Global Scientific JOURNALS
GSJ: Volume 10, Issue 11, November 2022, Online: ISSN 2320-9186
www.globalscientificjournal.com

Problem Solving Approaches and Mathematics Readiness: Their Influence on Students' Mathematical Achievement and Attitudes towards Mathematics

By:

Alex Labial Señara, DM. Jennie Estoque-Teruel, MS-AMS

Abstract

Amidst the changing environment brought about by the introduction of technology, the ability of the student learners in terms of their readiness specifically in mathematics has been distracted and shifted its focus to other learning avenues. Students' frame of mind is becoming half hazard due to their attitude towards the desired level of knowledge absorption. These can be detrimental on the part of the institution in achieving long-term academic goals and henceforth, to climb and attain the desired pedestal of change mandates that all the academic figureheads in different levels or colleges should subject all learners specifically the freshmen to undergo and submerge into the kingdom of numerical facet as a mandatory for them to propel and capture the so-called learning ownerships as they venture and develop their competencies. Making them endure the Constructivist Approach is one way of complementing other methods within and thereby creating a more active and interactive classroom activity. As part of the academic development program, knowledge gained in mathematics can be a tool for the learners to endure more in a subject such as mathematics and geometry.

Keywords: *Problem Solving Approaches and Mathematics Readiness.*

Introduction

The term problem-solving is used in many disciplines, sometimes with different perspectives, and often with different terminologies. For instance, it is a mental process in psychology and a computerized process in computer science. Problems can also be classified into two different types (ill-defined and well-defined) from which appropriate solutions are to be made. Ill-defined problems are those that do not have clear goals, solution paths, or expected solutions. Well-defined problems have specific goals, clearly defined solution paths, and clear expected solutions. These problems also allow for more initial planning than ill-defined problems. Being able to solve problems sometimes involves dealing with pragmatics (logic) and semantics (interpretation of the problem). The ability to understand what the goal of the problem is and what rules could be applied represents the key to solving the problem. Sometimes the problem requires some abstract thinking and coming up with a creative solution. Problem-solving is at the core of any learning activity. Over the years, trends in the philosophy and methods of pedagogy lead students to problem-solving as the finality of any learning unit. Whatever lessons are tackled in the classroom, teachers are likely to assess teaching and learning outcomes on the competence of students in meeting factual or numerical problem situations. It is in the teaching of mathematics that problem-solving is distinctly identified. It is that portion of the unit which allows students to apply the concepts they learned in the context of mathematical abstractions and skills developed. Here, teachers, may 2 allow different paths by which students follow to solve a problem at hand. If a student is keen enough, simple abstractions may lead him to fewer steps than what others have gone through before obtaining the right answer. It is the abstraction, no matter how simple it may seem, that makes problem-solving a difficult part of most mathematics courses. As observed in most classrooms, students would feel more comfortable working with number exercises than worded problems. Teachers, on the other hand, can only accommodate this reality by asking them to solve situations that are very analogous to the ones taken up by the teacher during discussion. Hence, more challenging tasks are avoided and more opportunities for the development of critical and analytical thinking or the development of higher-order thinking skills are denied. If this scenario is left unattended, it will be difficult to attain the objectives of mathematics education. That is, to devise ways of encouraging students to take more active roles in finding for themselves multiple representations and connections that are necessary inputs in meeting problem-solving episodes in their life. One of the significant parts of the teacher's responsibility is to equip students with knowledge and tools that enable them to formulate an approach and solve problems beyond those that they have studied. They should have opportunities to formulate and refine problems because problems that occur in real settings do not often arrive neatly packaged. The present trend of mathematics now advocates the need to change from the rote computational emphasis to an instructional approach that emphasizes critical thinking. NCTM (2000) pointed out that instructional programs should enable all students to understand patterns, relations, and functions, represent and analyze mathematical situations and structures using algebraic symbols, use mathematical 3 models to represent and understand quantitative relationships and analyze the change in various contexts. Competence in problem-solving refers to the capability of the student to perceive a problem-solving situation and schematize solutions to the problem at hand. This is manifested by the ability of the student to translate a worded problem into mathematical symbols and use learning algorithms in solving the problem. This also includes the ability of the student to justify the solutions that went through. It is in this light that this study is brought to the fore. The researcher intends to compare the efficacy of the two problem-solving approaches that will enhance the problem-solving competence of the students as well as redirect them towards a more positive and healthy attitude towards mathematics.

Theoretical Framework By its very nature, problem-solving is an extremely complex form of human endeavor that involves more than the simple recall of facts or the application of a well-earned procedure. It is for this reason that students should be helped to develop a clear understanding of what, why, and how of problem-solving. If students can interpret every problem situation and see both connections among component roles then they can deduce the solution to a particular problem. Many types of research had been undertaken on problem-solving interaction yet poor students' problem-solving performance persists over the years. And very little of the literature on mathematical problem-solving instruction neither discusses the specifics of the teacher's role nor adequately describes what happens in a problem-entered classroom (Lester, 1994) 4 Reforms in methodology advocated by the National Council for Teachers of Mathematics (NCTM) describe mathematics instruction as engaging learners in; (1) meaningful problem solving (2) arguing and proving their solutions; and (3) constructing their algorithms. From this perspective, learning is a constructive building process of meaning-making that results in reflective abstractions, producing symbols within a medium. These symbols then become part of the individual's repertoire of assimilatory schemes, which in turn are used when perceiving and further conceiving. And since these symbols themselves used on cognizing are the result of "taken as-shared" meaning by the class, these new constructions are further reflected upon and discussed. A process that is likely to generate both further possibilities and contradictions until new, temporarily "taken-as-shared" meanings are consensually agreed upon as viable. This process is represented by the figure that follows.

