesson could develop the memory techniques in problem solving. The relationship was found to be significant.

The relationship between the cognitive factors and the problem

solving capabilities was also found to be positive. This means that as the perception on the cognitive factors increases, the problem solving capabilities likewise increases. The relationships were significant. It was shown that students who better understood the language of mathematics perform better. The use of familiar terms and the conciseness of the presentation helped the students in the process of getting the correct solution to the problems. When word problems were written short and contain only the relevant and required units and quantities, students were able to grasp the content and were able to get the solution to them. The recognition of the different approaches to solving the problem also developed their conceptual skills and eventually allowed them to do well in the word problem examinations. When students had already known the basic concepts and the formulas related to the problem, they were able to get the solution. Because of frequent use, the mastery of fundamental operations can be a useful tool in the process of problem solving. Using a step-by-step process also led to the solution to the problem. The combination of the foregoing cognitive factors helped the students perform higher in the field of word problem solving.

There was also a direct relationship between the social factors and the problem solving capabilities. As the student made use of available help such as those coming from their classmates and their teachers, the performance in problem solving was improved. Learning can be achieved with inputs coming from various sources. Interaction with peers and asking the help of the authority, the teacher, increased the level of performance in word problem solving.

The correlation analysis revealed a significant, direct relationship between the personal, cognitive, and social factors and the student's performance in word problem solving. This shows that the problem solving capabilities could be a product of intermingling factors such as the personal, the cognitive, and the social factors.

The regression analysis revealed that 17.67% of the variation in the word problem solving capability was due to the personal, cognitive, and social factors. It shows the beta coefficients resulting from the regression analysis. In the table results shows that in the t-value it is not significant at 5%, but it is significant at 5%. The analysis revealed

that the three factors considered in the study have significant effect on the problem solving capabilities of the students. When analyzed individually, the cognitive and the social factors had a significant effect on the problem solving capabilities of the students, while personal factors had no significant effect.

To make a prediction on the problem solving capability of a student, the following regression equation was formulated.

Regression model:

$$Y = -45.0254 + 1.8021 (\text{personal}) + 14.4588 (\text{cognitive}) + 10.6874 (\text{social})$$

The analysis showed that to make predictions of the problem solving capability of an individual student, the use of the questionnaire that elicits their perception of the personal, cognitive, and social factors as affecting their capabilities can be used. The cognitive factors would contribute the most to forecasting the student's performance. This is followed by the social factors and the last is the personal factors. This further showed that the student's command of the language, the comprehension, the conceptual skills, the process skills, and the computational skills contributed a lot to the problem solving capabilities of the students.

CONCLUSIONS

Students were average in their knowledge of Mathematics. However, they had high capability on problem solving. Personal factors had affected the problem solving capability to a large extent. The attitude towards problem solving and the study strategies employed affected the problem solving capability to a large extent. The attitude towards problem solving and the study strategies, and the cognitive factors affected the problem solving capability to a large extent. These components were: the language used comprehension, conceptual, computational, and process skills.

There is significant relationship between the problem solving capabilities of the students and the personal, cognitive, and social factors. The cognitive and the social factors had a significant effect on

the problem solving capabilities of the students.

The attitude of the students toward mathematics is one factor that affects the capabilities of the students in mathematics problem solving. The personal, cognitive, and social factors affect the students' capabilities to solve word problems. There is significant relationship between the personal, cognitive, and social factors and the students' capability to solve word problems, alternative hypotheses is accepted. Of the three factors, the cognitive and the social factors had significant effects on the student's problem solving capabilities, alternative hypotheses is accepted.

RECOMMENDATIONS

Steps should be taken by the school and the teachers to make the learning of mathematics more interesting and meaningful to the students. This may be done through contests, fair, displays and the like. Activities in the math classes may be made more interesting with student-friendly teacher by encouraging the students to ask questions and participate in the discussions.

The school may create a committee to prepare a compilation of problems in mathematics which are according to the level and understanding of the students. The Mathematics Department and the English Department may coordinate in the preparation of mathematics problems to ensure clarity and specificity of the language used.

LITERATURE CITED

Boulter, L. T.

2002 Self-concept as a predictor of college freshmen academic adjustment. *College Student Journal*. (June, 2002).

Chick, H. (n.d.)

The future of the teaching and learning of algebra. University of Melbourne. www.edfac.unimelb.edu.au.

Kroll, D.L. & T. Miller.

1993 Insights from research on mathematical problem solving in

the middle grades. In D.T. Owens. Ed. Research ideas for the classroom: middles grades mathematics. N. Y.: Macmillan Publ. Co.

Laniog, M. SJ.

2001 Problem solving skills of selected students in college algebra, SY 2000-2001: A case analysis. Unpublished thesis. DLSU, Manila.

Lugo, M. D.

2005 Factors Affecting Word Problem Solving Capabilities in Algebra of the First Year Engineering Students of the De la Salle Lipa: Basis for Teaching Strategy. Unpublished thesis. PLM, Manila.

Jitendra, A., C. M. DiPipi, N. Perron-Jones.

2002 An exploratory study of schema-based word problem-solving instruction for middle school students with learning disabilities. Journal of Special Education. Spring 2002.

Perry, A. B.

2004 Decreasing math anxiety in college students. College Student Journal.

Weist, L. S.

2002 Focus on Learning Problems in Mathematics.