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Modular Cooperative Learning: A New Approach In Teaching Mathematics

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***Abstract*—Various studies have indicated the effectiveness of the modular and cooperative learning approaches in promoting learning. With this, combining the two may further result to better learning. Innovations such as this can be used to further achieve the aims of Outcomes-based Education in higher education. This study aims to determine the effect of the modular and cooperative learning approaches when combined together for teaching College Algebra.**

Using the quasi-experimental design, respondents were composed of BSCS freshmen: 30 students for the experimental group taught using the modular cooperative learning and 30 students also to the control group who were taught using the conventional lecture-discussion method. The study employed the pre-test and post-test to determine the respondents' performance before and after the intervention , mathematics achievement to determine their mathematics performance and Mathematics attitude inventory test to determine their attitudes towards mathematics before and after the intervention. A module was also developed for the purpose of this study. Scores were compared afterwards and the t-test was used to determine the significance of the differences.

Results indicated that modular cooperative learning has a positive impact on the performance of the students in Mathematics. There was also a significant difference between modular cooperative learning and the traditional approach of lecture-discussion. This implies that learning improves if educators become more creative and innovative in shifting from teacher-centered to learner-centered classroom setups. With this, teachers will be able to apply the principles of Outcomes-based Education and equip students with the necessary skills the 21st Century demands from them.

***Index Terms*—Mathematics, College Algebra, Modular CooperativeLearning , quasi-experimental, Isabela, Philippines.**

I. BACKGROUND, MOTIVATION, OBJECTIVES

The 21st Century has presented students with a new skill set that will help them navigate through the real world. Inasmuch, the educational sector has also been compelled to aid learners in mastering these skills; hence curriculum developers and educators are encouraged to design and try new teaching approaches that will equip learners to thrive not only locally but also globally.

With this, a majority of Higher Education Institutions are prioritizing Outcomes-Based Education as a main thrust. As a comprehensive approach, Outcomes-Based Education (OBE) puts its focus on the learners' demonstration of learning or what the learners will be able to do. Compared to content-based education, OBE places emphasis on the process of learning so as to enable learners with the knowledge and skills they will need in the world of work (Nakkeeran, Babu, Manimaran&Gnanasivam,
2018). In the Philippines, the Commission on Higher Education (CHED) had advocated a shift towards OBE in which teachers teach how to learn and students become more conscious and more responsible for their own learning. Following CHED's mandate, the Isabela State University has upgraded its curriculum to an OBE design. This is also in accordance to its vision to be a globally recognized institution and its mission to provide quality and competent graduates for global competitiveness.

In particular, Outcomes-Based Education is ideal for the following reasons: it provides clarity in the sense that students know what is expected of them and what they should accomplish and teachers understand what they should teach in the course; since it is a student-centered, there is no strict specification of instruction method and this signifies that the diversity of the learners are taken into consideration; moreover, student involvement ensures students responsibility. Nonetheless, the student-centeredness of OBE does not discount the role of the teacher. In fact, much of the implementation's success would depend on them. Hence, complete understanding, preparedness and ability to implement it are needed (De Guzman, Edano&Umayan, 2017). In addition to that, the selection of teaching method is also an important consideration.

A promising means of applying OBE is the application of modular-cooperative learning. In this approach, the methods and benefits of both modular and cooperative learning are utilized: aided by a well-developed module, students take charge of their own learning by interacting and cooperating with peers. They share ideas and brainstorm together. The teacher on the other hand, takes the role of a facilitator. With this kind of learning environment, 21st Century Skills like critical thinking, collaboration, communication, flexibility, initiative, productivity and social skills are also developed along with the outcomes of the curriculum.

Mathematics is a core learning area that requires meta-cognition. This is especially true with regards to problem-solving. While skills, tools and knowledge are requisites, it is more important for the learners to develop the capacity to actually use these in solving given problems. The modular approach has been found by Silk, Silk and Somblingo (2015) to be beneficial in improving the problem-solving skills of students in Mathematics. Similarly, in comparing the lecture method to modular

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method, Lim (2016) was able to determine that the latter was deemed more effective in teaching problem solving. On the other hand, cooperative learning in Mathematics encourages students to take more responsibility for learning. For one thing, when teachers employ traditional teaching methods, students are relegated to being passive listeners. However, if cooperative learning is applied, learners participate actively by working together towards a goal (Shafiuddin, 2010).

