



Integration of Structured Cooperative Learning in Mathematics Classrooms

Md. Anowar Hossain^{1*} and Muhammad Rezal Kamel Ariffin²

¹Natore Institute of Education and Research
Natore, Bangladesh

²Department of Mathematics, Faculty of Science,
Universiti Putra Malaysia

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ABSTRACT

Cooperative learning model played a dynamic role in improving students' achievement in mathematics. The purpose of this research study was to compare the effects of three instructional methods on students' mathematics achievement and attitudes toward mathematics among secondary students in Natore, Bangladesh. These instructional methods were used to teach students in three experimental groups such as group 1 with structured cooperative learning, group 2 with unstructured cooperative learning and group 3 with conventional teaching. 105 students took part in the experiment and completed pre-test and post-test of mathematics achievement and attitudes toward mathematics. The statistical analysis such as ANOVA, MANOVA and post hoc pairwise comparison were used to analyze the data. The results showed a significant effect of structured cooperative learning on mathematics achievement and attitudes toward mathematics. The findings revealed that the structured cooperative students outperformed the unstructured cooperative and conventional students on mathematics achievement due to structured form of cooperative learning integration. Therefore, structured cooperative learning can successfully be implemented to promote students' achievement in mathematics.

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Structured cooperative learning, mathematics achievement, Natore

1. Introduction

Cooperative learning models are well recognized in teaching and learning mathematics, science, language and many other subjects in different levels of institutions. Cooperative learning is working together in conjunction with others to achieve a mutual benefit. According to Johnson et al. (1994), cooperative learning is the instructional use of small groups through which students work together to maximize their own and each other's learning to reach a common goal. Cooperative learning is also working together in the form of structured cooperative groups to help each other, encourage each other and share each other's knowledge to solve mathematical problems to obtain a shared achievement. Over the past decades, the use of cooperative

¹Corresponding author's address: Natore Institute of Education and Research, Natore, Bangladesh
Nayabazar Highway, P.O. Dharabarisha, 6440, P.S. Gurudaspur, Dist. Natore, Bangladesh
Phone: +8801744313799
e-mail: anowar_24434@yahoo.com
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learning has greatly increased. Cooperative learning has grown into structured cooperative group works such as Learning Together, student teams-achievement division (STAD), teams-games-tournaments (TGT), team accelerated instruction (TAI), cooperative integrated reading and composition (CIRC), Jigsaw, group investigation (GI), etc. Hence Learning Together, STAD, TGT, TAI, CIRC, Jigsaw and GI are cooperative learning models, that is, structured cooperative learning activities in which students are held accountable for their contribution, participation and learning. Students are provided incentives to work as team in teaching others and learning from others (Slavin, 1995).

Researchers like Ozsoy and Yildiz (2004) in their study mentioned that cooperative learning is a group working but every group working is not cooperative learning. Group working is a cooperative learning when it is structured under group learning conditions, that is, groups are formed with students of different levels of abilities and work together for a shared goal such as Learning Together model. Hossain et al. (2013) in their study in Natore found that teachers in secondary mathematics classrooms used unstructured cooperative learning by the name of cooperative learning and familiar with conventional way of teaching. The result of secondary school certificate examination as seen in 2014 (BISE, 2014) no students from 24 schools came out successful in which most of them failed in mathematics. This high rate of failure indicates deficiency in teaching mathematics - teachers teach mathematics using conventional teaching method along with unstructured cooperative learning in line with their individual creativity. To develop students' achievement in mathematics, Hossain et al. (2013) encouraged mathematics teachers to implement structured form of cooperative learning, therefore, this research study is to focus on structured cooperative learning strategy, that is, Learning Together model of Johnson and Johnson (1994) because their model of developing cooperative learning based on five basic principles such as positive interdependence, individual accountability, face to face promotive interaction, interpersonal and small-group skills, and group processing are widely applicable for the successful implementation of cooperative learning in mathematics classrooms.

