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# Modular Approach in Teaching Problem Solving: A Metacognitive Process

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**Abstract:** ***The study assessed the mathematics readiness of students, and investigated whether the modular approach to teaching mathematical problem solving focused on metacognitive skills is a better than conventional teaching. It used a static-groups pretest-posttest design, with 144and 146 students for the control and experimental group, respectively. A TIMSS-based mathematics test was used to assess readiness, while a problem solving test was used for problem solving proficiency. Both groups showed an intermediate level of math readiness. Also, the experimental group showed significantly higher problem solving proficiency than the control group. Thus, the experimental group showed better metacognitive skills.***

**Keywords:** problem solving proficiency, metacognitive skills, modular approach, mathematics education

## 1. Introduction

### 1.1 Background

Mathematics is one of the core learning areas in most educational systems around the world including that of the Philippines. Educational planners and curriculum developers are concentrating much on this field as an integral learning area.. This subject seems to become one of the parameters of learning or so called literacy, and is necessary to the development of every Filipino student towards making him locally and globally competitive. However, there is a persistent problem with mathematics in the Philippine educational system and mathematics performance is considered by most citizens of the country to be deteriorating. Hence, new methods, strategies, techniques and approaches have been and must be engineered and reengineered to facilitate learning and address the problem.

According to Mayer, Tajika & Stanley (1991, cited in Sangcap 2010), this declining status of mathematics and poor mathematical performance among students had been a worldwide concern for the past years as indicated in the Programme for International Student Assessment (PISA) Report 2003. In concurrence, the 2003 Trends in International Mathematics and Science Study (TIMSS) reported low achievement scores for Mathematics (and Science) of Filipino students in Grade 4 and Grade 8 (2nd year high school).

In a presentation made by the National Education Testing and Research Center (NETRC), entitled "NAT Overview and 2012 Test Results", pupils/students performances in Mathematics subject in the National Achievement Test (NAT) for the past school years were below the mean percentage score (MPS) of 75 percent which is the lowest passing percentage score set by the Department of Education (DepEd). In school year 2011-2012 alone the MPS of Grade 3, Grade 4, and High school students were 59.87%, 66.47% and 46.37% respectively.

The Medium Term Development Plan (MTDP) 2004-2010 also reported that the overall performance of the higher education in terms of the average passing percentage across all disciplines in the higher education declined over the three year period from 45.35 percent to 41.71 percent. These are enough reasons for Mathematics teachers and other stakeholders to rethink and ponder upon the status of instruction in Algebra and the students' problem solving capabilities.

Understanding the nature of students' problem solving ability does not only involve the requisite skills, knowledge and tools or his cognitive capacity, but also on how to use these knowledge, skills and tools appropriately or his metacognitive aspect as may be necessary to achieve the desired solution or answer. The study of Go Silk (2012) revealed that the interaction of cognition and metacognition influence one's ability to solve word problems in Mathematics. This, however, is overshadowed by the more observable cognitive skills and the surreptitious nature of metacognition that they are not consciously and overtly observed or described. It was thus recommended that the teaching of Mathematics in general must not just be focused on the acquisition and mastery of cognitive skills, but must also cover the development of the regulatory and control skills to be able to appropriately apply cognitive skills.

The development of an approach to teaching mathematics, in general, and teaching problem solving concepts, in particular, with special focus on the development of metacognitive skills along with the cognitive skills would be beneficial both to the teacher and the learner. The outcome/s of the study would not only be limited on problem solving, but would serve as a prototype for teaching other mathematical concepts as well. The outcome/s also find great applications to higher levels of basic education where students are prepared for independent or self-learning in college and eventually lifelong learning.

### 1.2 Objectives of the Study

The study primarily intended to assess mathematics readiness of students and improve their mathematical achievement. Specifically, this study sought to determine whether a modular approach to teaching mathematical problem solving with special focus on developing the metacognitive skills of the students is effective.

## 2. Literature Survey

The term metacognition was introduced in 1975 by John Flavell a Psychologist from Stanford University. He used the term to denote:

"*One's knowledge concerning one's own cognitive processes and products or anything related to them* (...) [and] *refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes* (...), *usually in the service of some concrete goal or objective.*" (Flavell, 1979 in Pesut, 1990).

