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Effects of cooperative learning on students' achievement and attitudes in secondary mathematics

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Abstract

The main purpose of this study was to identify the effects of cooperative learning on students' mathematics achievement and attitudes towards mathematics in selected secondary schools in Bangladesh. A total of 80 students (40 from Boys' school and the other 40 from Girls' school) of grade nine participated in this study where quasi-experimental design was administered. Data were analyzed using independent-sample test. The results showed that cooperative learning had significant effects on mathematics achievement and attitudes towards mathematics. It was found that students' performance in mathematics and attitudes towards mathematics were affected by exposure to the cooperative learning. The findings of this study have shown a great improvement in mathematics achievement and attitudes towards mathematics. Therefore, cooperative learning can be successfully used to promote student' performance in mathematics in secondary schools in Bangladesh.

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1. Introduction

Cooperative learning has been well documented in the educational research as a successful pedagogy to improve students' academic achievement. It is a fundamental principle of cooperative learning that group members are linked together in such a way that they cannot succeed unless everyone succeed, they will actively assist each other to make sure that the assignment is done and the purpose of the group achieved (Deutsch, 1949). They acquire this by providing help and cooperation to each other, sharing resources, and encouraging each other's efforts. As a result, group members who work in cooperative groups outperform students who work by themselves or in competition with each other (as seen in competitive conventional classrooms) (Johnson & Johnson, 2004). Cooperative learning is one of the two ways of organizing the learning environment of a classroom, the other being competitive. In cooperative learning environment, the goals of separate individuals become so linked that there is a positive correlation between them; on the contrary, in a competitive conventional environment, the goals of the students are so linked that there is a negative correlation between their goal attainments (Johnson & Johnson, 1994). Cooperative learning establishes a community in which students can get help and support from other group members

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immediately in a non-competitive learning environment, just raising their hands and waiting for the right answers to be given.

To identify the students' performance in mathematics and attitudes towards mathematics in terms of cooperative learning effects, the researcher conducted this study in selected secondary schools in Natore, Bangladesh. Secondary school certificate (SSC) is the first major public examination faced by the students after completion of two years of secondary education. The SSC is an indicator of the quality of secondary education, but high rate of failure in SSC examination reflects poor quality of secondary education. Relatively high failure rate in mathematics indicates deficiency in teaching of this subject especially in rural secondary schools. Although eminent educationists and education administrators of the country have put up significant effort to improve secondary education for the past few years, it is regretful that the percentage of passes as seen in years 2001-2005 SSC examination result was below twenty percent at a large number of schools in the rural areas under Chittagong, Rajshahi, Barisal, Jessore and Comilla Education Boards (Board of Intermediate and Secondary Education, 2005). This reflects a poor quality of secondary education, especially with most of the students failed in mathematics. Samad (2005) mentioned from the findings of his study which has been conducted in the secondary school mathematics classrooms in Bangladesh that teachers are familiar with conventional mode of thought and teaching; teachers' teaching strategies are based on their individual creativity. He commented that this traditional teaching strategy has negative impact on students' performance in SSC examination. He stresses the need of involvement of secondary teachers with those methods of teaching which have positive impact on students' academic performance. Effandi (2003) embarked on a study to determine the effects of cooperative learning over the conventional teaching method in matriculation level mathematics. He found cooperative learning improved students' achievement in mathematics and attitudes towards mathematics. He concluded that utilization of cooperative learning method is a preferable alternative to traditional instructional method. Whicker et al. (1997) investigated the effects of cooperative learning on students' achievement and attitudes in a secondary mathematics classroom. They found that students in the cooperative learning had higher test scores than students in the comparison group. Vaughan (2002) examined the effects of cooperative learning on the achievement and attitudes towards mathematics of a group of fifth graders. The students participated for twelve weeks in cooperative learning in mathematics. The analysis of pre- and post-test scores revealed positive changes in attitudes and achievement. Other studies had similar findings showing that cooperative learning produces positive effect on mathematics achievement and improves students' attitudes towards mathematics (Johnson & Johnson, 1994; Davidson, 1990; Faizah, 1999; Ozsoy & Yildiz, 2004; Zakaria et al., 2010). Hence, this study aimed at identifying the effects of cooperative learning on students' mathematics achievement and attitudes towards mathematics in selected Boys' and Girls' schools in Natore, Bangladesh. The objectives of this study were:

- i. To identify the effects of cooperative learning on students' mathematics achievement.
- ii. To identify the effects of cooperative learning on students' attitudes towards mathematics.
- iii. To make a comparison of cooperative learning effects on mathematics achievement between experimental group students in Boys' and Girls' schools.
- iv. To make a comparison of cooperative learning effects on students' attitudes towards mathematics between experimental group students in Boys' and Girls' schools.