The effects of cooperative learning models has produced outstanding performance in mathematics education in various studies. Researchers in many countries implemented cooperative learning models as medium of instruction in teaching and learning mathematics and found that the students who learn mathematics using cooperative learning models outdone the students of other forms of instructional methods. Alabekee (2015) conducted a study on STAD model of cooperative learning in selected secondary schools in Nigeria and found that teachers were successful using STAD which developed students' achievement in mathematics improving their feelings of cooperation and level of understanding. Likewise, Ozsoy and Yildiz (2004) carried out an experimental study on the implementation of Learning Together model of cooperative learning with 7th grade students in Turkey. The findings revealed a significant effect of Learning Together model on students' performance in mathematics. Besides, researchers like Hossain et al. (2013) and Zakaria et al. (2010) found similar findings that cooperative learning models contributed to the improvement of students' performance in mathematics. Hence this research study aimed at investigating the effects of structured cooperative learning, unstructured cooperative learning and conventional teaching on mathematics achievement and attitudes toward mathematics among secondary students in Natore, Bangladesh. The objectives of this research study were:

1. To compare the effects of structured cooperative learning and unstructured cooperative learning on mathematics achievement and attitudes toward mathematics.
2. To compare the effects of structured cooperative learning and conventional teaching on mathematics achievement and attitudes toward mathematics.
3. To compare the effects of unstructured cooperative learning and conventional teaching on mathematics achievement and attitudes toward mathematics.

2. Method

This study is an experimental research conducted following the approval of District Education Officer with the Government of Bangladesh in selected secondary school mathematics classrooms for 5 months from the 1st of January to the 31st of May, 2015. The participants of this study were 105 students of grade IX randomly

selected from mathematics classrooms of Dharabarisha High School in the district of Natore, Bangladesh. Out of 105 participants, 34 were selected for experimental group 1, 35 for experimental group 2 and 36 for experimental group 3.

This research study compared the effects of three independent variables on two dependent variables. The independent variables are structured cooperative learning, unstructured cooperative learning and conventional teaching while the dependent variables include mathematics achievement and attitudes toward mathematics. Structured cooperative learning, unstructured cooperative learning and conventional teaching are the instructional methods were divided into three experimental conditions such as group 1 with structured cooperative learning, group 2 with unstructured cooperative learning and group 3 with conventional teaching. The students in the experimental group 1 were taught using structured cooperative learning while students in the experimental group 2 and experimental group 3 were taught using unstructured cooperative learning and conventional teaching respectively.

Pre-test of mathematics achievement and attitudes toward mathematics was employed before the beginning of this research study. The purpose of pre-test was to test the level of students' performance in mathematics achievement and attitudes toward mathematics at the start of this experiment.

As seen in Table 1 that mathematics achievement pre-test mean scores of structured cooperative learning, unstructured cooperative learning and conventional teaching are 11.03, 11.17 and 11.00 respectively which are relatively similar. And the pre-test mean scores of attitudes toward mathematics are 3.03, 3.00 and 2.92 for structured cooperative learning, unstructured cooperative learning and conventional teaching respectively which are also relatively similar.

Table 1. Pre-test mean and standard deviation of mathematics achievement and attitudes toward mathematics

Dependent variable	Group	Mean	Std. Deviation
Mathematics achievement pre-test	Structured cooperative learning (n = 34)	11.03	0.76
	Unstructured cooperative learning (n = 35)	11.17	0.66
	Conventional teaching (n = 36)	11.00	0.76
Attitudes toward mathematics pre-test	Structured cooperative learning (n = 34)	3.03	0.80
	Unstructured cooperative learning (n = 35)	3.00	0.87
	Conventional teaching (n= 36)	2.92	0.87

It was found from Table 2 that the pre-test MANOVA results across three groups are not significant ($F = 0.35$, $p = 0.84$), and follow up ANOVA results also not significant on mathematics achievement ($F = 0.56$, $p = 0.57$) and attitudes toward mathematics ($F = 0.17$, 0.85). This results indicate that the performance of participants across three groups are equivalent in mathematics achievement and attitudes toward mathematics and they started out equal prior to the experiment.