Similarly, Livingston (1997) and Imel (2002) have identified different components of metacognitive knowledge or skills. They have separately identified these components as knowledge about cognition and the knowledge to manipulate or manage cognition or cognitive skills.

Metacognitive instruction appears to enhance metacognition and learning in a broad range of students, thus, affording them positive consequences to learning like improved academic performance (Erskine, 2009; Lovett,. 2008; Veenman, Van Hout-Wolters, & Afflerbach, 2006), of particular relevance to poor students. However, a great number of students cannot instinctively gain a metacognitive competency, that is, they do not develop self-reflective abilities on their own, either because the opportunity to do so is missing or they do not see the relevance of investing effort in building up such a set of competencies, especially high school students and incoming college freshman students (Erskine, 2009; Joseph, 2006; Meijer, Veenman, & van Hout-Wolters, 2006).

Research has shown that metacognition can be taught and can be learned or developed. Involving students in a constant discussion about thinking and learning as well as affording opportunities for guided practice is essential to improving metacognition (Weimer, 2011; Lovett, 2008; Joseph, 2006; Meijer, Veenman, & van Hout-Wolters, 2006). Research literature makes clear that metacognitive skills can be developed

The concept of metacognition shall be considered as composed of two aspects: knowledge about cognition and regulation. A merging of Flavell's Model and Brown's Model of Metacognition will show how these concepts will be used in the study.

Furthermore, Kolb and Kolb (2002) in their development and further enhance of the experiential learning theory (ELT) have stressed the significance of experience in the acquisition of learning. Concrete experience allows learners to grasp abstractions a while reflections become open to applications and experimentations for further refinement of the experience. This is exemplified using the 4 A's approach, that is, Activity (the concrete experience), Analysis (the active reflection), Abstraction (conceptualization of knowledge), and Application (leads to experimentation). Furthermore, Kolb and Kolb (2009b) stressed on the use of the metacognitive model to describe how fundamental concepts of ELT interact.

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Moreover, in an intervention study conducted by Neuhaus Education Center (2008), showed students of the school who received intervention, that is, received metacognitive strategies demonstrated better reading comprehension results than those of the students in the other school who did not receive any intervention. The researchers concluded that the metacognitive strategies used as interventions in the study helped students to "think about their thinking" before, while, and after they read.

## 3. Methods

### 3.1 Research Design

This study used quasi-experimental two groups, non-random selection, pre-test, post-test design to test the hypotheses. This is also known as non-equivalent (static) groups pretest-posttest design. In the non-equivalent groups pretest-posttest design, the dependent variable is measured both before and after the treatment or intervention, as depicted here:

| **Group** | **Pre-test** | **Treatment** | **Post-test** |
|---|---|---|---|
| Control Group | $O_{11}$ | | $O_{12}$ |
| Experimental Group | $O_{21}$ | X | $O_{22}$ |

where , $O_i$ = test scores
X = treatment

This design, according to Marczyk, DeMatteo and Festinger (2005), gives it two advantages over its posttest only counterpart. First, with the use of both a pretest and a posttest, the temporal precedence of the independent variable to the dependent variable can be established. This may give the researcher more confidence when inferring that the independent variable was responsible for changes in the dependent variable. Second, the use of a pretest allows the researcher to measure between-group differences before exposure to the intervention. This could substantially reduce the threat of selection bias by revealing whether the groups differed on the dependent variable prior to the intervention. The design is illustrated below.

The variable $O_{11}$ represents scores obtained by the control group in the given pretest while $O_{12}$ will be the scores obtained from the experimental group given the same set of pretest. The variable $O_{21}$ represents scores obtained by the control group on the given posttest while $O_{22}$ will be the scores obtained from the same set of posttest administered to the experimental group. X represents the treatment which is the use of modular approach in teaching problem solving.

### 3.2 Participants

The subjects were not randomly assigned to the experimental and control group. Because of logistical reasons it is not possible to randomly assign subjects, so intact classes or all students in a particular two classes coming from the first year Associate in Computer Science from each participating units enrolled in Algebra to represent the control and experimental groups. To reduce further the threat of selection due to non-randomization, multiple control and experimental groups were considered in the study.

