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Effect of Cooperative Learning Method Anchored on Multiple Intelligence Theory on Students' Achievement in Mathematics

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ABSTRACT

Cooperative learning is defined as a category of instructional strategies that place students in mixed-ability groups in which students work together to achieve a common academic goal. This type of learning has become more desirable as researchers study individual learning differences and styles as well as multiple intelligences. The theory of multiple intelligences suggests that there are number of distinct forms of intelligence that each individual possesses in varying degrees and that the implication of the theory is that learning and teaching should focus on the particular intelligences of each person. This study was conducted to provide empirical facts on the effect of cooperative learning method supported by multiple intelligence theory on students' achievement in mathematics. This study used the nonequivalent control group design. The instruments used were the 90-item adopted Multiple Intelligence test and the 40-item teacher-made test for the topics Fundamental Operations on Rational Algebraic Expressions, Positive Integral Exponents, and Zero and Negative Exponents. The data gathered were summarized, translated, and analyzed using the mean scores for both pre-test and post-test. The difference between the post-test mean scores of the experimental and control group is statistically significant, which means

that students' achievement in mathematics is greatly affected when cooperative learning methods were used as teaching strategies compared to the traditional method. Furthermore, it is strongly recommended that cooperative learning method supported with multiple intelligence theory should be used in teaching mathematical concepts and even in other fields of study.

Keywords **-** Mathematics Education, Cooperative learning method, multiple intelligence theories, traditional lecture method, non-equivalent control group design, Philippines, Asia

INTRODUCTION

The National Assessment of Educational Progress (NAEP), also known as "The Nation's Report Card," has charted U.S. student performance for the past three decades and is the only national representative, continuing assessment of what students know and can do in a variety of academic subjects, including reading, writing, history, civics, mathematics, and science. From their report, it is found that most students still perform below levels considered proficient or advanced by a national panel of experts. Specifically, eighth graders scored below the international average in mathematics (National Center for Education Statistics, 2011).

Although mathematics is always given importance and the weekly teaching hours of mathematics are sufficiently intensive, the success of teaching mathematics in the Philippines cannot be regarded as satisfactory. There can be many reasons for the failure in teaching mathematics. Because mathematics topics consist of abstract concepts and abstract relationships (Isik & Tarim, 2009), it is challenging for students to change these abstract topics into concrete ones. Therefore, students generally fail in this course (Isik et al., 2009). Based on the results of the National Achievement Test given for school year 2009 – 2010 for the 2nd year students, Daniel R. Aguinaldo National High School ranked 19th out of the 70 schools in Davao City division, with a percentage score for mathematics of 32.77. Based on the scale used by the Department of Education's National Education Testing and Research Center (NETRC), a score of below 50% indicates low mastery. With the result, it can be concluded then that the performance of the school in that particular subject is quite low.

This study is, hence, conducted to test if cooperative learning method supported by the multiple intelligence theory could help DRANHS students gain mastery of the subject matter.

This study is significant as this would attest if cooperative learning method supported by multiple intelligence theory by means of categorizing the dominant intelligence of the students and putting them into groups with different abilities could help improve the academic achievement of students. This would also strengthen the idea of Kagan and Kagan (1998) on the importance of cooperative learning method to teach the students to be a functional part of a group so they realize that they have group responsibilities as well as individual responsibilities; and of Gardner, H. (1985) on the importance of multiple intelligence theory as it suggests a student-centered teaching and an approach that considers the individual differences of learners. A learning environment which acknowledges the Multiple Intelligence of students will provide the opportunity for the students to discover themselves and their potentials.

OBJECTIVE OF THE STUDY

This study was conducted to determine if cooperative learning method anchored on the multiple intelligence theory could help DRANHS students gain mastery of the subject matter.

METHODOLOGY

The Nonequivalent Control Group Design by Campbell and Stanley (1963) was used in this study. It was used because both the experimental and control groups were naturally assembled – identified as one group (section) at the beginning of the school year based on enrolment. As such, no student was transferred from one group to another. The experimental group was evaluated based on treatment X which made use of the cooperative learning methods (Jigsaw, Numbered Heads Together, and Team-Pair-Solo) anchored on Multiple Intelligence Theory; while the control group made use of the traditional method of teaching.