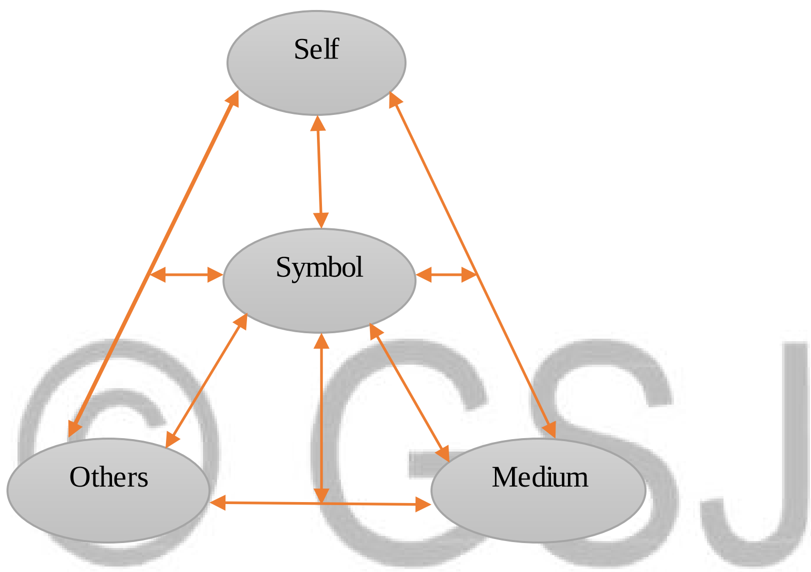

Fig. 1Constructivist Learning Model

Fig. 1Constructivist Learning Model Polya (1965) suggested that there are four stages in problem-solving. These are: a) Understanding the problem, b.) devising a plan, c.) carrying out the plan, d.)Looking back. He believed that an individual must do certain things and ask himself certain questions to succeed as a problem solver. It also implies that successful problem-solving involves an effort to understand the problem at both syntactic and semantic levels, organizing information to plan an attack on the problem, skills associated with implementing a plan, and mental processes related to evaluating what was done and what was learned. On the other hand, the Guided Constructivist approach allows the students in small groups to discuss among themselves the plan and actions to be done to solve a problem. The approach also provides the students opportunities to evaluate the Original Problem Solution to the Problem Solution to the Mathematical Version of Problem 6 their outputs and give personal views and justifications of the paths they have chosen from alternatives they were exposed to. While instructional methodologies find their ways to help develop better problem-solving skills, the students can only find meaning in these opportunities if they have the prior knowledge on which they can make meaningful connections. The students' mathematics readiness defines their ability to translate a word problem into an equation, a diagram, a matrix, or a model (Kantowski, 1981). This readiness is manifested in the student's competence in reading comprehension, basic algebra, and basic geometry skills. These skills are building blocks to problem-solving (Jones, 1984). The presented study was anchored on the guiding principles of the Guided Constructivist and Non-Constructivist approach to problem-solving and facilitated mathematics readiness to the student's problem-solving performance. Fig.3 shows the schematic diagram that guided the researcher in attaining the objectives of the study.

Method

This study used a non-comparable group experimental design which involved two experiment groups to determine the influence of the two problem-solving approaches and mathematics readiness on the problem to problem-solving performance and attitudes of the College Algebra Students. One group was exposed to the NonConstructivist Problem solving approach while the other group was exposed to the

Guided Constructivist Approach. After the pre-final examination, both groups were given the post-test and the Aiken Mathematics Attitude Scale Test to determine any signs of difference in their performance and attitudes towards mathematics.

O1	X	O2
O1	X	O2

Fig. The Non –equivalent Control Group Design

The subjects/respondents of the study were the students in two of the College Algebra classes in the College of Information Technology and Business Administration during the first semester SY: 2020 2021. These subjects composed the intact groups who were exposed to the two problem-solving approaches, namely the Non-Constructivist problem-Solving Approach and the Guided Constructivist Approach. They came from different colleges of the institute and were enrolled in College Algebra as their first college mathematics course. The study was conducted in the College of Information Technology and Business Administration at Tagoloan Community College (TCC), Baluarte, Tagoloan, Misamis Oriental. The institute is located strategically along the Barangay road in Baluarte Tagoloan, Misamis Oriental. It seeks to spearhead the region in science and technology along the functions of instruction, research, extension, and production. There are 9 colleges in the institute, namely: College of Arts and Sciences, College of Engineering and Information Technology, College of Education, College of Business Administration, College of Hotel and Restaurant Management, College of Criminology, and College of Midwifery.

For the study, the students were identified as the Guided Constructivist Group and the Non-Constructivist group. The students in the first group were made to work in groups of 4s or 5s. They made use of appropriate materials in solving word problems. These materials included colored chips, match sticks, ice 22 dropped sticks, graphing papers, etc. From these materials, they would search for patterns, raise their questions, and construct their models. The teacher would only give direction and guidance to assist the students in meeting whatever difficulties they would encounter. From this activity, they would discuss and agree on one best solution to a particular problem, They would all reflect on what they had done, and proceeded with the representation of the problem and the solution using algebraic symbols. On the other hand, in the Non-Constructivist group, the students were made to work on an activity in pairs. They were exposed to the twenty-one problem-solving strategies proposed by Polya as well as the 4-step process that they would follow in solving a particular pattern. These strategies included guessing and checking, using a diagram, using a variable, looking for a pattern, etc.

Sampling Procedure

The population of this study consisted of all the freshmen students of Tagoloan Community College (TCC) who were enrolled in College Algebra during the first semester of the school year 2014-2015. There were twelve (12) sections consisting of 60 to 80 students in each section. Two of the sections in the MWF schedule were selected at random as the subjects of the study. A validated pre-test to determine the students' entrance competencies in algebra and geometry was conducted before the employment of the two approaches. The researchers employed Aiken's Mathematics attitude Test to determine the students' attitudes toward mathematics. After the treatments, a post-test was conducted to determine the effect of the treatments on the performance of the students. The Aiken Attitude Scale Test was again conducted to determine if differential attitudes were affected after the treatments. All the items in the pre-test and post-test were validated through the usual procedure of instrument validation. The test was administered to a group of freshmen students who were not included in the study. Upon employment of the Kruder- 23 Richardson Formula 21, a reliable value of 0.72 was obtained which indicated that the test was reliable.

The Scoring Procedure

The respondents were asked to respond to the attitude test by checking an appropriate number that corresponds to the descriptive rating of their choice. A five-point Likert Scale was quantified as follows:

		Mean ranges
Strongly Agree	5	4.50-5.00
Agree	4	3.50-4.49
Undecided	3	2.50-3.39
Disagree	2	1.50-2.49
Strongly Disagree	1	1.00-1.49

Responses with mean values of 3.50 and above were given an equivalent description of positives while those with a mean value less than 3.50 were equivalent to Negative. The items in the pre-test and post-test were given points of one (1) for each number and zero (0) for an incorrect response.