The participants of the study were the students in the External Studies Units (ESUs) who were enrolled in Associate or Bachelor of Science in Computer Science curriculum and were taking up a course in Algebra. The treatment was conducted during the first semester of AY 2015-2016 when the Algebra course was offered.

Five (5) units were considered out of the seven (7) units offering the course since the other two only units have one class for the course, thus, they were not able to provide a control and experimental group necessary in conducting the experiment/ treatment. Subsequently, two (2) classes in each of the five (5) units under consideration were randomly selected, one to serve as the control group and the other as the experimental group. Hence, there were five control groups and five experimental groups. On the average, each group have 31 participants, with a total of 290 participants, 144 for the control groups and 146 for the experimental groups.

### 3.3 Procedure and Instrument

The study started with the development of a module using Kolb's experiential theory focusing on the development of metacognitive skills. The module followed the 4A's approach, i.e. Activity, Analysis, Abstraction and Application. It covered five (5) topics in problem solving. The module was submitted to the Instructional Support Materials Production (ISMP) Office for technical corrections. It was then field tested using a pilot group, analyzed based on psychometric properties and refined further for final implementation. Prior to administration of the intervention to the experimental group, a Mathematics Readiness Test was administered to the control and experimental group to determine their mathematics readiness. Teacher orientations on their role in the implementation of the intervention were also conducted, for uniformity of implementation, to eliminate, if not, reduce experimenter effects.

The instrument used in the pre- and post-tests was a researcher-made Problem Solving Test, designed to determine the proficiency of the students in problem solving. This was a response-type of test which consisted of five word problem solving types in Algebra namely: age problem, work problem, mixture problem, distance problem, and number relation problem. One question was constructed for each type of problem solving validated by a panel of specialists in mathematics and had a Cronbach's alpha coefficient of 0.78.

Prior to the application of the intervention, a pre-test was administered to determine the initial problem solving proficiency of the participants and establish that both groups have same level of proficiency prior to the implementation of the intervention to ascertain that changes in behavior was attributable to the intervention. After the completion of the intervention, which lasted for six weeks, a post test was administered to both groups using the same test.

Answers were assessed not only on the correctness of the final answers but were also be assessed as to how students carried out and analyzed the problems based on their presentations and solutions. To assure objectivity in the scoring, students' outputs were scored using the Northwest Regional Educational Laboratory Mathematics Problem Solving Model (NRELMPSM) involving the following traits: conceptual understanding, strategies and reasoning, communication, and computation and execution.

Data were processed using statistical software for descriptive and inferential analysis. The primary inferential statistics used were Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) to adjust the results on the possible effect of the covariate, that is, familiarity due to the pretest, as well as, paired-samples T-test.

## 4. Results and Discussion

### 4.1 Mathematics Readiness

Table 1 shows the math readiness of the participants from the five (5) different ESUs.

**Table 1:** Mean, standard deviation and coefficient of variation of the math readiness of the participants

| Unit | Group | $\bar{x}$ | SD | N | CV | Description |
|---|---|---|---|---|---|---|
| A | Ctrl | 4.26 | 1.678 | 27 | 39.39 | Intermediate |
| | Exp | 5.65 | 1.191 | 23 | 21.08 | High |
| | Total | 4.90 | 1.619 | 50 | 33.04 | Intermediate |
| B | Ctrl | 3.27 | 1.719 | 33 | 52.57 | Intermediate |
| | Exp | 3.78 | 1.813 | 37 | 47.96 | Intermediate |
| | Total | 3.54 | 1.775 | 70 | 50.14 | Intermediate |
| C | Ctrl | 4.59 | 1.859 | 44 | 40.50 | Intermediate |
| | Exp | 2.75 | 1.433 | 44 | 52.11 | Intermediate |
| | Total | 3.67 | 1.892 | 88 | 51.55 | Intermediate |
| D | Ctrl | 4.05 | 2.041 | 19 | 50.40 | Intermediate |
| | Exp | 4.71 | 1.546 | 24 | 32.82 | Intermediate |
| | Total | 4.42 | 1.789 | 43 | 40.48 | Intermediate |
| E | Ctrl | 3.52 | 2.136 | 21 | 60.68 | Intermediate |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Exp | 4.83 | 1.886 | 18 | 39.05 | Intermediate |
| | Total | 4.13 | 2.105 | 39 | 50.97 | Intermediate |
| Total | Ctrl | 4.00 | 1.911 | 144 | 47.78 | Intermediate |
| | Exp | 4.05 | 1.877 | 146 | 46.35 | Intermediate |
| | Total | 4.02 | 1.890 | 290 | 47.01 | Intermediate |