This study was conducted at Daniel R. Aguinaldo National High School (DRANHS), Davao City, Philippines on the month of September, and part of the second-grading period of school year 2012 – 2013. The researcher made use of the purposive sampling in assigning the participants. The participants were the two general sections of the second-year level. The two sections were Tsiko and Makopa, both composed of 45 students, with 24 boys and 21 girls. There was one (1) experimental and one (1) control group and the assignment were done randomly by tossed coin.

The following instruments were used in this study: a) The Multiple Intelligence Test. This tool, which was adopted from the module of Mindanao eLearning Space on the topic Multiple Intelligence (Gardner, 1985), was used to determine the dominant intellect of students who are the participants in this study. The result of the test was used to classify students for the three domains of Multiple Intelligences and the assignment of groups, each with students of different levels of ability. b) Teacher-made Test - This device was employed for the pre-test and post-test of both groups in order to determine the students' academic achievement in the subject Algebra. A 40-item questionnaire which is made up of the following topics - Fundamental Operations on Rational Algebraic Expressions – 13 items, Positive Integral Exponents – 13 items, and Zero and Negative Exponents – 14 items was given to the participants. The researcher made the initial draft of the test instrument along with a Table of Specification to determine the necessary domains. Pilot testing of the initial draft of the test instrument to 64 third-year high school students was conducted and the item analysis of the results followed. The test is found reliable; however, from the first draft of 50 items, 10 were discarded. The index of reliability test using the SPSS software was done with a result of 0.991 which means excellent based on Cronbach's Alpha test. After which, experts and other mathematics teachers were consulted to assess construct and content validity of the items and their suggestions were considered.

The following steps were perceived in the conduct of the study: a) Approval from the Principal - The researcher asked the approval and permission from the school principal for the conduct of the study; b) Administration of the Multiple Intelligence Test to the respondents – Ninety (90)–item questionnaire, each with 10 items per intelligence was given to the experimental and control group to identify the dominant intellect that were used in group assignments; c) Classification of Students for the three Domains of Multiple Intelligences - After the dominant intelligence was identified, the students were classified under the three domains of multiple intelligences. This grouping was done to organize the understanding of the fluid relationship of the intelligences; d) Scoring of the Pre-test and Post-test. The following qualitative description or rating was used in the scoring of the Pre-test and Post-test results:

Range of Mean	**Qualitative Description**	**Level**
80 – 100	Outstanding	Denotes very high level of achievement
60 – 79.99	Very Satisfactory	Denotes high level of achievement
40 – 59.99	Satisfactory	Denotes moderate level of achievement

20 – 39.99	Poor	Denotes low level of achievement
0 – 19.99	Very Poor	Denotes a very low level of achievement or a failing performance

e) Administration of the pre-test for the control and experimental group - Forty–item questionnaire was given to the respondents; f) Conduct of the Experiment - After the pre-test, the experimentation started. The experimental and control groups were taught by the researcher using the same lesson plan. One class followed the traditional method, while the other class was treated with the cooperative learning method; g) Administration of the post-test for the control and experimental groups - The same test was administered to the control and experimental group after the conduct of the research; h) Encoding of Data and Application of Statistical Treatment - Results of the pre-test and post-test of students were encoded and run through SPSS for statistical computations, and; i) Analysis and Interpretation of Results - Computed values were analyzed and interpreted using $\alpha = 0.05$ level of significance.

The data gathered were summarized, translated and analyzed using the following statistical tools: a) Mean scores - described the pre-test and post-test results of the experimental and control groups per domain, per area and the overall scores; b) Mean gain scores - defined the difference of the post-test mean score and the pre-test mean score; c) Independent t-test - was used to find a significant difference between the pre-test scores, post-test scores, and mean gain scores of the experimental and control groups under the three domains of multiple intelligences namely Analytical (logical, musical, naturalist), Interactive (linguistic, interpersonal, kinesthetic), and Introspective (existential, intrapersonal, visual) in the areas "Fundamental Operations of Rational Algebraic Expressions" (topic A), "Positive Integral Exponents" (topic B), and "Zero and Negative Exponents" (topic C); and d) Hypothesis testing was based on alpha $\alpha = 0.05$ level of significance.