Statistical Treatment

The data that were gathered were analyzed according to the results obtained after the employment of the statistical tools as follows:
1. Means, Frequencies, and Standard deviation for the scores in the pre-test and post-test.
2. Regression analysis for the influence of mathematics readiness on the students' problem-solving performance.
3. One-way Analysis of Covariance (ANCOVA) for the significance of the difference between the problem-solving performance of the students after exposure to the two approaches as well as on the deviation of attitudes after the treatments.
4. Two-Factor Analysis of Covariance (ANCOVA) for the significance of interaction in the achievement scores of the students as influenced by their level of mathematics readiness and the two problem-solving approaches. In testing the formulated hypotheses, the alpha level was set at 0.05 level of significance

Findings and Discussions

Problem 1. What is the level of readiness of the students in College Algebra in terms of:
1.1 Reading Comprehension
1.2 Algebra, and
1.3 Geometry?

Table 1. Respondents' Level of Mathematics Readiness in College Algebra

Variables	Constructivist Group		Non-Constructivist Group		Total	
	Mean	SD	Mean	SD	Mean	SD
Reading Comprehension	13.50	5.06	13.45	5.53	13.48	5.27
Algebra Skills	8.60	2.34	8.42	2.19	8.51	2.24
Geometry Skills	8.20	1.93	7.65	2.15	7.92	2.11

Table 1 shows the respondents' level of mathematics readiness in College Algebra in terms of reading comprehension, algebra skills, and geometry skills. The data on reading comprehension was taken from their scores in the 36-item verbal comprehension and reasoning category of the Entrance Examination which the students took upon enrolment to the institute. The mean and standard deviation values of the students in algebra and geometry skills were determined from their scores in the readiness test in algebra and geometry.

It can be observed that, in terms of reading comprehension, the students in both groups had means which were almost the same. The Constructivist group had a mean of 26 of 13.50 and the Non-Constructivist group had 13.45. Both of these values were equivalent to below average according to the specifications of the Entrance Examination. This indicates that both groups of students had poor preparation for College Algebra in terms of reading comprehension. This implies that the students were inadequate in one of the basic requirements for problem-solving encounters. According to De Cortes (1996), the English comprehension of a student should be more than average for him to work on word problems effectively.

The standard deviation of 5.06 among students in the Constructivist group and 5.53 among those in the Non-Constructivist group indicates that the former group was more homogeneous than the latter group. An f-ratio of their variances which is equal to 0.64 is lesser than the tabular f-ratio of 1.69 at 0.05 level. This means that the two groups were comparable in terms of reading comprehension. In terms of algebra skills, the table reveals that the Constructivist group had a mean of 8. 60 while the Non-Constructivist group had 8.42. These mean values were both very low considering that there were 20 items in the test. In the transmutation of the scores, both these values were equivalent to below average. This implies that the students did not have the basic competence in algebra which is another requirement for success in undertaking College Algebra.

The Constructivist group had a standard deviation of 2.34 while the NonConstructivist group had 2.19. This indicates that the students in the Non-Constructivist group had scores that were low and close compared with those in the Constructivist group. An f-ratio of their variances which is equal to 1.14 indicates that the two groups were comparable in terms of basic algebra skills.

In the 20-item geometry test, the Constructivist group had a mean of 8.20 while the Non-Constructivist had 7.62. While the former group had a higher mean value than the latter group, these values were very low from the expected average scores. These values were equivalent to below average. This implies that the students were poorly prepared for College Algebra in terms of geometry skills. It implies that the students needed help to strengthen basic geometry concepts and skills for them to develop competence in this subject.

The Constructivist group had a standard deviation of 1.93 while the NonConstructivist group had 2.15. This indicates that some students in the NonConstructivist had extremely high scores while others had extremely low scores. The ratio of their variances is equal to 0.81 which indicates that both students were comparable in terms of basic geometry skills. In summary, it can be noted that the students had an average level of mathematics readiness in College Algebra in terms of reading comprehension, algebra skills, and geometry skills. This means that the students were generally less prepared to undertake the lessons and exercises in College Algebra.

Problem 2**.** How does students' mathematics readiness influence their college algebra achievement scores and problem-solving performance?

Table 2. Regression Analysis of the students' Mathematics Readiness and College Algebra Achievement Scores

Variable	Beta Coefficient	f-value	Probability
Reading Comprehension	0.8905	29.59	0.000
Algebra Skills	0.0070	0.62	0.5117
Geometry Skills	0.5427	1.42	0.3362
Constant = 8.4783			
Multiple R = 0.5369			
R squared = 0.3020			
Adjusted R squared = 0.2697			
Computed f ratio = 13.35			
p-value 2.067 x 10^{-6}			

*significant at 0.05 level

Table 2 shows the result of the regression analysis which was done to determine what factors influenced the students' achievement scores in College Algebra. Reading readiness contributed significantly to the student's achievement scores in College Algebra as evidenced by the beta coefficient of 0.8905. This means that the students who had high reading comprehension ability had high achievement scores in College Algebra. This is supported by the probability which is lesser than 0.05. Geometry and Algebra skills showed weak and marginal influence on the achievement scores of the students in College Algebra

Results further showed that when taken jointly, the three factors formed a significant set of predictors for student achievement in College algebra as evident in the computed f-ratio of 13.35 which is significant at 0.05 level. Furthermore, 30.20% of the variance in the observed test scores is explained by the joint effect of the three factors considered with most of the variance explained by their reading readiness, the null 29 hypothesis is rejected concerning the factors that influenced the achievement in College Algebra

In summary, it can be deduced that the performance of the students in the College algebra achievement test was influenced by their mathematics readiness in terms of reading comprehension. Algebra and Geometry skills were not found to be good predictors in this study. This finding affirms the claims of Charles and Lester (1992) that the mathematical performance of the students is a function of their thorough understanding of concepts in mathematics.

The problem-solving performance of the students was determined through their scores in the 40-item translation and problem-solving category of the College Algebra achievement test. Table 3 shows the result of the regression analysis.

Table 3. Regression Analysis of the Students' Mathematics Readiness and Their Problem-Solving Performance

Variable	Beta Coefficient	f-value	Probability
Reading Comprehension	0.5360	15.30	0.001
Algebra Skills	0.0007	0.06	0.8130
Geometry Skills	0.0126	0.96	0.3251
Constant = 2.7431			
Multiple R = 0.4222			
R squared = 0.2021			
Computed f-ratio = 16.923			
p-value = 9.72 x 10^{-5}			

*significant at 0.05 level

It can be gleaned that reading comprehension came out as the best predictor of the student's problem-solving performance. This is evidenced by the probability value 30 which is lesser than 0.05. This means that the students who had high reading comprehension ability had high scores in the problem-solving items of the achievement test. The regression coefficient of reading comprehension is 0.5360 which is significant at 0.05 level. Algebra and Geometry skills again showed weak and marginal influence on the problem-solving performance of the students.