Categories: 0 - 2.5 Low; 2.51 – 5.0 Intermediate;

5.01- 7.5 High; 7.51 – 10 Advanced

All the study participants from the different units show comparable math readiness, which was found to be at the intermediate level, except that of the experimental group from unit A, which was found to be high. The overall means of the control and experimental groups were found to be 4.00 and 4.05, respectively. The table also shows that the levels of the mathematics readiness of the participants from the control and experimental groups have similar variedness or heterogeneity, as shown by the coefficient of variation of 47.78% and 46.35%, respectively. Though, one experimental group shows a high level of readiness and a relatively homogenous composition (having the lowest coefficient of variation of 21.08%), its impact to the overall level of readiness of the experimental group is not evident. This indicates that the control and experimental groups have very similar levels of math readiness, which implies that the control and experimental groups have comparable or relatively similar composition of participants.

Further analysis, using analysis of variance (ANOVA) was done to determine whether there is a significant difference in the mathematics readiness of the participants. The results are shown in Table 2.

**Table 2:** Summary table of the T-test analysis of the participants' Mathematics Readiness Scores

| | df | T-value | Sig. | Mean Diff. |
|---|---|---|---|---|
| Mathematics Readiness | 288 | -.216 | .829 | - .048 |

Table 2 shows that there is no significant difference in the mathematics readiness of the participants in the experimental groups and control groups from the different units with a computed T-value of - 0.216 and a probability value of .829 which is greater than the alpha level of 0.05. Hence, the mean difference of – 0.048 is statistically negligible. This means that participants' math readiness from the experimental group does not differ from that of the control group from the different units. This implies that students from different groups are of the same level in terms of their readiness in mathematics. This indicates that the participants from both groups have the same level skills in mathematics, that is, intermediate. Thus, both groups are on equal keel in terms of requisite or prior knowledge and skills in mathematics before the administration of the intended treatment.

Possessing intermediate level mathematics skills, the participants can apply basic mathematical knowledge in straightforward situation. They can add, subtract or multiply to solve one-step word problems involving whole numbers and decimals. They can identify representations of common fractions and relative sizes of fractions. They understand simple expressions and solve linear equations with one variable. They recognize basic notions of probability and can read and interpret graphs and tables.

Though the participants have an intermediate level of math readiness and that they possess the most basic mathematical skills it could be surmised that they fall below the national standards expected of a high school graduate. The Department of Education sets its standards at 75% mean percentage score (MPS), while the MPS equivalents of the math readiness of the control and experimental groups are 40% and 40.5%, respectively, way below the national standards. These results corroborate the findings of the NETRC Report on the National Achievement Test in 2012 where the MPS of the high school students were found to be 46.37% only.

### 4.2 Pretest Result

To determine the skill level of the participants in problem solving at the onset of the administration of the treatment a pretest was conducted. The summary of the results of the pretest is presented in Table 3.

**Table 3:** Mean and standard deviation and coefficient of variation of the participants' pretest scores in problem solving (*n = 290*)

| Problem type | Control | | Experimental | | Overall | |
|---|---|---|---|---|---|---|
| | $\bar{x}$ | *SD* | $\bar{x}$ | *SD* | $\bar{x}$ | *SD* |
| Age | 1.16 | 1.69 | 0.88 | 1.36 | 1.02 | 1.53 |
| Work | 1.77 | 1.9 | 2.62 | 3.97 | 2.2 | 3.14 |
| Mixture | 0.39 | 0.78 | 1.43 | 3.73 | 0.91 | 2.75 |
| Distance | 1.67 | 3.49 | 3.04 | 5.72 | 2.36 | 4.79 |
| Number | 0.16 | 0.64 | 1.13 | 3.1 | 0.65 | 2.3 |
| Total | 4.61 | 5.17 | 8.36 | 13.86 | 6.48 | 10.6 |
| CV | 112.15 | | 165.79 | | | |