RESULTS AND DISCUSSION

The Pre-test Mean Scores of the Experimental and Control Groups

Presented in table 1 are the pre-test mean scores of the experimental and control groups categorized under the three domains of Multiple Intelligences as Analytical, Interactive, and Introspective in the three-topic areas namely, Fundamental Operations of Rational Algebraic Expressions (topic A), Positive

Integral Exponents (topic B), and Zero and Negative Exponents (topic C). The pre-test mean scores of the students under the two groups are all in the range of 20 to 39.99 percent which denotes a low level of achievement. This result implies then that the participants have no background or have inadequate knowledge of the subject matter. It is expected since the participants have never been taught by their teacher or the researcher of the subject matter yet.

Table 1. Pre-test mean scores of the experimental and control groups under the three domains of multiple intelligences

Domains of Multiple Intelligences	Topics	Experimental		Control	
		Mean	Percent	Mean	Percent
Analytical	A	4.38	33.65	4.80	36.92
	B	3.94	30.29	4.73	36.41
	C	3.44	24.55	4.47	31.91
	All Topics	12.69	31.72	14.00	35.00
Interactive	A	4.92	37.87	3.71	28.57
	B	3.54	27.22	3.79	29.12
	C	4.00	28.57	4.64	33.16
	All Topics	12.46	31.15	12.14	30.36
Introspective	A	3.94	30.29	4.06	31.25
	B	3.44	26.44	3.94	30.29
	C	3.94	28.13	4.06	29.02
	All Topics	11.31	28.28	12.06	30.16

The Post-test Mean Scores of the Experimental and the Control Groups

Table 2 shows the post-test mean scores of the experimental and control groups. The results were presented based on the classification of the three domains of Multiple Intelligences and the three-topic areas namely Fundamental Operations of Rational Algebraic Expressions (topic A), Positive Integral Exponents (topic B), and Zero and Negative Exponents (topic C). The post-test mean scores of the experimental group, or those students under the treatment of which cooperative learning methods were applied as teaching strategies resulted to a great improvement on the students' achievement in mathematics. Jigsaw, Numbered Heads Together, and Team-Pair-Solo were the cooperative learning structures used for the three topics. For students under the Analytical

and Introspective domains, Jigsaw method as used for Topic A became the most favorable strategy for it gives an outstanding result of 82.21% for the Analytical and 84.13% for the Introspective domain, which signifies a very high level of success. The result supports the article of Gladstone (1999), stating that Jigsaw method as an approach enhances learning, retention, and engagement. On the contrary, students under the Interactive Domain of Multiple Intelligences got an exceptional result on the topic Positive Integral Exponents with 82.84% in which Numbered Heads Together was used as a strategy. The lowest mean percentage is 75% under Introspective domain - topic C, but still, it means a high level of achievement.

Table 2. Post-test mean scores of the experimental and control groups under the three domains of multiple intelligences

Domains of Multiple Intelligences	Topics	Experimental		Control	
		Mean	Percent	Mean	Percent
Analytical	A	10.69	82.21	7.00	53.85
	B	10.23	78.70	8.60	66.15
	C	10.94	78.13	7.00	50.00
	All Topics	32.31	80.78	22.60	56.50
Interactive	A	10.23	78.70	5.79	44.51
	B	10.77	82.84	7.71	59.34
	C	11.00	78.57	8.07	57.65
	All Topics	32.00	80.00	21.57	53.93
Introspective	A	10.94	84.13	6.50	50.00
	B	10.00	76.92	7.19	55.29
	C	10.50	75.00	7.06	50.45
	All Topics	31.44	78.59	20.31	50.78

The Mean Gain Scores of the Experimental and Control Group

Presented in Table 3 are the mean gain scores of the experimental and control groups categorized per domain and in the three topic areas. The data were presented based on the three topics of Algebra namely, Fundamental Operations of Rational Algebraic Expressions (topic A), Positive Integral Exponents (topic B), and Zero and Negative Exponents (topic C) with the classification of the Three

