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Cooperative Learning: Its Influence on the Quality of Work in Collegiate Mathematics

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Abstract:

The study investigated the relationship of attitude towards mathematics, level of engagement and participation to the quality of work in Mathematics among college students when cooperative learning was implemented. Forty-five (45) non-mathematics major students who were taking Problem Solving course participated. During the study, the students were not aware that they are under a study to let them work without restraint. At the end of the course, they were interviewed and given a questionnaire to complete. The result demonstrates statistically significant effect of cooperative learning in students' quality of work as determined by their attitude towards mathematics and level of engagement and participation. The result evidently implied that the higher the levels of these two predictors contribute to better quality of work to students. Cooperative learning strategy can be considered in college as a part of mathematics classroom especially during problem solving activities, wherein learners has mutual respect and employ in productive relationships that uphold motivation and engagement in the academic work. Educators must also consider strengthening these two predictors in order to achieve better quality of work from students.

Key words: Cooperative learning, attitudes towards math, level of engagement and participation, quality of work

INTRODUCTION

Learning and understanding mathematical concepts is acquired in a variety of different ways. The effect on student learning of changing a single teaching practice may be difficult to discern because of the simultaneous effects of both the other teaching activities that surround it and the context in which the teaching takes place (Grauws & Cebulla, 2000). Students can learn better from other students; thus, working cooperatively is an important skill that students can use outside the classroom to help work effectively with others to solve any problem or task (Johnsen, 2010). Jolliffe (2007) referred cooperative learning as one of the most heavily research areas of education where students' achievement is one of its main advantages. The notion of cooperative learning indeed, marks a significant trend in today's educational system.

Cooperative learning involves highly structured, wide ranging programs of activity, and makes use of jigsaw methods, in which students carry out individual tasks, and then share outcomes with other group members (Tolmie,A., et'al, 2010), and focuses on the problem solving that –when directly buy an effective teacher-can lead to deep learning, critical thinking, and genuine paradigm shifts in students' thinking (Millis, 2010).

Posamentier et'al (as cited by Zakaria et'al, 2010) averred that teaching mathematics is not about dispensing rules, definitions and procedures for students to memorize but engaging them as active participants through discussion and collaboration among students. According to Kolawole (2010), students in group interact with each other, share ideas and information, seek additional information, make decisions about their findings to the entire class. Zakaria et'al (2010), underscored that the development of education now requires teaching strategies that emphasize student involvement.

Many researchers such as Tolmie et'al (2010),Kalawole (2008), Carlan, Rubin, and Morgan (N.D.), Zakaria et'al (2010) and Johnsen (2010), previously undertaken studies in cooperative learning. Tolmie (2010) measured its impact on the social relation of the students. Kalawole (2008), Morgan (N.D.), Zakaria et'al (2010) and Johnsen (2010) studied the improvement of students in achievement and attitude in their cooperative learning Math class. However, there has been few research that intertwined the impact of cooperative learning to students' quality of work as determined by their attitude towards Mathematics and level of engagement and participation.

The current study provides a clearer perspective on the effect of cooperative learning to the quality of work of undergraduate students, and identifies a new mode of instruction in mathematics in order to meet the new century demands especially in the increasing number and diversity, varying levels of preparations, and expectations of students. Cognizant of the fact that cooperative learning becomes a trend in teaching Mathematics, this study purports to address the following objectives: (i) describe the respondents' quality of work, attitude towards mathematics, and level of engagement and participation when cooperative learning structures was implemented; (ii) investigate the significant relationship of respondents, quality of work, attitude towards mathematics, and level of engagement and participation when cooperative learning structures was implemented; and (iii) establish effect ,singly or in combination, in respondents' quality of work attitudes, level of engagement and participation when cooperative learning structures was implemented.

This study aimed to prove hypotheses which are (i) there is a significant relationship between the respondents' quality of work, attitude towards mathematics, and level of engagement and performance when cooperative Learning was implemented and (ii) there is a significant effect, singly or in combination, in

respondents' quality of work attitudes, level of engagement and participation when cooperative learning structures was implemented.