2. Method

The quasi-experimental pre-post test control group design was administered to identify the effects of cooperative learning in the experimental schools. The quasi-experimental design compared a control group using conventional teaching method with an experimental group using cooperative learning in light of three major points: (i) pre-test of students' mathematics achievement and attitudes towards mathematics was given to both experimental and control groups, (ii) control and experimental groups were guided by the two teachers (one from each school) who had more than twelve years of teaching experience in mathematics. Each teacher taught two classes in each school in one academic session for the duration of 15 -weeks, (iii) post-test of students' mathematics achievement and attitudes towards mathematics was given to both experimental and control groups. Table 1 shows a graphic form of quasi-experimental design of this study. A represents the experimental group while B represents the control group. O_1 represents the pre-test while the post-test is represented as O_2 for the experimental and control groups respectively. The cooperative learning treatment is represented as X.

Table1: Pre- and -post- test control group design

Group	Pre-test	Treatment	Post-test
A (n = 40)	O ₁	X	O ₂
B (n = 40)	O ₁	-	O ₂

The participants of this study were the ninth grade students of selected Boys' and Girls' schools in Natore, Bangladesh. Prior to the implementation of the study, the researcher obtained permission from the District Education Officer of the Government of the People's Republic of Bangladesh for conducting the study. Mashinda High School and Sreepur Adarsha Girls' High School were approved by the District Education Officer to carry out this study. A total of 80 full-time students (40 students for experimental group and the other 40 students for control group) constitute the sample. Each experimental school comprised two sections in which Section -I was represented as the experimental group while Section -II represented the control group in grade nine mathematics classrooms as per the directives of the Headmasters of the sample schools. This study took place from the 2nd of February to the 15th of May in 2008.

3. Results

The results of the study are reported based on the objectives stated earlier as follows:

3.1. Identifying the effects of cooperative learning on students' mathematics achievement

Independent-sample t-test was conducted in comparing the mathematics achievements of the two groups. The post-test mean scores of students' mathematics achievement for the experimental group taught by the cooperative learning was 47.56 (SD = 2.74), and that for the control group taught by the conventional teaching it was 35.31 (SD = 1.89). Table 2 shows that the mean for the experimental group (M = 47.56) was greater than that for the control group (M = 35.31). The difference between these two post-test mean scores was significant $t(78) = 23.24$, $p < 0.05$ in favour of the experimental group, which revealed that the performance of experimental group was significantly better than control group. As such, cooperative learning positively affects students' mathematics achievement.

Table 2: Independent-sample t-test comparing means of students' mathematics achievement post-test scores between experimental and control groups

Group	n	Mean	SD	t	df	Sig(2-tailed)
Experimental	40	47.56	2.74	23.24	78	0.00
Control	40	35.31	1.89			

3.2. Identifying the effects of cooperative learning on students' attitudes toward mathematics

To compare the effects of cooperative learning on attitudes towards mathematics between experimental and control groups, the independent-sample t-test was also conducted. The results showed that the mean for the experimental group, M = 4.75 (SD = 0.06) was greater than that for the control group, M = 4.00 (SD= 0.07). As stated in Table 3, a significant difference was found $t(78) = 47.66$, $p < 0.05$ between these two post-test mean scores in favour of the experimental group, which revealed that the experimental group showed improvement in attitudes towards mathematics in comparison to control group.

Table 3: Independent-sample t-test comparing means of students' attitudes toward mathematics post-test scores between experimental and control groups

Group	n	Mean	SD	t	df	Sig(2-tailed)
Experimental	40	4.75	0.06	47.66	78	0.00
Control	40	4.00	0.07			

3.3. Making a comparison of cooperative learning effects on mathematics achievement between experimental group students in Boys' and Girls' schools

The statistical test used to make a comparison of cooperative learning effects on mathematics achievement between experimental group students in Boys' and Girls' schools was also the independent-sample t-test. The Girls' school scored mean of 47.75 (SD = 2.55), which is slightly higher than the Boys' school with mean score of 47.37 (SD = 2.97). As mentioned in Table 4, a non-significant result was found $t(38) = -0.42, p > 0.05$, which indicated that there is no statistically significant difference in mathematics achievement post-test mean scores between experimental group students in Boys' and Girls' schools. The results show that experimental group students in Boys' and Girls' schools were equal in their performance in mathematics achievement after cooperative learning implementation.