Domains of Multiple Intelligences as Analytical, Interactive and Introspective. The mean gain score of the experimental group of all topics in the Analytical Domain is 19.6250 or 49.06%, while for the Interactive and Introspective Domains are 19.5385 or 48.84% and 20.1250 or 50.31% respectively. The mean gain scores in all of the three domains are nearer to the 50% range which means an increase of more than half of the number of items from the pre-test to the post-test. This result supports the idea presented by Adeyemi (2008), which states that cooperative learning, when used appropriately, has enormous positive effects on academic achievement.

The mean gain score of students of the control group under the Analytical Domain in all topics is 8.6000 or 21.50%, while for the Interactive and Introspective Domains are 9.4285 or 23.57% and 8.25 or 20.63% respectively. As observed, the mean gain scores of the control group are categorized as poor, which denotes a low level of achievement. It means that there is a low improvement of the scores from the pre-test to the post-test. The information supports the findings presented by the National Science Foundation (2006), stating that one of the disadvantages of the Traditional Lecture Method is, it places students in a passive rather than an active role, which hinders learning; it requires a considerable amount of unguided student time outside of the classroom to enable understanding and long-term retention of the content.

Table 3. Mean gain scores of the experimental and control groups under the three domains of multiple intelligences

Domains of Multiple Intelligences	Topics	Experimental			Control		
		Mean (Pre-test)	Mean (Post-test)	Mean Gain Score	Mean (Pre-test)	Mean (Post-test)	Mean Gain Score
Analytical	A	4.38	10.69	6.3125	4.80	7.00	2.20
	B	3.94	10.23	6.2933	4.73	8.60	3.87
	C	3.44	10.94	7.5000	4.47	7.00	2.53
	All Topics	12.69	32.31	19.6250	14.00	22.60	8.60
Interactive	A	4.92	10.23	5.3077	3.71	5.79	2.07
	B	3.54	10.77	7.2307	3.79	7.71	3.93
	C	4.00	11.00	7.0000	4.64	8.07	3.43
	All Topics	12.46	32.00	19.5385	12.14	21.57	9.43

Introspective	A	3.94	10.94	7.0000	4.06	6.50	2.44
	B	3.44	10.00	6.5625	3.94	7.19	3.25
	C	3.94	10.50	6.5625	4.06	7.06	3.00
	All Topics	11.31	31.44	20.1250	12.06	20.31	8.25

Mean Difference between the Pre-test Mean Scores of the Experimental and Control Group

The mean difference between the pre-test mean scores of the experimental and control groups classified under the Three Domains of Multiple Intelligences as Analytical, Interactive and Introspective and in the three-topic areas namely, Fundamental Operations of Rational Algebraic Expressions (topic A), Positive Integral Exponents (topic B), and Zero and Negative Exponents (topic C) resulted to the t-value of 0.784, 0.171, and 0.691 for Analytical, Interactive, and Introspective Domain respectively, is not statistically significant at alpha 0.05 level. The null hypothesis that states, there is no significant difference between the pre-test mean scores of the experimental and control group under the three domains of multiple intelligences in the three topic areas, is, therefore accepted. This means that prior to the conduct of the experiment; the students of both groups were almost the same in terms of their achievements in mathematics in all of the three topic areas.

Mean Difference between the Post-test Mean Scores of the Experimental and Control Groups

The mean difference in table 4 shows the differences in the post-test mean scores of the experimental and control groups in the areas Fundamental Operations of Rational Algebraic Expressions (topic A), Positive Integral Exponents (topic B), and Zero and Negative Exponents (topic C) of students classified as either belonging to Analytical, Interactive or Introspective domain of Multiple Intelligences.