Results further showed that when taken jointly, the three predictors formed a significant set of predictors of the student's problem-solving performance. This is supported by the computed f-ratio of 15.30 which is significant at 0.05 level. Also, 20.21% of the variance in the observed score in the problem-solving items is explained by the joint effect of the three factors considered, with most of the variance explained by the reading readiness of the students. The null hypothesis is rejected concerning the factors that influence the problem-solving performance of the students.

In summary, it can be deduced that the students' mathematics readiness significantly influences their College Algebra achievement scores and problem-solving performance. These findings agreed with the findings of Arbon (1979). De Castro (1996), and Aure (1996) identified mathematics readiness as a predictor of a student's success in problem-solving.

Problem 3. How do students' problem-solving performance compare as influenced by the problem-solving approaches:
3.1 Constructivist problem-solving approach
3.2 Non-Constructivist problem-solving approach?
31 The problem-solving performance of the students was determined through their scores in the problem-solving items in the pretest/posttest.

Table 4. Problem Solving Performance of the Students on the Pretest and in the Posttest

Problem Solving Approaches	Pre-test		Post-test	
	Mean	SD	Mean	SD
Constructivist Approach	5.30	2.45	15.40	8.50
Non-Constructivist Approach	5.55	3.20	14.95	7.43

It can be observed that the pretest means for the Constructivist group is 5.30 while it is 5.55 for the Non-Constructivist group. This means that the scores of the students in both groups are almost the same and are very low taking into consideration that there were 40 items

Regarding the standard deviation, the Constructivist group had 2.45 and the Non-Constructivist group had 3.20. This means that the score of the students in the Constructivist group was less spread compared to those in the Non-Constructivist group. However, the f-ratio of the variance yielded 1.32 which is lesser than the tabular f-ratio of 1.69 at 0.05 level. This means that the two groups were comparable in terms of problem-solving performance before the treatments were given.

In the posttest, the Constructivist group had increased their mean score to 15.40 while the Non-Constructivist group increased their mean score to 14.95. This indicates that both problem-solving approaches improved the problem-solving performance of the students. The Constructivist group had a higher mean value of 32 compared to the Non-Constructivist group. However, analysis was done to determine whether a significant difference existed.

It can be noted further that the standard deviation values in the posttest also increased from 2.45 to 8.50 for the Constructivist group and from 3.20 to 7.43 for the Non-Constructivist group. This implies that score of the students had extremely high scores while others had very low scores. The scores of the students in the Constructivist group had a wider spread than the scores of the students in the NonConstructivist group

Table 5. Summary Table of One-Way ANCOVA on Problem-Solving Performance as Influenced by the Problem-Solving Approaches

Source of Variation	Adjusted SS	df	Adjusted Mean	F computed	F critical
Treatment	47.76	1	58.40	1.20	3.58
Within	3747.70	77	46.67		
Error	3795.46	78			

To determine whether there was a significant difference in their scores, a one-way ANCOVA was utilized. Table 5 shows the results obtained from the analysis.

It can be gleaned that the ANCOVA resulted in an f-ratio of 1.20 which is lesser than the critical tabular value of 3.58 at 0.05 level. This means that there is no significant difference in the problem-solving performance of the students as influenced by the problem-solving approaches. The Constructivist group had a higher mean score than the Non-Constructivist group but the difference was not significant. It can be inferred that the Constructivist problem-solving approach was as effective as the NonConstructivist problem-solving approach in improving the problem-solving performance of the students.

These findings run encounter with the findings obtained by Ramos (2001) in her study, constructivism approach was found to be more effective than the traditional approach in the teaching of arithmetic. In this study, the Constructivist approach was not found to be more effective than the Non-Constructivist approach. This could be because College Algebra is more of an abstraction than arithmetic. During the treatments, it was observed that the students found it difficult to move from their constructions to algebraic symbolism.

Problem **4.** Is there a significant interaction in the students' achievement scores as influenced by their mathematics readiness and problem-solving approaches? Table 6 shows the general achievement scores of the students in the pretest and posttest. The students in both groups are classified as average and below average in their level of mathematics readiness.

Table 6. General Achievement Scores of the Students in College Algebra

Problem Solving Approaches	Mathematics Readiness							
	Average				Below Average			
	X		Y		X		Y	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Constructivist Approach	14.50	6.80	28.90	10.96	11.00	3.83	21.35	8.15
Non-Constructivist Approach	14.35	7.20	27.20	10.48	9.96	2.82	20.10	5.99

X-pretest Y- posttest

It can be observed that the Constructivist group with Average mathematics readiness obtained a pretest mean of 14.50 while the Non-Constructivist group obtained a pretest mean of 14.35. These scores were almost similar which indicates that the students had similar abilities in the pretest. In the posttest, the Constructivist group had a mean of 28.90 while the Non-Constructivist group had a mean of 27.20. It can be inferred that the performance of the students in both groups improved in the post-test. A two-factor ANCOVA was employed to determine if a significant difference existed in the effect of mathematics readiness and problem-solving approaches.

In terms of standard deviation, both groups had almost similar values. The Constructivist group had 6.80 and the Non-Constructivist group had 7.20. This indicates that the score of the students in both groups was already widely spread in the pretest. Also, the scores of the students in the Non-Constructivist group were more dispersed than the scores in the other group.

In the posttest, the standard deviation was 10.96 for the Constructivist group and 10.48 for the Non-Constructivist group. The increase in the standard deviation indicates that the spread had become wider for both groups in the post-test. There was a greater increase in the standard deviation of the Constructivist group indicating that there was a wide disparity of scores in that group as compared to those in the Non-Constructivist group. This means that some of the students in the Constructivist group had very high scores while others had very low scores.

From among those with below-average mathematics readiness, the same pattern can be observed. The pretest means of both groups were almost similar. The Constructivist group was 11.00 and the Non-constructivist group had 9.96. These values were very low because there were 60 items in the test. There was a large 35 increase in their mean scores in the posttest. The Constructivist group had a mean of 21.35 and the Non-Constructivist group had 20.10. This indicates that the general achievement of the students in College Algebra had improved. A Fuller analysis was done to determine if a significant difference in their mean scores existed.