Table 4: Independent-sample t-test comparing means of students' mathematics achievement post-test scores between experimental group students in Boys' and Girls' schools

School	n	Mean	SD	t	df	Sig(2-tailed)
Boys'	20	47.37	2.97	-0.42	38	0.67
Girls'	20	47.75	2.55			

3.4. Comparing the effects of cooperative learning on students' attitudes toward mathematics between experimental group students in Boys' and Girls' school

The independent-sample t-test was also conducted to make a comparison of cooperative learning effects on students' attitudes towards mathematics between experimental group students in Boys' and Girls' schools. As described in Table 5, the students of Boys' and Girls' school scored post-test mean of 4.77 (SD = 0.06) and 4.73 (SD = 0.06) respectively. The difference between these two post-test means was non-significant $t(38) = 1.99, p > 0.053$, which revealed that the experimental group students' performance in attitudes towards mathematics in Boys' and Girls' schools were equivalent after cooperative learning integration.

Table 5: Independent-sample t-test comparing means of students' attitudes toward mathematics post-test scores between experimental group students in Boys' and Girls' schools

School	n	Mean	SD	t	df	Sig(2-tailed)
Boys'	20	4.77	0.06	1.99	38	0.053
Girls'	20	4.73	0.06			

4. Discussion

Findings from this study indicate that cooperative learning has significant effect on students' performance in mathematics and attitudes towards mathematics. The experimental group shows significant improvement in students' mathematics achievement and attitudes towards mathematics in comparison to control group. The result suggests that the increase of the students' mathematics achievement and attitudes towards mathematics post-test mean scores for the experimental group was due to the significant effects of cooperative learning. The findings of

the study, therefore, are consistent with the results as reported by Effandi (2003), Whicker et al. (1997) and Vaughan (2002). The findings of this study are also consistent with studies by Johnson and Johnson (1994), Davidson (1990), Faizah (1999), Ozsoy and Yildiz (2004), and Zakaria et al. (2010). However, the findings of cooperative learning effect on attitudes towards mathematics are in contrast to the findings by Ismail (2000). Ismail found no significant difference in attitudes towards mathematics between experimental and control groups. The short treatment period of three and a half weeks might be the possible reason for no significant difference between the two groups.

The study also made a comparison of cooperative learning effects on mathematics achievement and attitudes towards mathematics between experimental group students in Boys' and Girls' schools, it was found that experimental group students in Boys' and Girls' school were equivalent in their performance after cooperative learning implementation. The findings indicated that cooperative learning had positive impact on students' performance in mathematics and attitudes towards mathematics, and it provided students with the opportunity to determine their algebraic expression, geometric theorem and trigonometric ratio confidently. Cooperative learning enabled students to acquire the appropriate problem solving techniques, and therefore, they were able to solve their problems better than the students in the control group. Students in the experimental group worked cooperatively to obtain shared group goals.

5. Conclusions

Significant differences in students' mathematics achievement and attitudes towards mathematics were found between experimental and control groups. After the treatment, experimental group students showed significant improvement in mathematics achievement and attitudes towards mathematics in comparison to control group students. It was found that students' performance in mathematics and attitudes towards mathematics were affected by exposure to the cooperative learning. Students seem to prefer learning mathematics by sharing knowledge. They feel contented when they can function effectively in the group work. It is hoped that the findings of this study may assist policymakers and teachers to identify appropriate measures that could promote cooperative learning in mathematics classrooms. The results of the study might also advance our understanding on practical contribution of cooperative learning.

On the whole, the findings of this study have shown a great improvement in mathematics achievement and attitudes towards mathematics. Therefore, cooperative learning can be successfully used to promote student' performance in mathematics in secondary schools in Bangladesh. Future research should focus on the longitudinal study of cooperative learning on academic achievement in various disciplines.

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