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# Modular Cooperative Learning: A Designed Mathematics Instruction for 21st Century Education

Freddie R. Cabrera
**Isabela State University - Cauayan Campus**

## ABSTRACT

*Modular cooperative learning is a kind of approach wherein, modular and cooperative approaches are combined to come up with a better strategy in teaching. This study was conducted to determine the effectiveness of modular cooperative learning in teaching college algebra.*

*This study made use of quasi-experimental research that involved the BSIT I-7 which is composed of 30 students assigned as the experimental group exposed in modular cooperative learning and BSIT I -9 with 32 students assigned as the control group exposed in the traditional lecture -discussion method. The study started with the administration of pretest and pre-mathematics attitude test and it ended with the administration of a posttest and post –mathematics attitude test. The instruments used to gather data included the module, pretest and posttest and mathematics attitude inventory test. The scores were compared and the significance of their differences were determined using the t-test.*

*Findings showed that modular cooperative learning improved mathematics performance of the students. It also performed significantly better than the traditional lecture-discussion method. Positive changes taking place when teachers change their teaching methods towards a more student-centered approach like modular cooperative learning. Hence, modular cooperative learning should be adopted to develop a more enjoyable learning environment.*

**Keywords***:* Mathematics, College Algebra, Modular Cooperative Learning, quasi-experimental, Isabela, Philippines.

## INTRODUCTION

Mathematics teachers play an important role in the innovation of teaching in mathematics. Global initiative of promoting quality education to produce quality and competent graduates and continuous effort of searching and trying new teaching approaches had been the concerns of Higher Education Institutions. Concerns that the education system cannot adequately prepare students for life and work in the 21st Century have prompted people across the country to explore new ways of designing education (Caguimbal, 2013). To be able to cope up with the international standards of foreign universities and colleges, higher education institutions in the Philippines are seeking new ways of designing education to improve the existing educational system

of the country as well as to prepare students in facing the challenges of the 21st century (Bersoto, 2014) . Implementation of Outcomes-Based Education (OBE) is the main thrust of most Higher Education Institutions in the Philippines today to go along with the standards of foreign universities and colleges all over the world (Laguador, 2014). Outcomes–based education (OBE) is student–centered learning method which empirically measures student performance–the outcome. It clearly focuses and organizes everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences. It starts with a clear picture of what is important for students to do, then organize curriculum, instruct and assess to make sure this learning ultimately happens. OBE requires the students to understand the contents by "extending the meaning of competence far beyond that of narrow skills and the ability to execute structured tasks in a particular subject area and classroom. To be able to cope in trying to strengthen the quality assurance system in Philippine higher education, institutions of higher learning were mandated to upgrade higher education curricular offerings to international standards (Valdez, 2012) by employing OBE. With this, the Isabela State University with its vision to be a globally recognized institution and its mission to provide quality and competent graduates for global competitiveness started to upgrade its curricular offering to international standards by shifting the teaching approaches from teacher-centered approach to OBE designed approach. Willoughhby (2000) mentioned that "innovation in the teaching of Mathematics is needed because the world is changing" .One way of innovating teaching and learning process is by utilizing OBE teaching approach like modular-cooperative learning. Modular cooperative learning is a combination of modular and cooperative learning approaches wherein the student studies with his/her peers. This learning process allows students to ask one another on concepts which are not clear to them and they got to share ideas with one another just like brainstorming using modules. In this approach, the teacher's intervention is very minimal or limited. This is an obvious student- centered approach where self-discovery encourages learning, a self-learning package dealing with one specific subject unit and teaching is a secondary activity that is tasked to the teacher. This approach evolved strategies and procedures that can help the groups solve their own problems and acquire information through collective effort. The learning environment is characterized by strong motivation and smooth interpersonal interactions.

The Outcomes Based Education focuses on what the learners should learn which is opposite to the traditional education planning (Bersoto, 2014). In OBE, what the learners should learn must be identified first, followed by how they are going to learn these. The assessment and teaching strategies will be dependent on the desired learning outcomes unlike in the traditional planning, the lessons that should be learned will be identified first and from these lessons the outcomes will be identified. Killen (2000) mentioned that there are two basic types of outcomes from any educational system. The first type includes performance indicators such as test results,

completion rates, post-course employment rates, etc. The second type of outcome is less tangible and is usually expressed in terms of what students know, are able to do, or as a result of their education. In implementing outcomes-based education in teaching and learning process, the instructors should employ student –centered approaches like modular learning, cooperative learning or a combination of modular and cooperative learning. Tsay & Brady (2010) reported that students who fully participated in group activities like modular cooperative learning, exhibited collaborative behaviours, provided constructive feedback and cooperation with the group achieving higher likelihood of receiving better test scores and course grades at the end of the semester. Zhang and Huang (2006) believed that cooperation comes into three basic types: comprehensive cooperation, cooperation based on job division, and cooperation enabled by communication. Coke (2005) concluded that educators can best promote cooperative learning practices by "practicing what one preaches". According to Brown and Parker (2009), cooperative learning develops and contributes to one another's knowledge mastery on a topic by regularly discussing material, encouraging one another, and supporting the academic and personal success of group members. Base group learning is effective for learning complex subject matter over the course or semester and establishes caring, supportive peer relationships, which in turn motivates and strengthens the student's commitment to the group's education while increasing self-esteem and self-worth.