While the standard deviation values were almost similar in the pretest, there was a greater standard deviation among the Constructivist group than with the NonConstructivist group. The Constructivist group had a standard deviation of 3.83 while the Non-Constructivist group had 2.82 which indicated that the scores in the Constructivist group were more widely spread than those in the other group. In the posttest, the standard deviation increased for both groups. The Constructivist group had 8.15 while the Non-Constructivist group had 5.99. This implies that some students in the Constructivist group had very high scores while others had very low scores. This implies further that the scores of the students in the Non-Constructivist group were less spread than those of the other group.

A two-way ANCOVA was employed to determine if there was significant interaction in the students' achievement scores as influenced by their mathematics readiness and problem-solving approaches.

Table7. Two-Factor ANCOVA with Interaction on Students' Achievement Scores as Influencedby Mathematics Readiness and problem-Solving Approaches

Sources of Variation	Adjusted SS	df	Adjusted MS	f-ratio computed	f-ratio critical
Readiness	60.53	1	60.53	0.85	4.00
Approaches	3.28	1	4.20	0.05	4.00
Interaction	4.55	1	5.50	0.07	4.00
Error within	5962.18	75	70.55		

Table 7 shows the result of the analysis of covariance between the influence of mathematics readiness and the problem-solving approaches on the student's achievement in College Algebra. This analysis yielded a computed f-ratio 0f 0.85 which was lesser than the tabular f-ratio of 4.0 at the 0.05 level. This means that the general performance of the students in College Algebra did not differ significantly as influenced by the student's level of mathematics readiness. This implies that whether the students had average or below-average of mathematics readiness, their performance in College Algebra was not affected.

In terms of the problem-solving approaches, the computed f-ratio was 0.05 which means that there is no significance. This implies that one approach was as effective as the other in improving the general performance of the students in College Algebra.

Table 7 also shows that the f-ratio obtained in interaction was equal to 0.07 which is lesser than the tabular value 0f 4.00 at 0.05 level. This indicates that there is no significant interaction between the students' achievement scores as influenced by their mathematics readiness and the problem-solving approaches. It means that the students with low scores on the mathematics readiness test got low scores on the College Algebra achievement test. This was true for all the students in the Constructivist group and the Non-constructivist group.

These results implied further that both approaches may be used effectively in the classroom. One approach may complement the other, providing a more interesting classroom climate. Consequently, the students will be encouraged to be more involved in the class during problem-solving encounters. As they engage in more proactive, meaningful learning, they would also be able to develop better attitudes toward learning.

Problem 5. What are the students' attitudes toward mathematics when exposed to
5.1 Constructivist problem-solving approach and
5.2 Non-Constructivist solving approach

Table 8. Mean and Standard deviation of the Respondents' Attitude Toward Mathematics

Statements	Constructivist Group		Non-Constructivist Group	
	Mean	**SD**	**Mean**	**SD**
1. Mathematics is important for the progress of civilization or society	4.62	0.65	4.55	0.68
2. I am interested and willing to increase my knowledge in mathematics.	4.60	0.72	4.70	0.52
3. There is nothing creative in Math; it is just memorization of facts and formulas.	3.45	1.20	2.85	1.19
4. Mathematics is needed in almost everything we do.	4.58	0.75	4.52	0.82
5. I am interested to use mathematics outside of school	3.70	1.05	3.80	0.87
6. Mathematics is not interesting because it gives me no freedom to express my personal opinion.	1.75	1.13	1.80	0.75
7. Learning mathematics makes me feel uneasy and confused.	3.60	1.05	2.50	1.05
8. Mathematics is enjoyable and exciting.	3.45	1.10	3.50	0.85
9. I enjoy doing more than the assigned work of math and trying to solve the new problem.	3.55	1.28	3.60	0.95
10. I would like to develop my mathematics skills and study the subject more	4.40	0.85	4.30	0.79
11. Mathematics is not important in everyday life.	1.66	0.99	1.70	0.99
12. An understanding of mathematics is needed by artists and writers as well as a scientist.	3.35	1.30	3.15	1.25
13. Mathematics is a very useful and necessary subject.	4.40	0.85	4.20	0.90
14. Mathematics help to develop a person's mind and teaches him to think.	4.40	0.85	4.25	0.47
15. Mathematics has contributed greatly to science and other fields of knowledge.	4.20	0.81	4.20	0.91
16. I never liked mathematics and it is the subject I am most afraid of...	2.50	0.95	2.38	0.99
17. Mathematics makes me feel nervous and comfortable.	3.25	1.20	2.80	1.10
18. Mathematics is very interesting: I have always enjoyed my mathematics class.	3.35	1.00	3.40	0.90
19. Mathematics is not as important as other school subjects.	1.75	1.04	1.60	0.85

20. I enjoy studying my lessons in mathematics.	3.42	1.22	3.75	0.89
21. The world cannot go on without mathematics.	4.15	0.95	4.10	3.45

Table 8 reflects the mean responses of the students to each of the items in the Aiken Mathematics Attitude Scale Test. The table also shows the corresponding standard deviation of each response. In item 1, the students in the Constructivist group had 39 a mean of 4.62 while those of the Non-Constructivist group had 4.55. This indicates that the students strongly agreed that mathematics is important for the progress of society. This also implies that the students recognized the significance of their achievement in College Algebra to their achievement in other subjects. The standard deviations of both groups of students were almost the same. This implies that the responses in both groups had the same spread.

In item 2, the mean of the students in both groups indicates strongly agree. This implies that both groups of students were highly motivated to learn mathematics, particularly increasing their knowledge and skills in College Algebra as their first mathematics course. It was observed that the students were enthusiastic during the conduct of the experiments. The standard deviation of the students in the Constructivist group was 0.72 while those in the Non-Constructivist group were 0.52. This means that the responses of the students in the Constructivist group were more spread than those of the other group.

In the third item, the students in the Constructivist group had a mean of 3.45 or Agree while those in the Non-Constructivist group were 2.85 or Undecided. This means that the students in the Constructivist group observed that they were able to use their creativity in their group activities. This was what they realized in their manipulation of the materials during problem-solving sessions. On the other hand, the students in the Non-Constructivist group were not able to determine whether their outputs were products of their creativity or just the application of the formulas that they were exposed to. This could be because, in all problem-solving exercises, most of them used only one strategy which was using a variable. Only a few tried other strategies like drawing a picture or drawing a diagram. The standard deviation of 1.20 in the Constructivist group and 1.19 in the Non- Constructivist group indicates that the responses of the former group were close and less spread than those of the latter group.