Cooperative Learning

Schimazoe and Aldrich (2010) as cited by Zakaria, Chin, & Daud (2010), provides several benefits on the use of cooperative learning approach for students such as (a) cooperative learning promotes deep learning of materials, (b) students achieve better grades in cooperative leaning compared to competitive or individual learning, (c) students learn social skills and civic values, (d) students learn higher-order, critical thinking skills, (e) cooperative learning promotes personal growth, and (f) students develop positive attitude towards autonomous learning. Also, Kalawole (2008), mentioned that cooperative learning helps to improve student achievement and retention, increase self-esteem and intrinsic motivation and develop more positive attitude towards learning skills and social skills.

Furner and DeHass (2011) mentioned that cooperative learning has been reported to result in students who have improved attitudes towards school, teachers, academic tasks, and their peers (Aronson, Blaney, Stephan, Sikes & Snapp, 1978; Jacob, 1999; Johnson & Johnson, 1995; Slavin, 1991, 1995). The researchers also added that the classroom should be perceived as a community of learners where students treat one another with respect and engage in constructive relationships that promote student motivation and ability to engage in the academic work of the classroom. In the part of the teacher, he/she should create a classroom atmosphere where students think of their peers as helpful resources in their pursuit of learning and understanding rather than as potential competitors for a limited pool of top scores or teacher accolades.

In the study of Arbaugh and Benbunan-Fich (2007), the researchers claimed that students in collaborative courses experience higher levels of learner-learner, and learner-system interaction than those in more individualistic sections. Research suggests that the whole-class discussion can be effective when it is used for sharing and explaining the variety of solutions by which individual students have solved problems. It allows students to see the many ways of examining a situation and the variety of appropriate and acceptable solutions (Grauws & Cebulla, 2000). Thus, this study examined the impact of cooperative learning should be in a mathematics class.

Quality of Work

Mathematics can appear as a foreign language to many people because it has its own alphabet, comprised of numbers and symbols, and is constructed with a complicated syntax (Ashby, 2009). With this complexity, previous researches already tried to analyze students' quality of work in mathematics. Quality of work, in this study, is defined on respondents' perceived quality of work after cooperative learning was implemented.

On the result of previous studies, students' with high mathematics achievement demonstrated high levels of mathematics confidence which shows strong positive levels of affective and behavioral engagement and a positive attitude to learning mathematics (Barkatsas, Kasimatis & Giamlas , 2009). But it should be noted that the result of this study is limited on the engagement and attitude of students in the use of technology such as computers.

Most research studies found in the lieu of this study shows limited results on how students perceived quality of their work in mathematics as being affected by their attitude towards mathematics and their level of engagement and

participation, and also the intervention of the cooperative learning.

Attitude towards Mathematics

Schenkel (2009) quoted William James, "It is our attitude at the beginning of a difficult task which, more than anything else, will affect its successful outcome." This idea is further related between the attitudes towards the mathematics to the mathematical success in the classroom. He also cited McLeod (1992), that attitude towards mathematics is related to mathematics success in the classroom, and vise versa. Research on attitude has a long history on mathematics education (Zan and Martino, 2007) which was motivated by the belief that something called "attitude" plays a crucial role in learning mathematics.

Guttierez (2008) defined attitude as the sum total of man's inclinations and feelings, prejudices or biases, preconceived notions, ideas, fears, threats, and convictions about a specific topic. Zan and Martino (2007) also defined attitude as a positive or negative degree of affect associated with a certain subject. According to them (Zan & Martino, 2007) the attitude towards mathematics is just a positive or negative emotional disposition towards mathematics.

Zorofi (2010) said in his study that among the factors affecting the quality of learning have been the factors in attitude towards mathematics. Also in his study, it confirmed its hypothesis that attitude towards mathematics is significantly related with the quality of their learning in mathematics courses.

As suggested by Akinzola and Olowojaiye (2008), in order to identify further the impact of students' attitude towards mathematics, it is very important to continue to search for linkages between instructional method that could facilitate

the development of the positive attitude towards the learning of Mathematics. Hence, this research.