The researcher is aware of the conditions of mathematics education in the Philippines. This served as a motivation to develop a new approach in teaching and innovate the teaching approach from teacher-centered to student-centered approach. This study is a different attempt to try innovative approach in teaching mathematics by combining two teaching approaches –the modular approach and cooperative learning approach into one teaching approach – the modular cooperative learning approach and discover new approach and principles of teaching. In this approach, the modular form of teaching combined with cooperative learning using the two components - Student Team Achievement Division (STAD) and Team Game Tournament (TGT), the researcher perceived that the combination of these two approaches in teaching could be an effective method in optimizing learning in mathematics. This approach may enable students to understand problems, principles and procedures more easily.

With such investigations on the effectiveness of the modular cooperative learning to teaching different subjects stating its idea, purposes, advantages, and outlooks, the researcher tried to look into a more particular idea of the method identifying its effectiveness in a more specific course, in Mathematics, in the tertiary level to be able to come up with an endorsement of the method in the local setting as one of the effective tools in the teaching-learning process. It is for this reason that the researcher conducted this study.

This study determined the effectiveness of modular cooperative learning in teaching College Algebra. Specifically it aimed to determine the pretest and posttest scores of the students exposed in modular cooperative learning and traditional – lecture discussion method, compare the posttest scores of the students exposed in modular-cooperative learning and students exposed in traditional lecture-discussion method, determine and compare the mathematics achievement of the students exposed in modular cooperative learning and students exposed in traditional- lecture discussion method; and determine the attitudes of the experimental group before and after they were exposed in modular approach in teaching and the control group before and after they were exposed in the traditional method.

## METHODOLOGY

The researcher made use of the quasi-experimental type of research to determine the effectiveness of modular cooperative learning. Cook and Campbell (2000), defined quasi experimental research as an experiment which is not based on random assignment of subject to groups, but which attempts to overcome this shortcoming by various compensatory strategies. The pretest- posttest control group design was specifically used in the study. There are two groups of respondents involved in the study namely: the BSIT 1-7 with 30 students assigned as the experimental group exposed in modular cooperative learning in teaching college algebra and the BSIT 1-9 composed of 32 students from whom the traditional lecture-discussion method was used. Both classes were taught personally by the researcher.

This research made use of modules, mathematics achievement test, and mathematics attitudes inventory scale as data gathering instruments. The modules and mathematics achievement test were developed and formulated by the researcher and patterned with the course syllabus prescribed for mathematics 11 (College Algebra) . This was content validated by the Mathematics specialists of ISU-Cauayan City. The Mathematics Attitude Scale is a Likert scale composed of 30 items for which 16 items are positive and 14 items are negative.

The modular form of teaching combined with cooperative learning using the two components - Student Team Achievement Division (STAD) and Team Game Tournament (TGT) were used to the target group, the first year Bachelor of Science in Information Technology in employing this new approach. The researcher distributed the module to each student of the experimental group. After distributing the module, the researcher divided the class into six groups with five members in each group. They work, study and learn together through sharing ideas using modules. The groups are headed by a leader who leads the group in working activities and guide each member of the group to accomplish a certain task or activities given to them. Each group of the

class is motivated to accomplish activities and task given to them because the performance of each member affects the performance of the groups.

In the cooperative learning or experimental group, the students were grouped into smaller groups, they were given specific roles and duties ,students interacted face-to-face and each one was expected to be accountable for completing one's own assigned task while in the traditional method , the teacher discussed the lessons well while the students participated actively .

## RESULTS AND DISCUSSION

### Pretest and Posttest Scores of the Students Exposed in Modular Cooperative Learning

The pretest and posttest scores of the students who were exposed to modular cooperative learning were compared statistically with the t-test of significant difference between means for dependent samples. Results of the analysis are presented in table 1.

