Eurasian Journal of Educational Research, Issue 47, Spring 2012, 1-22

Gender-Related Effects of Group Learning on Mathematics Achievement among the Rural Secondary Students

Md. Anowar HOSSAIN*

Rohani Ahmad TARMIZI**

Suggested Citation:

Hossain, M.A., & Tarmizi, R.A. (2012). Gender-related effects of group learning on mathematics achievement among the rural secondary students. *Egitim Arastirmalari-Eurasian Journal of Educational Research*, 47, 1-22

Abstract

Problem Statement: Gender differences in the effects of group learning play a contested role in mathematics education. Several researchers concluded that male students perform better on mathematics than female students. Whilst on the other hand, others reported that female students perform best under the group learning setting whereas the male students perform best in the conventional teaching environment. Consequently investigating gender differences on students' mathematics performance is our main focus.

Purpose of Study: The aim of this research was to identify the male and female students' performance with the integration of progressive series of group learning on mathematics achievement in selected rural secondary schools in Bangladesh. The focus of this study is to examine gender-related differences on mathematics achievement of 9th grade students.

Methods: The quasi-experimental equivalent pre-post test control group design comprising an experimental group (n = 84) with group learning treatment whilst a control group (n = 84) was given conventional teaching for duration of 15-week. The independent-sample t-test was used to compare the effects of group learning between experimental and control groups, and to examine the gender-related differences in achievement with group students. The MANOVA with repeated measures was employed to determine the main and interaction effects of group learning on test-time and achievement.

* Corresponding author, Post Doctoral Researcher, Dr., Universiti Putra Malaysia, Institute for Mathematical Research, anowar_24434@yahoo.com

** Assoc. Prof. Dr., Universiti Putra Malaysia, Institute for Mathematical Research, rohaniat@gmail.com

Findings and Results: The results showed a significant effect of group learning on mathematics achievement and a significant effect on gender-related differences on mathematics achievement. The findings revealed that the group learning students outperformed the conventional students, and both the male and female students in the experimental group improved their mathematics achievement in which the performance of female students were significantly better than that of male students after group learning treatment.

Conclusions and Recommendations: Group learning had significant effects on students' mathematics achievement. Gender-related differences with the effects of group learning in terms of mathematics achievement was also significant. Overall performance of both the male and female students was significant while female students outperformed male students in the experimental group after group learning intervention. As such it can be concluded that group learning enhanced mathematics achievement for female students, whilst the male counterparts do not benefit as much as the female group. Thus it is important that female students be provided with opportunities to learn mathematics in the classroom in the group learning environment. Therefore, group learning may be a tool that can be professionally implemented to develop female students' performance in Bangladesh.

Keywords: Group learning, gender differences, mathematics achievement, quasi-experimental equivalent pre-post test control group design.

Group learning is well documented as an effective pedagogy in Mathematics education throughout the world. Several studies also conclude that gender-related effect of group learning has a strong influence in mathematics learning. Recent studies of national trends confirm that females are as likely to enroll in mathematical courses and have higher GPAs as males in mathematics but do not always perform as well on standardized mathematical assessments (Hyde et al., 2008). A meta-analysis of several national data and independent research studies from the 1960s through 1980s concluded that the gender differences in mathematics achievement depends on several demographic characteristics such as age. Linn and Peterson (1985) found that females outperform males starting at a very young age, but that advantage disappears by age 17. During elementary and middle school, girls have been shown to do better at computation and there were no gender differences for problem solving. However at high school, males demonstrated an advantage in problem solving (Hyde et al., 1990).

Gender differences in mathematics based on specific mathematical ability reveals that males perform better relative to females on word problems in middle school, high school, and college. Higher scores among females are reported on items that deal with direct application of knowledge garnered from classroom instruction while

males score higher on items requiring visual spatial skills, problem-solving, and reasoning (Byrnes, 2005).

Halpern has shown that female students tend to perform better on verbal tasks while male students tend to perform better on tasks based on logic and action (Halpern, 1997). Other researchers have found gender differences in learning (Sax, 2005; Steinback & Gwizdala, 1995) and mentioned that in co-educational classrooms female students did better in learning mathematics with more concrete objects and manipulatives, and male students tend to perform higher at calculations demonstrated with the aid of using chalkboard. The gender differences in mathematics achievement in group learning were recently been investigated by Kolawole (2007). Kolawole concluded that male students perform better on mathematics than female students. –Joiner (1999) reported that female students perform best under the group learning setting whereas the male students perform best in the conventional teaching environment.

Gender differences, however, vary in many ways, and some differences affect how well male and female students learn and their performance in learning. Many studies also reveal that female students are no weaker in mathematics in comparison with male students, even though male students show confident in their mathematics abilities. Whilst gender gap in mathematics persists throughout the world, in light of lack of related research in Bangladesh, the researchers undertake to compare the performance of male and female students in mathematics in group and conventional learning conditions. This study was also conducted among rural students enrolled in grade nine, secondary schools in Bangladesh.