Level of Engagement and Participation

School is central to the daily life of many youths, where they view schooling as essential to their long-term wellbeing, and this attitude is reflected in their participation in academic and non-academic pursuits (Wilms, 2003). Santos and Barmby (2010) said that engagement is important primarily because of its relationship with the academic achievement of learners.

Wilms (2003) referred *student engagement* as students' attitudes towards schooling and their participation in school activities. (Newmann et al., 1992), as cited by Santos and Barby (2010) defined engagement as "students' psychological investment in an effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote".

Barkatsas, Kasimatis, & Gialamas (2009) gave three dimensions of students' engagement as (1) students' need to develop and express competence, (2) students' full participation in school activities, and (3) students being immersed in authentic academic work. It is believed that most students commence their school life being inherently motivated but for many of them this motivation diminishes or entirely disappears, because the students are involved in routine and boring activities and they try to get by with as little effort as possible.

It is claimed students who are engaged with school are more likely to learn and find the experience rewarding. Engagement in the classroom also contributes to students' social and cognitive development as well as academic achievement (Attard, 2009).

In many researches, the relationship of students' engagement in the classroom to the academic performance has always been studied. However in this paper, students' engagement is considered as an exogenous variable that may probably affect students' performance in a cooperative learning environment.

METHOD

Design. This paper used a correlational design to examine the impact of cooperative learning to respondents' quality of work in mathematics based on their attitude towards mathematics, and level of engagement and participation.

Sampling and Procedure. Using a purposive sampling technique, forty-five non-mathematics major students who were taking Problem Solving course during the first semester of the academic year 2010-2011 participated in the study. During the study, the respondents were not aware that they are under a study to let them work without restraint. The teacher used cooperative learning techniques to let the students work in mixed-ability groups. A survey questionnaire was given at the end of the course to elicit the data about the students' responses towards cooperative learning activities and they were given ample time to fill the questionnaire. During distribution of survey questionnaire, they were informed about the purpose of the study. Also, interview was conducted to further explain the responses of students on the questionnaire.

Questionnaire. An 8-point likert scale on cooperative learning was adapted by the researchers gathered from different questionnaires used by other researchers in mathematics and revised them to align it towards cooperative learning. The Constructivist Learning Environment Survey (CLES) developed by Taylor and Fraser was also adapted in the instrument. A psychologist was asked to validate the categories of the

questionnaire namely the students' attitude towards mathematics, level of engagement and participation, and the quality of work.

Data Analysis. Data was analyzed with the aid of Statistical Package for Social Sciences (SPSS). Cronbach Alpha was used to test the instrument's reliability and internal consistency. A 97% reliability coefficient was achieved, indicating the items measuring the construct were internally consistent. Descriptive statistics were used to describe the student's attitude, level of engagement and participation; and the quality of work towards mathematics. Pearson Correlation Coefficient was conducted to test the relationship of quality of work, attitude, and level of engagement and participation of the respondents. 'Multiple regression' was used to further test the effect of the variables under the study after meeting the normality assumption in regression using the Kolmogorov-Smirnov Z test of normality.

RESULTS

Table 1 Statements on Respondents' Quality of Work when Cooperative Learning was Implemented

Statements	Mean	SD	Rank
Working in groups in math class will help me do better work.	7.20	1.12	3
Working in groups will help me learn through my mistakes	7.24	1.00	2
Interaction with my peers help improved my performance in math	6.98	1.20	7
Working cooperatively in a group will help me improve my problem-solving skills	7.16	1.15	4
I learn math more when I work with groups.	6.87	1.14	9
I perform better when I am working in group.	6.58	1.34	12
I become more cautious with my solutions when I work in groups.	6.6	1.10	11
Working in groups help me develop my higher order thinking skills (HOTS)	6.98	0.94	8
I learn mathematics well when I am working in groups.	6.84	1.13	10
I participate in class by asking questions.	5.84	1.58	13
I choose hard math problems to complete.	4.84	1.82	14
I feel better and do more when I receive positive feedback.	7.73	1.08	1
I think that group activities are a good way to learn math content.	7.11	1.09	5
Engaging in cooperative learning in math enhances my problem solving skills.	7.07	1.01	6