Table 4. Mean difference between the post-test mean scores of the experimental and control groups

Domains of Multiple Intelligences	Topics	Experimental Mean (Post-test)	Control Mean (Post-test)	t-value	Decision
				5.331^{S}	Reject H_o
	A	10.69	7.00		
	B	10.23	8.60	2.450^{S}	Reject H_o
Analytical	C	10.94	7.00		
				4.204^{S}	Reject H_o
	All Topics	32.31	22.60		
				5.262^{S}	Reject H_o
				5.485^{S}	Reject H_o
	A	10.23	5.79		
	B	10.77	7.71	2.883^{S}	Reject H_o
Interactive	C	11.00	8.07		
				2.796^{S}	Reject H_o
	All Topics	32.00	21.57		
				4.232^{S}	Reject H_o
				6.008^{S}	Reject H_o
	A	10.94	6.50		
	B	10.00	7.19	3.174^{S}	Reject H_o
Introspective	C	10.50	7.06		
				4.003^{S}	Reject H_o
	All Topics	31.44	20.31		
				5.222^{S}	Reject H_o

As displayed in the table, the t-values of the three domains and the three topic areas of each domain is statistically significant at 0.05 level. The null hypothesis that states, there is no significant difference between the post-test mean scores of the experimental and control groups under the three domains of multiple intelligences and on the three-topic areas, is hence, rejected. This result means that the mathematical achievement of the students under the experimental group in which cooperative learning methods were used as teaching strategies was greatly affected and has shown significant improvement. This further implies that cooperative learning method is an effective strategy in helping students improve their achievement in mathematics. This outcome also supports the research findings of Gillies (2002), stating that cooperative learning is a better way to promote academic achievement than traditional instruction. Moreover, articles on cooperative learning saying that it is highly an effective teaching strategy,

which gives enormous positive effects on academic achievement, proved the findings true.

Difference between the Mean Gain Scores of the Experimental and Control Group

Table 5. Difference between the mean gain scores of the experimental and control group when classified under the three domains of multiple intelligences

Domain of Multiple Intelligences	Mean Gain Scores		t	Decision
	Experimental	Control		
Analytical	19.6250	8.6000	7.194^{S}	Reject H_o
Interactive	19.5385	9.4286	4.709^{S}	Reject H_o
Introspective	20.1250	8.6875	7.215^{S}	Reject H_o
All MI's	19.7778	8.8889	11.069^{S}	Reject H_o

The mean gain scores of the experimental group are 19.6250, 19.5385, and 20.1250 for Analytical, Interactive, and Introspective domain respectively. The scores were higher compared to that of the control group with 8.6000, 9.4286, and 8.6875 for the three domains of multiple intelligences as observed. With this figure, it gave the t-values of 7.194, 4.709 and 7.215 correspondingly which are all statistically significant at alpha 0.05 level. The null hypothesis which states that there is no significant difference between the mean gain scores of the experimental and control group when classified under the three domains of multiple intelligences is, hence, rejected. This result means that students' achievement in mathematics is greatly affected when cooperative learning methods were used as a teaching strategy compared to the traditional method of teaching. The result is somewhat similar to the research findings of Ozsoy and Yildiz (2004) that cooperative learning method is a more effective strategy than traditional teaching method. Moreover, this supports the article of Gillies (2002), stating that in cooperative learning, interaction between group members implies that students gain approximately five times more input concerning the content than students who engaged in individualized tasks. This results in more relevant information, as well as improved language expression. The academic benefits make cooperative learning a highly desirable asset in the education society.

CONCLUSIONS

Students' knowledge on the subject matter prior to the conduct of the study denotes a low level of attainment. Cooperative learning methods anchored on multiple intelligence theory as used in grouping students with different abilities, and the traditional method of teaching implemented in 15 days were found to be effective in improving students' achievement in mathematics, but it is the cooperative learning methods anchored on multiple intelligence theory that showed significant improvement and a very high level of achievement. Therefore, it is an effective strategy in improving the students' achievement in mathematics. There was no significant difference between the pre-test mean scores of the experimental and control groups under the three domains of multiple intelligences in the areas of Fundamental Operations on Rational Algebraic Expressions, Positive Integral Exponents, and Zero and Negative Exponents; but there was a significant difference between the post-test mean scores of the experimental and control groups. Findings of this study encourage math teachers to use cooperative learning methods anchored on multiple intelligence theory as teaching strategies since it greatly affect the students' achievement in mathematics compared to the traditional method of teaching.

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