**Table 1**
**Results of t-test of Significant Difference Between the Pretest and Posttest Scores of Students in the experimental Group**

| Modules | Mean Scores | | Mean Difference | t-value | Decision |
|---|---|---|---|---|---|
| | Pretest | Posttest | | | |
| Sets | 3.71 | 7.38 | 3.67 | 15.58 | Reject Ho |
| Algebraic Expression | 3.93 | 7.19 | 3.26 | 14.94 | Reject Ho |
| Special Product and factoring | 3.45 | 7.57 | 4.12 | 19.82 | Reject Ho |
| Equations | 3.78 | 8.10 | 4.32 | 19.87 | Reject Ho |

t(.05)=2.21

Table 1 shows that there is an improvement of scores with the use of modular cooperative learning which is evident in the increase in mean scores obtained in the posttest. The computed t-values are all greater than the tabular value (2.21) which implies that there is a significant difference in the pretest and posttest scores of the experimental group exposed in modular cooperative learning. Their posttest scores are significantly higher than their pretest scores in all areas of the Mathematics test administered to the students.

**Pretest and Posttest Scores of Students Exposed in Traditional Lecture Method**

It is seen in the table that there is an improvement of scores of the students exposed in traditional lecture-discussion method in the four topics of college algebra namely: sets, algebraic expressions, special product and factoring.

**Table 2**
**Results of t-test of Significant Difference Between the Pretest and Posttest Scores of Students in the Traditional Group**

| Topics | Mean Scores | | Mean Difference | t-value | Decision |
|---|---|---|---|---|---|
| | Pretest | Pos-test | | | |
| Sets | 3.52 | 6.18 | 2.66 | 11.14[s] | Reject Ho |
| Algebraic Expression | 4.23 | 7.41 | 3.18 | 2.71[s] | Reject Ho |
| Special Product and Factoring | 3.75 | 7.16 | 3.41 | 16.12[s] | Reject Ho |
| Equations | 3.68 | 6.41 | 2.73 | 10.46[s] | Reject Ho |

t(.05)=2.02

When t-test was employed to determine if there is a significant difference in the pretest and posttest scores of the control group, it yielded t-values which are all greater than the tabular value of 2.021 at .05 level of significance leading to the rejection of hypothesis. It means that there is a significant difference in the pretest and posttest scores of the students exposed in traditional lecture-discussion method. It also means that there is a significant improvement in the figures of the students exposed to the traditional –lecture discussion method.

**Posttest Mean Scores Between the Experimental and Control Groups in College Algebra**

**Table 3**
**Results of t-Test of Significant Difference in the Posttest Mean Scores of the Students in the Experimental and Control Groups**

| Topics | EXPERIMENTAL (Modular Cooperative) | | CONTROL (LECTURE) | | Mean Difference | Gain ratio | Computed t-Value | Decision |
|---|---|---|---|---|---|---|---|---|
| | Mean | Sd | Mean | Sd | | | | |
| Sets | 7.38 | 1.38 | 6.18 | 1.17 | 1.2 | .06 | 4.36 | Reject Ho |
| Algebraic Expression | 7.41 | 1.45 | 7.19 | 1.45 | 1.23 | .01 | 4.47 | Reject Ho |
| Special Product and Factoring | 7.57 | 1.12 | 6.21 | 1.18 | 1.36 | .07 | 5.22 | Reject Ho |
| Equations | 8.10 | 1.05 | 6.41 | 1.30 | 1.69 | .08 | 6.59 | Reject Ho |

Critical value at .05 = 2.003

The students who were exposed in modular cooperative learning scored higher than those who were exposed in the traditional lecture-discussion method as evident in the posttest mean scores .The gain ratio ranges from .01 to .08 which implies that the Modular Cooperative Learning group achieved one to eight percent score, which is consistently higher than that of the control group.

When t-test was employed to determine if there is a significant difference in the posttest scores of the students exposed in modular cooperative learning and students exposed in traditional lecture –discussion method, it yielded t-values which are all greater than the tabular value of 2.003 at .05 level of significance. Hence, there is a significant difference in the posttest scores of the experimental group and control group. This implies that students exposed in modular cooperative learning approach showed better performance in College Algebra than students exposed in traditional lecture discussion method. This affirms the findings of Tarim and Akdeniz (2008) that using cooperative learning provide positive effects on students' academic achievement in mathematics.

**Comparison Between the Experimental Control Groups in the Pre and Posttest Scores in College Algebra**

Table 4 presents the results of t-test of the pretest and posttest scores between the experimental and control groups.