Table 1 shows the statements on respondents' quality of work when cooperative learning was implemented. "I feel better and do more when I receive positive feedback"(μ=7.73, SD=1.08), "Working in groups will help me learn through my mistakes" (μ=7.24, SD= 1.00), and "Working in groups in math class will help me do better work" (μ=7.20, SD=1.12) gained the top three highest mean while "I choose hard math problems to complete" (μ=4.48, SD=1.82), "I participate in class by asking questions,"(μ=5.84, SD=1.58), and "I become more cautious with my solutions when I work in groups," (μ=6.60, SD=1.10) scored the lowest mean.

Table 2 Statements on the Students' Attitude towards Mathematics with which respondents Express Most Agreement

Statements	Mean	SD	Rank
I like math.	5.71	1.71	20
I'm good at math.	5.38	1.45	22
I will be more tolerant when I work in groups.	6.24	1.21	16
When working in groups, I feel responsible for the success of each individual in the group.	7.07	1.01	3.5
I like to solve word problems	5.64	1.80	21
I find mathematics class enjoyable	6.30	1.76	15
I like to discover new things during my mathematics class.	6.75	1.35	11
I am happy to compute numbers	5.84	1.78	19
I enjoy working with me classmates on mathematics activities	7.02	1.10	5
I feel confident with my work when I do it with my group mates.	6.89	1.21	9
Working in groups increases my confidence.	7.07	1.21	3.5
Working in groups makes me an active participant in class discussion.	6.96	1.15	7
Cooperative learning approach forced me to take on more responsibility for learning.	6.98	1.10	6
I try to learn mathematics because it helps develop my mind and helps me think more clearly in general.	7.18	1.07	2
Communicating with other students helps me have a better attitude towards mathematics.	6.87	1.08	10
I persist in math class even when I do not get it right the first time.	6.13	1.42	18
I want to know more than my teacher is teaching.	6.45	1.21	13
When I see my friends learn to do the math, I feel that I can too.	7.56	0.62	1
I find mathematics learning pleasurable and I am interested in solving mathematics problems.	6.16	1.24	17
I am very interested to know how to solve new mathematics problems.	6.31	1.29	14
I really make an effort in the mathematics lesson.	6.51	1.50	12
I prefer to learn by doing something in class.	6.91	1.01	8

Table 2 shows the statements on the students' attitude towards mathematics with which respondents express most agreement. "When I see my friends learn to do the math, I feel that I can

too" (μ= 7.56, SD= 0.62) was the most agreed by the respondents. Other items identified among the top five included "I try to learn mathematics because it helps develop my mind and helps me think more clearly in general" (μ=7.18, SD=1.07), "Working in groups increases my confidence" (μ=7.07, SD=1.21), "When working in groups, I feel responsible for the success of each individual in the group" (μ=7.07, SD=1.01), and "I enjoy working with me classmates on mathematics activities" (μ=7.02, SD= 1.01). Five items were considered least agreed namely "I'm good at math," (μ=5.38, SD=1.45), "I like to solve word problems,"(μ=5.64, SD=1.80), "I like math" (μ=5.71, SD= 1.17), "I am happy to compute numbers," (μ=5.84, SD=1.78), and "I persist in math class even when I do not get it right the first time" (μ=6.13, SD= 1.42).

Table3 Respondents' Statements on their Level of Engagement and Performance towards Mathematics

Statements	Mean	SD	Rank
I feel comfortable to ask for help from other students when I work in a group.	7.11	1.05	4
People think I have important things to say in math class.	6.27	1.05	12
I like to work with other students when I do math.	6.76	1.23	9
I understand math better when I work with a group.	7.04	0.98	5
Working in groups in math class is helping me get along better with my classmates.	7.24	0.98	2
I think I pay attention better when I work in a group.	6.87	1.16	7
Working in group help enhanced cooperation among the group members	7.42	1.08	1
Interaction among group members helped me obtain a deeper understanding in math	7.18	1.01	3
I want to talk with other students about how to solve problems.	6.38	1.23	11
I enjoy working in groups on my assignment in math	6.71	1.38	10
I love sharing ideas with my classmates.	7.02	1.25	6
I do well when we have group activities in class.	6.13	1.73	18
I always take part in the discussion in the mathematics class.	6.84	1.04	8