Given the current conditions of Mathematics education in the Philippines and in consideration to the aforementioned literature, the researcher was motivated to innovate the teaching of College Algebra in Isabela State University Cauayan Campus. Accordingly, the study will use modular cooperative learning. To accomplish this, two components are put to use: Student Team Achievement Division (STAD) and Team Game Tournament (TGT). With the richness of literature that supports the effectiveness of both modular and cooperative learning, the researcher believes that combining them would result to a more effective instruction for Mathematics.

This study therefore aimed to determine the effectiveness of the method in teaching College Algebra. It will be accomplished by examining the pretest and posttest scores as well as the achievement of the students who underwent the modular cooperative learning and those who underwent the traditional method or 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 to the traditional method.

II. MATERIALS AND METHODS

The quasi-experimental design was used to accomplish the aim of the study. This kind of design is selected mainly for its effectiveness in evaluating a treatment—in this case, an educational intervention, modular cooperative learning.
Since the two-group quasi-experimental design was used, two groups of respondents were involved in the study. 30 freshmen students in the BSCS 1-1 program were assigned to the experimental group. They were exposed to modular cooperative learning for their course in College Algebra. On the other hand, 30 freshmen students also from BSCS 1-2 were assigned to the control group wherein the traditional lecture-discussion method was used. Both groups were homogeneously grouped upon enrolment. The researcher taught both groups in the same room and the same time but different in day schedule. The BSCS 1 was taught every Monday and Wednesday from 8:30-10:00 while the BSCS 1-2 was taught every Tuesday and Thursday, 8:30-10:00 also.

The researcher used modules,pre and post test , mathematics achievement test, and mathematics attitudes inventory scale as data-gathering instruments. Said module and achievement test were personally developed by the researcher in accordance to the course syllabus of College Algebra. The contents were validated by Mathematics specialists in Isabela State University Cauayan Campus. Meanwhile, the Mathematics Attitude Scale is a 30-item Likert scale in which 16 items are positive and the remaining 14 are negative.

To combine the elements of modular and cooperative learning approaches, two components were developed as follows: Student Team Achievement Division (STAD) and Team Game Tournament (TGT) The module was given to each student in the experimental group and they were divided further into six smaller groups composing of five members each. Each group was asked to work together in learning through the module's help. A leader headed each group and guides all members to accomplish assigned activities specified in the module. They were expected to fulfill duties assigned to them and they collaborated to facilitate each other's learning. In the traditional method , the teacher discussed the lessons l while the students listened and participated actively.

III. RESULT, DISCUSSION AND CONCLUSION

Table 1
Pretest and Posttest Scores of the Students Exposed in Modular Cooperative Learning

	Mean		Mean Difference	t-value	Interpretation
	Pre-test	Posttest			
Sets	3.81	7.54	3.73	16.02	Significant
Algebraic Expressions	3.87	7.68	3.81	14.87	significant
Special Product and Factoring	3.12	7.76	4.64	19.81	Significant
Equations	3.76	8.15	4.39	19.43	Significant
Inequality	3.72	7.82	4.1	19.02	Significant

Tabular value = 2.21 (0.5 level of significance)

The table indicates that the use of modular cooperative learning had a positive impact since there was an evident increase in the mean scores of the post-test.The computed t-values of 16.02 (sets), 14.87(Algebraic Expessions) , 19.81 (special product and factoring) , 19.83 (equations) and 19.02 (inequality) were all greater than the tabular value of 2.21 at .05 level of significance hence a significant difference between the pre-test and post-test scores of respondents in the experimental group.
These results imply that modular cooperative learning is effective in the teaching of Mathematics particularly College Algebra. Similar results were seen in the studies of Melad (2016) and Paspasan (2015) when the students used modular approach in learning Mathematics. LikewiseSofroniou&Poutos (2016) evaluated the effectiveness of pairing cooperative learning and modular learning; outcomes indicated that the combination of the two was effective and therefore should be encouraged.