Legend: 0 – 25 Emerging; 25.01 – 50 Developing; 50.01 – 75 Proficient; 75.01 – 100 Exemplary (based on MPS)

Table 3 shows the problem solving pre-test results of the control and experimental groups. Based on the table, the control group showed poorest performance in the number-related problem with a mean score of 0.16, while the experimental group have showed poorest performance in the age problem with a mean of 0.88. The control group had their best in the work problem with a mean score of 1.67, while the experimental group had their best in the distance problem with a mean of 3.04. These indicate that the performance of the control and experimental groups in the five (5) problem types in the pre-test are still in the emerging level. In the overall analysis, the control group have a mean score of 4.61 and the experimental group with 8.36. These translate to an MPS of 5.76% and 10.45%, respectively. Though the pre-test score of the experimental group is slightly higher than the control group, the variation of the scores within the experimental group, SD = 13.86, is higher than that of the control group, SD = 5.17. This means that majority of the class would have scores below 25% of the highest possible score. Hence, both groups can be considered to possess similar initial skill sets in relation to problem solving and are both classified as emerging.

To empirically determine whether the observed disparity in the pretest scores of the control and experimental group is statistically significant, further analysis using ANOVA was made. This rendered results presented in Table 4.

**Table 4:** Summary table of the Analysis of Variance (ANOVA) of the participants' problem solving pretest scores

| | df | T-value | Sig. | Mean Diff. |
|---|---|---|---|---|
| Pretest Result | 220.70 | -1.538 | .126 | - 1.771 |

It can be gleaned from Table 4 that there is no significant difference in the problem solving proficiency of the participants in the pretest from both groups based on the computed T-value of -1.538 with a p-value of .126 which is greater than the alpha level 0.05. This implies that all participants from both groups have similar levels of problem solving proficiency. Though the descriptive information showed a mean difference of -1.771 in the pretest performance between the control and experimental groups, with the experimental group on the higher end, it was found to be statistically not significant. Thus, the initial skill sets of both the control and experimental groups are the same which is an essential prerequisite at the start of the administration of the treatment.

Thus, the students tend to commit any or all of the following errors - mathematical representations of the problem were incorrect; they used the wrong information in trying to solve the problem; the mathematical procedures used would not lead to a correct solution; used mathematical terminology incorrectly; strategies were not appropriate for the problem; they didn't seem to know where to begin; the reasoning did not support their work; apparently there was no relationship between their representations and the task; there was no logic to the solution; errors in computation were serious enough to flaw their solution; labeled problems incorrectly; gave no evidence of how they arrived at the solution; their thinking cannot be followed and explanation seemed to wander. These errors are characteristic of an emergent skill and are cognitive or metacognitive in nature.

The emergent skill level is the lowest level of problem solving proficiency. Thus, the students have shown a very low performance in problem solving. This indicates either they were not able to apply the prior mathematical knowledge and skills that they have or that they needed additional inputs or new set of skills specific to these types of problems or both.

### 4.3 Problem Solving Posttest Result

A posttest was administered to determine the skill level of the participants in problem solving at the onset of the administration of the treatment after the treatment was made. The summary of the results of the posttest is presented in Table 5.