**Table 4**
**t-test Between the Experimental and Control Groups in the Overall Mean Scores of the Students in College Algebra**

| Topics | EXPERIMENTAL (Modular Cooperative ) | | CONTROL (LECTURE) | | Mean Difference | Computed Value | Decision |
|---|---|---|---|---|---|---|---|
| | X | Sd | X | Sd | | | |
| Pretest | 3.72 | 1.03 | 3.80 | 1.04 | 0.08 | -0.68 | Do Not Reject Ho |
| Posttest | 7.61 | 1.21 | 6.50 | 1.37 | 1.11 | 5.52 | Reject Ho |

tabular t-value - 1.96 at 5 % level of significance

The results show that the pretest mean score of the experimental group exposed in modular cooperative learning was 3.72 with a standard deviation of 1.03 and that of control group was 3.80 with a standard deviation of 1.04. The results indicate that the computed t-value was 0.68 which is less than the tabular value of 1.96 at .05 level of significance. This, therefore, means that the experimental and control groups were at the same level of achievement at the start of the study. This

implies that the two groups of respondents have the same entry level and have the same knowledge in the subject before the start of the study.

In the posttest scores, students exposed in modular cooperative learning scored higher than those who were exposed in the traditional lecture-discussion method as evident in the posttest mean scores of 7.61 of the experimental group and 6.50 for the control group with a mean difference of 1.11. When t-test was employed to determine if there is a significant difference in the posttest scores of the students exposed in modular cooperative learning and students exposed in traditional lecture –discussion method, it yielded a t-value of 5.52 which is greater than the tabular value of 1.96 at .05 level of significance. Hence, there is a significant difference in the posttest scores of the experimental group and control group. This implies that students exposed in modular cooperative learning approach showed better performance in College Algebra than students exposed in traditional lecture discussion method. This affirms the findings of Tarim and Akdeniz ( 2008) and Hsiung (2012 )that using student – centered approach like modular cooperative learning provide positive effects on students' academic achievement in mathematics.

Table 5 presents the difference between the mathematics achievement scores of the experimental and control groups. It covers the different topics in College Algebra like sets, algebraic expression, product and factoring and equations.

**Table 5**
**Difference Between the Mathematics Achievement of the Experimental and Control Group**

| Group | Mean | SD | Mean Diff | t-value | Decision |
|---|---|---|---|---|---|
| Experimental Group | 32.55 | 4.46 | 2.14 | 2.17$^{s}$ | Reject Ho |
| Control Group | 30.41 | 4.68 | | | |

tabular t-value = 2.00

As shown in the table, the performance mean score of the experimental group exposed in modular cooperative learning was 32.55 with a standard deviation of 4.46 and that of control group who exposed in traditional lecture discussion method was 30.41 with a standard deviation of 4.68 with a mean difference of 2.14 in favor to the experimental group. When t-test was employed, it yielded a t-value of 2.17 which is greater than the tabular value of 2.00 at .05 level of significance. This means that there is a significant difference in mathematics achievement of the experimental and control groups. The experimental group performed better and improved their achievement in mathematics.

Hence, the modular cooperative learning as a method in teaching college algebra is an innovative approach that affects the students' achievement, performance and attitude towards mathematics. The result of this study strongly

supports the research findings **o**f Tarim and Akdeniz (2008); Nichols and Miller (1994); and Akinsola (2008). Employing better and higher achievement in mathematics and it greatly affects attitudes of the students towards mathematics. Through this approach, the students will have more opportunities to learn, discuss and solve mathematical problems and provide ideas with each other.

**Attitude Towards Mathematics of Experimental and Control Groups**

Table 6 presents the pre and post-attitude mean score towards mathematics of the students exposed to modular cooperative learning and students exposed to traditional lecture discussion method. The table reveals that the pre-attitude mean score towards mathematics of the experimental group was 2.86 while that of the control group was 2.78.This means that experimental and control group have a neutral attitude towards mathematics before the study.

**Table 6**
**Pre and Post-Attitude Scores Towards Mathematics of Experimental and Control Groups**

| Group | Pre-Attitude | | Post-Attitude | |
|---|---|---|---|---|
| | Mean | DV | Mean | DV |
| Experimental Group<br>Control Group | 2.86<br>2.78 | Neutral<br>Neutral | 3.72<br>3.50 | 3.72<br>3.50 |

In the post-attitude mean score, the experimental group had a post-attitude mean score of 3.72 which means that the respondents have a positive attitude towards mathematics after they were exposed in modular cooperative learning while the control group had a post-attitude mean score of 3.50 which means that they still have a neutral attitude towards mathematics.

**CONCLUSION**

Teaching Mathematics through modular cooperative approach improved and enhanced the learning of the students. The experimental group scored significantly higher than the control group on posttest and achievement test showing the supremacy of modular cooperative learning approach over traditional method of teaching. This is a very clear indication that modular cooperative learning in teaching mathematics among the students is effective than the usual traditional lecture - discussion method. Modular Cooperative learning as a teaching approach develops in students a positive attitude towards mathematics. Hence, mathematics teachers should adopt modular cooperative learning as a new and alternative approach in teaching mathematics for the 21$^{st}$ century for global competitiveness.

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