Table 3 presents the mean ranking of statements on the respondents' level of engagement and performance towards mathematics. "Working in group help enhanced cooperation among the group members" (μ= 7.42, SD= 1.08) had the highest mean score, followed by "Working in groups in math class is helping me get along better with my classmates" (μ=7.24, SD= 0.98), and "Interaction among group members helped me obtain

a deeper understanding in math" (μ=7.18, SD= 1.01). Considered as the least agreed statements are "I do well when we have group activities in class" (μ= 6.13, SD=1.73), "People think I have important things to say in math class" (μ=6.27, SD= 1.05), and "I want to talk with other students about how to solve problems" (μ=6.38, SD=1.23).

Table 4 Descriptive summary of the respondents' responses

Variables	Mean	SD	Rank
Attitude towards Mathematics	6.54	0.83	3
Level of Engagement and Participation	6.79	0.80	1
Quality of Work	6.76	0.87	2

Table 4 presents the descriptive summary of the respondents' responses. The level of engagement and participation (μ=6.20, SD= 1.47)of the respondents gained the highest mean, followed by their quality of work (μ=6.76, SD= 0.87), and attitude towards Mathematics (μ=6.54, SD=0.83)

Table 5 Relationship between the respondents' quality of work, attitude towards mathematics, and level of engagement and performance when Cooperative Learning was Implemented

	R-value
Quality of work vs. Level of Engagement and Participation	.961**
Quality of Work vs. Attitude towards Mathematics	. 795**
Attitude towards Mathematics vs. Level of Engagement and Participation	.727**

**significant at level .01

Table 5 indicates the relationship between respondents' quality of work, attitude towards mathematics, and level of engagement and performance, when cooperative learning was implemented. Notably, the relationship between each variable revealed significant relationship. Pearson R Correlation Coefficient revealed that the respondents quality of work is significantly related to their attitude towards mathematics (r= .795), and their level of engagement and participation(r=.795). Similarly, the respondents' attitude towards mathematics and their level of engagement and participation also showed significant relationship. Strong evidence at 1% level of

significance indicated that there exists a significant relationship between the said variables.

Table 6 Multiple Correlation Analysis of Respondent's Quality of Work in Mathematics, Attitude towards Mathematics and Level of Engagement and Participation

Predictors	Beta	t
Attitude towards Mathematics	**.274**	**8.959****
Level of Engagement and Participation	**.716**	**3.431****

Note: Multiple R=.935; R^2=.874; adjustedR^2=.868; F=145.211; Significance F=.000

**significant at level .01

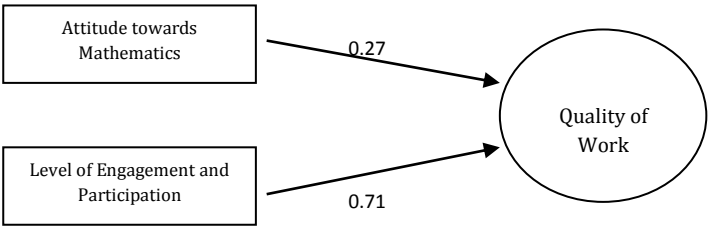

Figure 1 Graphical Model of the Multiple Regression Analysis

Table 6 and Figure 1 present the multiple regression analysis of respondents' quality of work in Mathematics, level of engagement and participation, and attitude towards mathematics and its graphical model, respectively. Multiple correlation analysis was done using the backward selection which puts into the model all the predictor variables. This selection method removed the weakest predictor variable if any, and the regression is re-calculated. The model accounted 87% of variation in the criterion. Standardized estimates (beta coefficients) of each variable reflect the relative importance of variables in the model; the larger the estimate, the higher the importance of the variable in the model. The result showed that the two predictors significantly affect the quality of work of the respondents. The beta coefficients indicated that the respondents' level of engagement and participation (ß= .716,

p=.000) had the stronger impact on their quality of work than their attitude towards mathematics (ß= .274, p=.001).