In item 4, both groups of students had the same mean of 4.58 or strongly agree. This is an agreement with their response to item 1. This means that the students understood that mathematics is important in everyone's life. The different problem situations which they worked on had given them insights into the different applications of their knowledge and skills. Hence, this is an indication that the students had an appreciation of the usefulness of mathematics concepts. The standard deviation of both groups was almost the same which indicates that their responses had the spread.

In item 5, the mean of the students in the Constructivist group was 3.70 while it was 3.80 for those in the other group. This indicates that both groups of students agree that mathematics concepts and skills are useful in meeting actual situations outside of school. This also implies that the students were consistent in their acceptance of the significance of learning mathematics and internalizing the concepts as their tool in meeting real-life situations. The standard deviation of the students in the Constructivist group was 1.05 and 0.87 of those in the Non-Constructivist group. This indicates that the responses of the students in the former group were more dispersed than those of the latter group.

For the sixth item, the students disagreed that mathematics is not interesting and that it did not give them the freedom to express their options. The students in the Constructivist group had a mean of 1.75 and the other group had a mean of 1.80. This response could be because in both approaches the students were asked to justify each step that they went through in finding the solution to a given problem. They were also asked to express what they could say about the process that they went through. Thus, the students were given the freedom to express their views and opinions during the different classroom activities. The standard deviation values were 1.13 and 0.75, respectively. This means that the responses of the students in the Constructivist group had a wider disparity than those of the Non-Constructivist group.

Item 7 elicited responses that indicated undecided. The students in the Constructivist group had a mean of 3.60 and the Non-constructivist group had a mean of 2.50. This means that the students did not feel uneasy and confused in class. However, since they had to work with others, as in the Constructivist group, and with a seatmate as in the Non-Constructivist group, each student had to adjust with each other. Also, the learning activities required a lot of thinking processes and sharing of ideas. These ideas may sometimes confuse a team member but must be explored and accepted if agreed upon by the majority of the group. The standard deviation of the Constructivist group was 1.05 and the deviation of the Non-Constructivist group was 1.05. This indicates that the responses of the students in the former group were more dispersed than those of the latter group.

The two problem-solving approaches were able to provide a conducive learning atmosphere for the students. This could be evidenced by their responses to item 8. The students in the Constructivist group had a mean of 3.45 and the students in the NonConstructivist group had a mean of 3.50. Both responses indicate agreement. This means that the students in both groups enjoyed the learning activities. It was observed that the students always looked forward to every succeeding activity. This was because they liked the idea of brainstorming where they could freely share their ideas. Also, they enjoyed working with their materials and even competing with other groups. In the NonConstructivist group, their pairing also provided them with more confidence to work on the activity. They could talk to their teammate without the fear of not knowing the answer and of being insulted. They could level their experiences and apply what they had gained from these experiences. Then from here, they could decide on a final solution to a given problem.

The standard deviations of both groups of students were almost the same. This means that their responses had the same spread.

In item 9, the students in the Constructivist group had a mean of 3.55 or undecided while the students in the Non-Constructivist group had a mean of 3.60 or agree. This means that the students in the Constructivist group did not find the same enthusiasm in doing their assignments alone as in doing their work in a school with group mates. This could be because, in the classroom, more ideas can be explored, and obtaining the correct solution to a given problem could be more convenient. On the other hand, it can be recalled that the students in the Non-Constructivist group had a high mean response to item 2. Their mean response to item 9 just confirms their enthusiasm to learn more in mathematics. Working with another classmate offers the same enthusiasm to work on an assignment as working alone. The standard deviation of 1.28 of the Constructivist group and 0. 95 of the Non-Constructivist group indicates that some of the students in the former group had responses that had extremely high scale values while others had responses with extremely low scale values. The responses of the students in the Non-constructivist group were less spread than those of the other group.

The students agreed to develop their mathematics skills and study the subject more. The students in the Constructivist group responded to item 10 with a mean of 4.40 and the students in the Non-Constructivist group had a mean of 4.30. This means that the students were consistent in their desire to learn mathematics and to develop skills 43 so that they will be more equipped to undertake succeeding mathematics courses. This was observed in their active participation during the conduct of the experiments. The standard deviation values were almost the same for both groups of students. This indicates that the students in both were homogeneous in their desire to perform well in College Algebra.

Students were in unison to disagree on item 11. Both groups had a mean of 1.66. This means that the lessons given to them gave them insights into the importance of mathematics in everyone's life. This also implies that the students valued what they learned from their mathematics class and expected to use their knowledge in meeting different life situations. The standard deviation was 0.99 for the Constructivist group and 0.99 for the Non-Constructivist group. These values were the same, indicating that the responses of these students in both groups had the same spread.

In item 12, the students in the Constructivist group had a mean of 3.35 while those in the other group had a mean of 3.15. Both values indicate undecided. This means that both groups of students did not realize the applicability of mathematics concepts to the works of artists and writers. This is an indication that the teacher was not able to provide examples that would relate mathematics concepts to the world of artists and writers. The standard deviation of the Constructivist group was 1.30 while those of the Non-Constructivist group were 1.25. This indicates that the responses of the students in the former group had a wider disparity than those of the latter group.

Item 13finds the students in agreement that mathematics is a useful and necessary subject. The mean of the students in the Constructivist group was higher than the mean of the students in the Non-Constructivist group. This indicates that more of the students in the former chose responses with higher scale values than those in the 44 latter groups. This could be because the students in the Constructivist group found their use and manipulation of materials to be very effective in problem-solving activities and that without these materials it would be difficult to perform the experiments. The standard deviation of the Constructivist group was 0.85 while it was 0.90 in the Non-Constructivist group. This indicates that the responses of the Constructivist group were closed and had less spread than those of the other group.

The students were again in agreement that mathematics helps develop a person’s mind and teaches them how to think. The Constructivist group had a mean of 4.40 and the Non-Constructivist group had a mean of 4.25. Both values are equivalent to agree. This means that both groups of students appreciated what they gained from their group activities. These activities helped them develop their analysis and reasoning skills. These were particularly provided in the different aspects of the experiments. They were always asked to think and give the answers to the questions regarding the activity that they had in the class. It can be noted that the standard deviation of the Constructivist group was 0.85 while it was 0.47 in the Non-Constructivist group. This indicates that some students in the Constructivist group had responses with extremely high scale values while others had responses with extremely low scale values. This implies further the responses of the students of the Non-Constructivist group.