**Table 5:** Mean, standard deviation and coefficient of variation of the participants' posttest scores in problem solving (*n = 308*)

| Problem Type | Control | | Experimental | | Overall | |
|---|---|---|---|---|---|---|
| | $\bar{x}$ | *SD* | $\bar{x}$ | *SD* | $\bar{x}$ | *SD* |
| Age | 1.97 | 2.36 | 1.58 | 2.18 | 1.78 | 2.28 |
| Work | 3.62 | 4.39 | 7.37 | 5.39 | 5.5 | 5.25 |
| Mixture | 2.98 | 4.79 | 5.95 | 6.49 | 4.47 | 5.89 |
| Distance | 6.64 | 6.7 | 13.08 | 5.18 | 9.87 | 6.79 |
| Number | 2.77 | 4.99 | 4.11 | 5.81 | 3.44 | 5.45 |
| Total | 17.91 | 16.16 | 32.08 | 13.23 | 25 | 16.36 |
| CV | 90.23 | | 41.24 | | | |

Legend: 0 – 25 Emerging; 25.01 – 50 Developing; 50.01 – 75 Proficient; 75.01 – 100 Exemplary (based on MPS)

Table 5 shows the problem solving post-test results of the control and experimental groups. The table shows that both the control and experimental groups performed the poorest in the age problem with a mean score of 1.97 and 1.58, respectively. They performed the best in the distance problem with the control group obtaining a mean score 6.64 and 13.08 for the experimental group. Further scrutiny of the mean scores would reveal a relative consistent trend for both groups; they find the problems in increasing order of difficulty as follows — distance problem, work problem, mixture problem, number problem and age problem. The overall mean scores are 17.91 for the control group and 32.08 for the experimental group, which translates to a mean percentage score of 22.39% and 40.10%. Also, the control group scores are highly differentiated by about 90% as indicated by the CV compared to the experimental group's 41%. These indicate higher scores for the participants in the experimental group compared to their control group counterparts. Though there is a discernable increase in the post-test scores compared to the pre-test results, the control groups performance remains to be in the emergent level while the experimental group have moved up to the developing level.

To determine if the difference between the posttest scores of the control and experimental groups, further analysis was done using Analysis of Covariance (ANCOVA). Result of the analysis is presented in Table 6.

**Table 6:** Summary table of the Analysis of Covariance (ANCOVA) of the participants' problem solving posttest scores

| Source of Variance | df | F | Sig. |
|---|---|---|---|
| Unit | 4 | 2.873 | .166 |
| Group | 1 | 9.044 | .039 |

Based on Table 6 there is no significant difference in the problem solving proficiency among the different ESUs in the post-test as indicated in the computed F-ratio of 2.873 and a significant value of .166 which is greater than alpha level 0.05. This indicates that the overall performance of the students from both experimental and control groups in each ESU does not differ. But, Table 6 shows that the difference in the posttest scores between the experimental and control groups are significant with a computed F-ratio of 9.044 and a p-value that is less than 0.05 found at 0.039. This denotes that the level of problem solving proficiency of the control



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and experimental groups are different. This implies that the results of the posttest in problem solving of the experimental group are significantly higher than that of the control group with a mean difference of 14.17. Hence, the experimental group's skill level in problem solving has significantly improved after the treatment.

Consequently, the experimental groups choice of forms to represent the problem was correct but accurately or completely labeled; used some but not all of the relevant information from the problem; the mathematical procedures used would lead to a partially correct solution; used terminology imprecisely; used an oversimplified approach to the problem; offered little or no explanation of the strategies used; some of the representations accurately depicted aspects of the problem; sometimes made leaps in the logic that were hard to follow; the process led to a partially complete solution; made minor computational errors and weren't able to sustain the good beginning.

Moreover, to empirically establish that the improvement is significant, a comparison of the means using T-test paired samples was done. Result of the analysis is shown in Table 7.

**Table 7:** Summary of the T-test for Paired Sample

| Groups | Post Test | | Pre-test | | t | p-val |
|---|---|---|---|---|---|---|
| | $\bar{x}$ | SD | $\bar{x}$ | SD | | |
| Control | 17.91 | 16.16 | 4.61 | 5.17 | 1.98 | < 0.0001 |
| Exp | 32.08 | 13.23 | 8.36 | 13.86 | 1.98 | < 0.0001 |

The table shows the t-test result for the paired samples comparison of post-test and pre-test results for the control and experimental groups. The analysis of the control group's post-test and pre-test results revealed a computed t-value of 1.98, and a p-value less than 0.0001 which is significant at 0.05 and 0.01. This means that there is a significant difference in the pre-test and post test scores of the control group. Furthermore, the post test scores are statistically higher than their pre-test scores. Similarly, analysis of the experimental group's test results yielded a computed t-value of 1.98, and a p-value that is also significant at 0.05 and 0.01. This means that the post test and pre-test scores of the participants in the experimental group differ significantly. Moreover, the post test scores of the experimental group are higher than their scores in the pre-test. Clearly, these differences are attributed to the treatment.