Table 2. MANOVA and follow up ANOVA results on mathematics achievement and attitudes toward

mathematics pre-test

MANOVA effect and Dependent variable	Multivariate F Pillai's Trace df = 4, 204	Univariate F df = 2, 102
Group effect	0.35 (p = 0.84)	
Mathematics achievement pre-test		0.56 (p = 0.57)
Attitudes toward mathematics pre-test		0.17 (p = 0.85)

The instruments used in this study were the mathematics achievement test and attitudes toward mathematics questionnaire. The instruments - mathematics achievement test and attitudes toward mathematics questionnaire were content validated by the expert in mathematics education. The reliability of mathematics achievement test were calculated by using Kuder-Richardson 20 formula. The K-R 20 reliability coefficient of mathematics achievement test was 0.72. The reliability of attitudes toward mathematics questionnaire was determined by computing the Cronbach's Alpha reliability index. The Cronbach's Alpha reliability coefficient of attitudes toward mathematics questionnaire was 0.85.

Post-test of mathematics achievement and attitudes mathematics was administered at the end of this research study after the integration of structured cooperative learning in experimental group 1, unstructured cooperative learning in experimental group 2 and conventional teaching in experimental group 3. Post-test was conducted to identify the changes made in mean scores of mathematics achievement and attitudes toward mathematics in comparison to pretest.

The data which collected after pre-test and post-test were analyzed using MANOVA, ANOVA and ANOVA post hoc pair wise comparison. MANOVA was used to determine the effects of three independent variables on two dependent variables. MANOVA examined how dependent variables were influenced by independent variables. ANOVA was performed as follow up analysis of post MANOVA results. Follow up ANOVA examined the effects of three independent variables on each dependent variable. ANOVA post hoc pair wise comparison was administered to find out where the differences of means existed for each dependent variable in terms of three independent variables.

3. Results and Discussion

The results of this research study are presented based on the objectives stated earlier. The study was conducted to compare the effects of three independent variables such as structured cooperative learning, unstructured cooperative learning and conventional teaching on two dependent variables, mathematics achievement and attitudes toward mathematics. The post-test results of this study identified that the students' mathematics achievement and attitudes toward mathematics were influenced and affected by three instructional methods based on three experimental conditions such as structured cooperative learning, unstructured cooperative learning and conventional teaching groups of 105 students.

As seen in Table 3 that mathematics achievement post-test mean scores of structured cooperative learning, unstructured cooperative learning and conventional teaching are 21.79, 19.83 and 18.44 respectively. And the post-test mean scores of attitudes toward mathematics are 4.47, 4.03 and 3.83 for structured cooperative learning, unstructured cooperative learning and conventional teaching respectively. There are differences in post-test mean scores across three groups in mathematics achievement and attitudes toward mathematics.

Table 3. Post-test mean and standard deviation of mathematics achievement and attitudes toward

mathematics

Dependent variable	Group	Mean	Std. Deviation
Mathematics achievement post-test	Structured cooperative learning (n = 34)	21.79	02.19
	Unstructured cooperative learning (n = 35)	19.83	02.22
	Conventional teaching (n = 36)	18.44	01.96
Attitudes toward mathematics post-test	Structured cooperative learning (n = 34)	04.47	0.51
	Unstructured cooperative learning (n = 35)	04.03	0.62
	Conventional teaching (n = 36)	03.83	0.56

Table 4 shows post-test MANOVA results of comparing three groups are significant ($F = 11.17, p = 0.00$), and follow up ANOVA results also significant on mathematics achievement ($F = 21.93, p = 0.00$) and attitudes toward mathematics ($F = 11.64, p = 0.00$). The MANOVA results suggest that three types of instructional methods significantly influence mathematics achievement and attitudes toward mathematics. The results of ANOVA describe significant differences between students' mean scores on mathematics achievement and attitudes toward mathematics across three experimental groups.