In item 15, the students in the Constructivist group had a mean of 4.20 while those in the Non-Constructivist group had a mean of 4.20. These mean values are equivalent to an agreement which signifies that the students in both groups were aware of the contributions of mathematics to science and other fields of knowledge. It can be recalled that the students strongly agree that mathematics is important in all endeavors in life. Thus, their mean response to item 15 just confirms the conviction. This implies further that the students had a clear understanding of the significance of mathematics as a tool for different breakthroughs in science and technology. This was provided in the realistic examples given by the teacher so that the students will have an awareness of the applicability of mathematics to science and technology. The standard deviation of the Constructivist group was 0.81 and the standard deviation of the Non-Constructivist group was 0.91. This is an indication that the responses of the former group were more spread than those of the latter group.

It is widely accepted that students do not like mathematics and many students are afraid of this subject. The mean responses of the students to item 16 runs counter to this perception. The Constructivist group had a mean of 2.50 and the NonConstructivist group had a mean of 2.38. Both values are equivalent to disagree. This means that many of the students were able to develop a positive attitude toward mathematics. This could be because both groups were provided with a learning environment where they could feel secure and find enjoyment while learning. The standard deviation of the Constructivist group was 0.95 while it was 0.99 for the Non- Constructivist group. This implies that the responses of the students in the former group were more homogeneous than those of the latter group.

The responses of the students to item 17 were equivalent to undecided. It can be noted that the Constructivist group had a higher mean than the Non-Constructivist group. This indicates that some of the students were not able to completely conquer their fears about mathematics. This implies that more interesting examples must be given and more student-centered activities must be undertaken so that they would be encouraged to participate more actively. This implies further that the teacher has to be 46 more patients with the students' shortcomings and help them improve their performance. This will also help them realize that there is nothing to fear about mathematics. The standard deviations of both groups were almost the same, indicating that the responses of the students in both groups had the same spread.

The mean responses of the students to item 18 were equivalent to undecided. The Constructivist group had a mean of 3.35 while it was 3.40 for the Non-Constructivist group. This means that some of the students were unable to find their mathematics classes very interesting and enjoyable. This establishes the fact that some students were still hesitant to free themselves of negative feelings about mathematics. This could be an effect of bad experiences that the students encountered in the past. College Algebra is their first mathematics course in college and they still had to eliminate learning barriers as they also realize their learning inadequacy. While they adjust to the rigors of college life, they had also to structure their study habits since they will be required to do a lot of thinking and deciding for their knowledge. They had to accept the fact that mathematics is an important subject in college, they must learn it and pass the subject to succeed in their studies.

In terms of the standard deviation, the Constructivist group had 1.00 while the Non-Constructivist group had 0.90. This indicates that the responses of the former group were close and had less spread than those of the latter group.

While some of the students were undecided about their feelings inside the classroom, they disagreed on item 19. The Constructivist group had a mean of 1.75 and the Non-Constructivist group had a mean of 1.60. This means that the students were still consistent in their admission that mathematics is an important subject. This also implies that they also acknowledge that mathematics concepts complement the other 47 concepts in the total development of a person. The standard deviation of the Constructivist group was 1.04 as compared to 0.85 of the Non-Constructivist group indicating that in the former group some students had responses with extremely high scale values while others had responses with extremely low scale values and that the responses of the Non-Constructivist group were low and close.

In item 20, the students in the Constructivist group had a mean of 3.42 or undecided while the Non-Constructivist group had a mean of 3.75 or agree. This is inconsistent with their response to item 9. This means that the students in the Constructivist group enjoy their group activities and seek to learn with teammates than on their own. In the Non-Constructivist group, the students worked in pairs and it was observed that, sometimes, in the learning activities, one idea dominated the other. This could give motivation for each teammate to try working alone and enjoy their discoveries which were, at times, something more than what they believed they could attain.

In terms of the standard deviation, the Constructivist group had 1.22 while the Non-constructivist group had 0.89. This indicates that the responses in the former group had a wider disparity than those of the latter group. In the last item, the students in the Constructivist group had a mean of 4.15 and the students in the Non-Constructivist group had a mean of 4.10. This implies that the students agreed that mathematics concepts are the foundation blocks of all the concepts in this world. This is therefore an indication that the students realized the importance of being able to learn mathematics and relate their knowledge and skills to real-life encounters. This realization could be helpful in the development of students' appropriate attitudes toward learning. If they will be able to internalize what they learn, 48 it will help them develop more appreciation for knowledge and it will lead them to seek true and total personal development. It can be noted that the standard deviation of the Constructivist group which was 0.95 was lower than the standard deviation of the Non-Constructivist group which was 3.35. This indicates that the responses of the former group were more homogeneous than those of the latter group. This implies further that some of the students in the NonConstructivist group had responses with extremely high scale values while others had responses with extremely low scale values.

Table 9. Mean Values of the Students' Attitudes Before and After the Treatments

Mean Values				
	Before Treatment		**After Treatment**	
Problem Solving Approaches	Mean	SD	Mean	SD
Constructivist Approach	3.50	0.24	3.51	0.27
Non-Constructivist Approach	3.56	0.26	3.64	0.19

Table 9 shows the mean values on attitudes towards mathematics. The students in the Constructivist group had a mean which is 3.50 before the treatment and 3.51 after the treatment. This means that before the treatment, the student's attitude was already positive and had very little increase after the treatment.

The students in the Non-Constructivist group had a mean value of 3.56 before the treatment and 3.64 after the treatment. This means that the students had a positive attitude towards mathematics and this also had a very little increase after the treatment. Although both groups yielded mean values which mean positive attitudes towards mathematics, these values indicated that there was much room for the development of better attitudes. On a scale of 1-5, it would be more appropriate for students to have mean values between 4 and 5.

The standard deviation before the treatment was 0.24 for the Constructivist group and 0.26 for the Non-Constructivist group. This indicates that the scores were almost the same. This implies that before the treatments, the students in both groups were homogeneous in terms of attitudes toward mathematics. In the posttest, the standard deviation for the Constructivist group was o. 27 and 0.19 for the Non-constructivist group. This means that the students in the Constructivist group became less homogeneous than the other group after the treatment. This could be because the Constructivist group was new to them and it required a lot of thinking processes. They enjoyed the construction of ideas with their materials but some of them encountered difficulty in the symbolism. It seemed that some of them did not understand how to feel about the whole thing.