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Table 2
Pretest and Posttest Scores of Students Exposed in Traditional Lecture Method

Group	Mean		Mean Difference	t-value	Interpretation
	Pre-test	Posttest			
Sets	3.56	6.24	2.68	12.85	Significant
Algebraic Expressions	3.30	6.30	3.0	19.03	Significant
Special Product and Factoring	4.01	6.21	2.20	12.02	Significant
Equations	3.7	7.12	3.42	19.05	Significant
Inequality	3.81	7.29	3.48	18.76	Significant

Tabular value = 2.21 (0.5 level of significance)

It is seen in the table that there is an improvement of scores of the students exposed in traditional lecture-discussion method in the five topics of college algebra namely: sets, algebraic expressions, special product and factoring, equations and inequality. It revealed in the table that the there is an improvement in the performance exposed to traditional lecture discussion as evidenced by a mean difference of pre-test and post- test scores of 2.68; 3.0; 2.20 ; 3.42 and 3.48 respectively. The t-test result also revealed that the t-values were all greater than the tabular value 2.21 at .05 level of significance. This just shows that there is a significant difference in the pre-test and post-test scores and performance of the students exposed in traditional lecture discussion method.

Furthermore, the results also reflect the emerging trends in teaching Mathematics as indicated by Abulwahed, Jaworski & Crawford (2912): that there has been a shift from Behaviorism—as embodied by traditional teacher-centered classrooms—to Cognitivism and Constructivism which emphasizes student-centeredness. In addition, Goodwin (2010) has also posited that constructivist principles have greatly reformed Mathematics instruction as a whole by enhancing outcomes and learning experiences.

Table 3
Posttest Mean Scores Between the Experimental and Control Groups in College Algebra

	EXPERIMENTAL (Modular Cooperative)		**Control(Traditional Lecture)**		**Mean Difference**	**t-value**	**Decision**
	X	SD	X	SD			
Pre-test	3.66	1.10	3.68	1.15	.02	0.73	Not Sig.
Post-test	7.79	1.32	6.63	1.41	1.16	6.01	Significant

Tabular value-1.96 (.05 level of significance)

With regard to the pre-test, the table shows that the experimental group who were instructed using modular cooperative learning garnered a mean score of 3.66 and a standard deviation of 1.10. On the other hand, the control group got 3.68 with a standard deviation of 1.15 . With this, the computed t-value was 0.73 which is less than the tabular value of 1.96 at a .05 level of significance. This indicates that both groups were at the same levels of achievement at the beginning of the study.

As for the posttest scores, students instructed through modular cooperative learning scored higher than those who were instructed through traditional lecture-discussion method with the posttest mean scores of 7.79 and 6.63 respectively as well as a mean difference of 1.41. The t-test came up with a t-value of 6.01 which is greater than the tabular value of 1.96 at a .05 level of significance. This implies that students instructed through modular cooperative learning approach performed better in College Algebra compared to the students instructed through traditional lecture discussion method.

Table 4
Difference Between the Mathematics Achievement Scores of the Experimental and Control groups

Group	**Mean**	**SD**	**Mean Difference**	**t-value**	**Decision**
Experimental Group	**34.58**	**4.52**	**4.87**	**1.89s**	**Reject Ho**
Control Group	**29.71**	**4.71**			

Tabular value – 2.00(0.05 level of significance)

Data indicates that the performance mean score of the experimental group was 34.58 with a standard deviation of 4.52 while that of control group was 29.71 with a standard deviation of 4.71 with a mean difference of 4.87 in favor to the experimental group. Also, the t-test yielded a t-value of 1.89 which is greater than the tabular value of 2.00 at a.05 level of significance.

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This signifies that there is a significant difference in mathematics achievement of the experimental and control groups with the experimental group performing better and improving their Mathematics skills overtime.

With this, it can be said that the implementation of modular cooperative learning is beneficial in the teaching of Mathematics. As Czajka& McConnell (2019) stated, the utilization of student-centered materials in higher education results into a positive outcome for both teachers and students.

Table 5:
Attitudes Towards Mathematics

Pre and Post-Attitude Scores Towards Mathematics of Experimental and Control Groups Group	Pre-Attitude		Post-Attitude	
	Mean	Interpretation	Mean	Interpretation
Experimental Group	2.86	Neutral	3.72	Positive
Control Group	2.78	Neutral	3.50	Neutral

Table 5 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.

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.

IV. CONCLUSION

The modular cooperative approach in the teaching of mathematics improved the students' learning as the experimental group scored significantly higher compared to the control group in the post-test and achievement test. This signifies the advantage of modular cooperative learning approach over traditional method of teaching such as lecture discussion. Modular cooperative learning approach in teaching has made significant improvement in the learners'achievement and showed positive effect on the formation of a more positive attitude towards mathematics among students.With this, teachers will be able to apply the principles of Outcomes-based Education and equip students with the necessary skills the 21st Century demands from them.

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