DISCUSSION

This research study provides further evidence on the impact of cooperative learning in respondents' quality of work as determined by their attitude towards mathematics and level of engagement and participation. It is also important to note that cooperative learning was implemented. With these results, this study helps answer recent calls for more research into the factors that influence the quality of work of the respondents in a cooperative learning structure. Respondents described the three factors involved in the study namely quality of work, as the criterion, and attitude towards mathematics and level of engagement and participation, as the predictors, to have closely akin in terms of their mean ratings.

On the one hand, respondents' response which received highest agreement showed that students work well when they are working in groups. Respondents agreed to greater extent that when they see their friends learn and do math, they feel that they can do it too, and they try to learn mathematics because it helped them develop their mind and helped them think more clearly in general. It should also be noted that respondents posted most agreed that they feel comfortable to ask questions to ask for help from others students when they work in group. These findings are in consonance with Kalawole (2008) that cooperative learning helps students improve their achievement and retention, increase their self-esteem and intrinsic motivation, and develop more positive attitude towards learning skills and social skills. It has been noted by Furner and DeHass (2011) that cooperative learning improves attitudes towards school, teachers, academic tasks and their peers. On the other hand, it showed least agreement on respondents' response that they choose hard math problems to

complete and their likeness in mathematics. This basically agreed on the context that Mathematics can appear as a foreign language to many people because it has its own alphabet, comprised of numbers and symbols, and is constructed with a complicated syntax (Ashby, 2009). Meanwhile, on the level of engagement, the least mean ranking of the items measured still gained high mean value, thus respondents positively agreed that they do well when they have group activities *(Refer to table 3)*.

In this study the relationship of the quality of work of students from their level of engagement and attitude towards Mathematics was also examined. As expected and consistent to previous researches, students' attitude towards mathematics and their level of engagement and participation are significantly related to their quality of work when cooperative learning was implemented (Kalawoe, 2010, Morgan, ND, and Johnsen, 2010, (Newmann et'al, 1992, Barkatsas, Kasimatis &Giamalas, 2009). Attitude towards mathematics is related to mathematics success in the classroom, and vice versa, (Schenkel, 2009).

Respondents' quality of work determined by the respondents' attitude towards mathematics and their level of engagement and participation revealed significant effect. The result evidently implied that the higher the levels of these two predictors contribute to better quality of work to students. Though both predictors revealed significant effect, it is interesting to note that the level of engagement and participation indicated stronger effect to the criterion compared to the respondents' attitude towards mathematics. Students who are engaged with the school are more likely to learn and their engagement contributes to students' social and cognitive development as well as academic achievement (Attard, 2009).

CONCLUSION

This study attempted to ascertain the impact of cooperative learning on the quality of work of students in relation to attitudes towards mathematics and the level of engagement and participation.

Results of the study accepted the hypothesis drawn, which is consistent with the extant researches. The predictors under study showed significant relationship and significant effect to the quality of work of the respondents when cooperative learning structure was implemented.

These results provide evidences and bases on the use of cooperative learning in a mathematics class. Cooperative learning strategy can be considered in college as a part of mathematics classroom especially during problem solving activities. This kind of classroom can be perceived as a community of learners where they treat each other with respect and engage in constructive relationships that promote student motivation and engagement in the academic work (Furner & DeHass, 2011). Furthermore, since attitude towards mathematics and level of engagement and participation affect the quality of work of students, educators must also consider strengthening these two predictors in order to achieve better quality of work from students.

However, the implications drawn from this study must be viewed in the light of the limitations inherent to the research, primarily the size and scope of the samples. Although this study encompassed limited respondents, future researchers may pursue the same study, measuring the same construct but with greater and wide range of samples, and consider some other factors like academic performance, learning styles, etc in order to generalize the conclusions derived from this research.

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