Table 10. One-Way ANCOVA on the Attitude towards Mathematics

Source of Variation	Adjusted SS	df	Adjusted MS	f-ratio computed	f-ratio critical
Treatment Between	0.011	1	0.011	0.22	3.90
Error within	3.72	78	0.048		
Total	3.73	79			

α = 0.05 level of significance

To determine if a significant difference existed in the attitudes of the students toward mathematics, a one-way ANCOVA was employed. Table 10 shows the F-ratio which is equal to 0.22. This is lesser than the critical f-ratio of 3.90 at 0.05 level. This indicates that there is no significant difference in the attitude towards mathematics between the students before and after exposure to both problem-solving approaches. 50 This could be attributed to the fact that the students still had to understand what they felt about College Algebra as their first college mathematics course. Also, the time element involved during the treatments was not long enough for them to immediately determine a change of attitude. This confirms the findings of Rudnitsky (1995) Kulm (1980) and Rhodes (1993) which states that attitudes cannot be easily changed in a short period.

Conclusion

This study was conducted to determine the efficacy of two problem-solving approaches to the problem-solving performance and attitudes of the students in College Algebra. This was conducted at Tagoloan Community College, Baluarte, Tagoloan, Misamis Oriental. The non-comparable group experimental design was used in the study. The students were grouped into two: one group was exposed to the Guided Constructivist group while the other group was exposed to the Non-Constructivist group. The findings of the study were the following:

1. The students had a below-average level of mathematics readiness in College Algebra in terms of reading comprehension, algebra, and geometry.
2. Regression analysis revealed that reading comprehension was the best predictor of the students' College Algebra achievement scores. Algebra and Geometry skills were not found to be important predictors of the students' College Algebra achievement scores.
3. Reading comprehension was the best predictor of the students' solving performance.
4. The one-way ANCOVA yielded an f-ratio which indicated that there was no significant difference in the problem-solving performance of the students as influenced by the problem-solving approaches.
5. The two-way ANCOVA on the pretest and posttest scores of the students in both groups when grouped according to mathematics readiness yielded a ratio indicating no significant interaction in the students' achievement scores as influenced by their mathematics readiness and the problem-solving approaches.
6. The students had a positive attitude towards mathematics as influenced by the problem-solving approaches.
7. The one-way ANCOVA resulted in an f-ratio which indicated no significant difference in the student's attitude towards mathematics as influenced by the problem-solving approaches.

Recommendation

With the aforementioned conclusions, the researcher forwards the following recommendations. The deans of the different colleges of the institute should require freshmen students to take preparatory mathematics courses before enrolling in College Algebra to help them cope with the required input competencies in the said subject. The Constructivist Approach can be used to complement other effective methods to create more interesting and more active problem-solving sessions in the classroom. The institute must formulate student development programs that will help meet the needs and abilities of the students in mathematics, and further studies on other areas of mathematics such as geometry may be conducted to determine the efficacy of the same approaches in these areas.

References

1. Aure, Diana S. (1992). "Factors Affecting Students Mathematical Learning: "An Analysis". Philippines
2. Bill (2008). Are the skewness and kurtosis useful statistics
3. Dr. Donald Wheeler's book Advanced Topics in Statistical Process Control (www.spcpress.com)
4. Davidson, A.C. Statistical model. Cambridge Series in Statistical and Probabilistic Mathematics
5. Davidson, Neil (1990). Cooperative Learning in Mathematics. A handbook for Teachers. Massachusetts: Addison-Wilson Publishing House.
6. De Corte, E., Greer, B., et al.(1996). Handbook of Educational Psychology. New York; McMillan Publishing House.
7. , George A. (1971). Statistical Analysis in Psychology and Education. Tokyo: McGraw Hill Ltd.
8. Fosnot, Catherine T. (1996) Constructivism: Theory, Perspective, and Practice. New York: Teachers College Press.
9. Goldin, G.A. (1998). "Observing Mathematical Problem Solving Through Task-Based Interviews", Qualitative Research Method in Mathematical education Monograph 9, p.40 Heston, VA: NCTM Inc.
10. Joy Molina (2001) Asymptotic Properties of mean–squared errors for radial basis function networks as estimators of chaotic dynamical systems. MPSC
11. Lester, Frank K. (1989) Musings about Problem Solving Research Journal for Research in Mathematics Education., 29, 436 -442
12. Leikin, Roca (1997) Facilitating Student interaction in Mathematics: In a cooperative Learning setting, Journal for Research in Mathematics Education, 331 – 354
13. Loquinte, Dioscoro M.(1999) NonParametric Estimation of Regression Function by Local Polynomials: p=2, p=3, MPSC
14. Luna, Charita D. (2000). Principles and Standards for School Mathematics: A Paper Dissemination at MPSC, Cagayan de Oro City, Phils.
15. Musser, Gary L., And Burger, William F. (1994) Mathematics for Elementary Teachers. New York: McMillan Publishing Co.
16. Pagoso, Cristibal M. (1978) Fundamental Statistics
17. Pal, Samajit K., Penasco, Anthony M and Prado, Nenita L. (2001) Methods of Research, Phil. CMU Research and Development Unit.
18. Polya, George (1957) How to Solve it. 2nd ed. New York: McMillan.
19. Ragasa, Carmelita. (1987) some factors Affecting Mathematical Problem Solving Ability in the Second Year". Unpublished. UP, Phils
20. Ramos, Marife A. (2001). "Constructivism Approach: It's Influence on Pupils' Mathematical Achievement, Beliefs, and Attitudes towards Mathematics. Unpublished Masteral Thesis., MPSC, Cagayan de Oro City
21. Schoenfield, Alan, et. Al (2000). Principles and standard for School Mathematics. USA. NCTM, Inc.

Sweller, John (1990). General Problem Solving Strategies. Journal for Research in Mathetics education, 22, 411 -415

22. Valdez, Jerome Y. (2002). "Analysis of Xavier University Placement Test Results in Mathematics: It's Implication to Students' Readiness for College Mathematics. Unpublished material, MPSC, Cagayan de Oro City
23. Vygotsky, L. (`986). Thought and Language. Cambridge: MIT Press
24. Walpole, Ronald E. (1982) Introduction to Statistics. New York: McMillan Publishing Co., Inc.
25. Ward, Cherry D.(2000). Under Construction: On Becoming a Constructivist given the Standards. Mathematics Teachers.