Table 4. MANOVA and follow up ANOVA results on mathematics achievement and attitudes toward mathematics post-test

MANOVA effect and Dependent variable	Multivariate F Pillai's Trace df = 4, 204	Univariate F df = 2, 102
Group effect	11.17 ($p = 0.00$)	
Mathematics achievement post-test		21.93 ($p = 0.00$)
Attitudes toward mathematics post-test		11.64 ($p = 0.00$)

As depicted in Table 5, the students of structured cooperative learning (Mean = 21.79, SD = 2.19) performed significantly better ($p = 0.00$) than the students of unstructured cooperative learning (Mean = 19.83, SD = 2.22) and conventional teaching (Mean = 18.44, SD = 1.96) on mathematics achievement with a mean difference of 1.97 and 3.35 respectively. And the performance of unstructured cooperative learning (19.83, SD = 2.22) students is significantly higher ($p = 0.02$) than conventional teaching (18.44, SD = 1.96) students on mathematics achievement with a mean difference of 1.38. Besides, structured cooperative learning students (Mean = 4.47, SD = 0.51) performed significantly better ($p = 0.00$) than unstructured cooperative learning students (Mean = 4.03, SD = 0.62) and conventional teaching (Mean = 3.83, SD = 0.56) on attitudes toward mathematics with a mean difference of 0.44 and 0.64 respectively. In addition, the mean of unstructured cooperative learning (4.03, SD = 0.62) students is higher than conventional teaching (3.83, SD = 0.56) students on attitudes toward mathematics which is insignificant ($p = 0.32$).

Table 5. ANOVA post hoc pairwise comparison between independent variables on dependent variables

Independent variable	Dependent variable			
	Mathematics achievement		Attitudes toward mathematics	
Comparison group	Mean difference	Sig.	Mean difference	Sig.
Structured cooperative learning versus unstructured cooperative learning	1.97	0.00	0.44	0.00
Structured cooperative learning versus conventional teaching	3.35	0.00	0.64	0.00
Unstructured cooperative learning versus conventional teaching	1.38	0.02	0.20	0.32

The findings revealed that the students of structured cooperative learning outperformed the students of unstructured cooperative learning and conventional teaching on mathematics achievement. The performance of structured cooperative learning students is much better in comparison to unstructured cooperative learning and conventional teaching students on mathematics achievement and attitudes toward mathematics. It was found that students in structured cooperative learning group outdone the students in unstructured cooperative learning and conventional teaching groups due to structured form of cooperative learning integration.

The findings of this research study are consistent with the findings of Alabekee’s (2015) study. Alabekee found that students in the STAD model had higher mean scores than their counterparts in the other forms of experimental conditions promoting their learning outcomes in mathematics which encouraged them actively involved in the structured way of cooperative learning. The results of this research study are also consistent with the study of Ozsoy and Yildiz (2004). Ozsoy and Yildiz’s study revealed that the students who taught using Learning Together model of cooperative learning outdone the students of conventional method of teaching on mathematics achievement. The findings of this research study are also in line with the findings of other studies by Hossain et al. (2013) and Zakaria et al. (2010). Hossain et al. implemented Learning Together and Zakaria et al. used STAD models in their studies and found a significant effect on mathematics achievement in favor of cooperative learning models.

4. Conclusion

This research study showed that structured cooperative learning had a significant effect on students’ achievement in mathematics. The findings revealed that the improvement of mathematics achievement for structured cooperative students was due to structured cooperative learning integration. The researcher found that structured cooperative learning was more effective in teaching and learning mathematics in comparison to unstructured cooperative learning and conventional teaching. It was found structured cooperative learning contributed to develop students’ mathematics achievement and attitudes toward mathematics, therefore, teachers are suggested to implement structured cooperative learning to improve students’ performance in mathematics. Teachers in primary, secondary and tertiary levels are encouraged to implement structured form of cooperative learning in their teaching and learning activities to bring a change in the system of unstructured cooperative learning and conventional teaching.

In conclusion, the researcher is lending two recommendations on the basis of the findings of this research study as follows:

1. This research study was limited to mathematics on a sample of 105 students in selected secondary school for 5 months, further studies can be conducted on mathematics with a larger number of samples for a longer period of time in primary, secondary and tertiary institutions.
2. Studies can be conducted to show the comparison between male and female, co-educational and single gender school, general and religious school, rural and urban school students through the implementation of structured cooperative learning, unstructured cooperative learning and conventional teaching.

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