These imply that the both techniques used in teaching how to solve the five (5) types of word problems in algebra have an impact on the skill levels and abilities of the students. However, based on the preceding analysis, the students in the experimental group performed better than those in the control group. Thus, the use of the modular approach in teaching problem solving is better than the conventional approach or lecture method.

## 5. Conclusions and Recommendations

The results of the analyses revealed that the level of mathematics readiness of the students is at the intermediate level. The students were found to be able to add, subtract or multiply to solve one-step word problems involving whole numbers and decimals; identify representations of common fractions and relative sizes of fractions; understand simple expressions and solve linear equations with one variable; recognize basic notions of probability and can read and interpret graphs and tables. These skills though basic as they may seem are necessary requisites to problem solving and may suffice to solve problems with simple to intermediate levels of complexity. In addition, the level of readiness of the control and experimental group are within the intermediate level. This indicates that both groups under consideration in the study possess the same skill sets at the onset of the study.

The pretest scores of the students were found to be very low. This indicates an emergent skill level, the lowest level of problem solving proficiency. This level includes students who tend to make mathematical representations of the problem incorrectly; use the wrong information in trying to solve the problem; use mathematical procedures that would not lead to a correct solution; use mathematical terminology incorrectly; use strategies that are not appropriate for the problem; get confused where to begin; use lines of reasoning that do not support their work; commit serious flaws in the logic, structure, and basic details of the solution. Their thinking cannot be followed and explanation seemed to wander. This is not what is expected of students who already have learned a decent set of basic mathematical skills such as those having intermediate level of mathematics readiness. Thus, this indicates that either they were not able to apply the prior mathematical knowledge and skills that they already have learned or that they needed additional inputs or new set of skills specific to these types of problems or both. But since the students have the same levels of problem solving proficiency, it can be used as a baseline information and it helped the study to establish empirical evidence on the positive effect of the modular approach to teaching problem solving.

From the analysis of the posttest scores have shown significant improvement in the experimental group's problem solving proficiency and an improvement in their skill set and approach in solving problems, that is, from emergent to developing. This is not the case for the control group, which have shown a certain level of improvement but not sufficient enough to cause a change in the skill set and remained in the emergent level. The experimental group has shown to use more accurate or complete labels and use some but not all of the relevant information from the problem. They use mathematical procedures that would lead to a partially correct or complete solution due to leaps in the logic that were hard to follow and minor computational errors. Errors committed are reduced to use of imprecise terminology and use of an oversimplified approach to the problem. Hence, it can be inferred that the modular approach has a positive influence on improving the students' learning of problem solving skills. The built-in metacognitive nature of the modular approach provided students better alternatives on how to solve the problems.

It is recommended then that the modular approach be used as primary approach to teaching problem solving, especially in the External Studies Units. This would greatly help in developing the metacognitive skills of the students. The module used in this study is recommended as a template for teaching mathematics in ESUs focusing on the metacognitive skills development using modular approach. A fully independent modular learning, however, is not advised since it was observed in the modules that most of the students would leave out certain metacognitive activities and questions, if answers to these questions are left optional by the teacher.

It is also recommended that its use in other courses and topics be explored as metacognitive skills are not domain specific and they are remarkably consistent across different fields (Weimer, 2011). The constancy of exposing the students to metacognitive activities similar to the ones used in the module will help them develop their metacognitive skills.

Finally, it is recommended that the use of the modular approach be introduced as early as the high school. Literature on teaching metacognition would show that metacognitive ability develops with age over the course of adolescence and metacognitive ability for perceptual task was higher in the adolescents compared with the adults (Weil, et al., 2013). Since the outcomes are not necessarily context specific, these outcomes will also find applications to teaching mathematics in higher education institutions (HEIs) and even in the junior and senior high school, or in other subjects/ disciplines seeking to develop the metacognitive skills of the students.

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