According to Davidson (1990), group learning has been recognized as one of the effective methods in improving students' mathematics achievement. Group learning brings together students working together to accomplish shared goals, is an instructional approach in which high-ability and low-ability students work together to solve a problem. Group learning is an instructional method in which students are grouped in small learning teams and work in cooperation with each other to solve a common problem or to perform a task presented by the teacher (Johnson & Johnson, 2004). There are many strategies in group learning. The researcher in this study has focused on Johnson and Johnson's (1994) Learning Together Model because their approach of developing group learning based on five basic principles is widely applicable in any group learning situation. Rimmerman (2004) referred to Johnson and Johnson's work as the modern era of group learning. This model of group learning which is known as Learning Together can be applied to any discipline and grade level was conducted progressive learning sessions in the mathematics classrooms.

Mathematics achievement has always been perturbed in many countries, and this phenomena has prevailed for years in Bangladesh. The first major public examination secondary school certificate (SSC) is significant for pupils and guardians all over Bangladesh. The result of SSC has a great significance to success of both individual and communal life. The percentage of students' passing the SSC at many

rural secondary schools as seen in years 2000, 2001, 2003, 2004 and 2005 were found below twenty percent (Board of Intermediate and Secondary Education, 2005). These reflect poor quality of secondary education, specifically with many of the students failed in mathematics. Samad (2005) reported that based on samples of Bangladesh's secondary students mathematics performance, there is crucial need to improve and reinforce students' mathematical knowledge through various ways of instructions. Teachers are required to be creativity and critical in their role in teaching of mathematics. According to Ali (1987), teachers in the secondary school context are familiar with traditional method of teaching. Teachers also lack the motivation to venture into new modes of teaching and this is largely due to lack of professional development training in adopting new approaches in teaching and learning mathematics.

Johnson and Johnson (1994) in their study found that group learning had improved students' mathematics achievement of the ninth and tenth graders. Other studies had similar findings in different mathematics grades reported by Whicker et al. (1997) and Jacobs et al. (1996). Johnson et al. (1998) reviewed 168 studies comparing group learning to traditional styles of instruction focusing on student achievement to strengthen the case for using group learning in mathematics. They found that the use of group learning facilitated learning in an active rather than a passive way. They claim that group learning must be employed in mathematics classes if mathematics instruction is to help students think mathematically, understand the relationships among various mathematical facts and formulas, and apply mathematical knowledge.

Effandi (2003) and Lee (1999) also mentioned from the findings of their studies which have been conducted in Malaysia, that group learning enhance mathematics performance among students and promote positive attitudes toward mathematics than the traditional way of teaching. The effectiveness of group learning has shown rapid growth in mathematics achievement and attitudes toward mathematics in various studies (Zakaria et al., 2010; Faizah, 1999; Ozsoy & Yildiz, 2004). As such the researcher implemented group learning based on Learning Together model of Johnson and Johnson (1994) in the rural secondary mathematics classrooms in Bangladesh. Specifically the objectives of this study were:

1. To identify the effects of group learning on students' mathematics achievement.
2. To examine the gender-related effects of group learning on mathematics achievement.

Methods

Research Design

To identify the effects of group learning in comparison to conventional teaching, the study employed a quasi-experimental "Equivalent Control Group with Pre-Post test" (Berg & Latin, 1994; Campbell & Stanley, 1963) design. The equivalent control

group refers to the elements that no characteristics between two groups had a different expected value. Prior to the experimental treatment, two groups should be similar in every respect. An initial observation (a pre-test) can confirm that the two groups are at least similar in terms of the dependent variables under investigation. If one group receives the experimental treatment, group differences can be found with respect to the dependent variable, and then the study comes to a conclusion that the post-treatment differences is the result of that treatment (Leedy & Ormrod, 2001). A total of 168 full-time students participated in this study. The preliminary pre-test was conducted on students' mathematics achievement in both control (n = 84) and experimental (n = 84) groups, and the results illustrated that both groups were equivalent in terms of students' mathematical performance prior to the treatment, hence they started out equal before the treatment strategy was given.

After the pre-test, the experimental group undergone the group learning mode whilst the control group, undergone the conventional mode of learning. The group learning and the conventional teaching were conducted by the same teachers in one academic session for the duration of 15 weeks of classroom teaching. Post-test of students' mathematics achievement was administered to both experimental and control groups. Table 1 shows a graphic form of the quasi-experimental design. O_1 represents the pre-test while the post-test is represented as O_2 for the experimental and control groups respectively. The group learning treatment is represented as X.

Table 1
Pre-Post Test Control Group Design

Group	Pre-Test	Treatment	Post-Test
Experimental (n = 84)	O_1	X	O_2
Control (n = 84)	O_1	-	O_2

Sample

The sample consists of grade nine students of selected rural secondary schools in Natore, Bangladesh. Prior to conducting this study, the researcher obtained permission from the District Education Officer of Bangladesh Government. The samples were selected from the four rural secondary schools namely, Mashinda High School, Kachugari Fakir Bari High School, Poal Shura Patpara High School, and Sreepur Adarsha Girls' High School. A total of 168 full-time students from four secondary schools constituted 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. The selection of mathematics classrooms was upon directives of the Headmasters of the experimental schools.

Instrumentation

The major instrument used in this study was the students' mathematics achievement test. A copy of a 20-item students' Mathematics Achievement Test (MAT) instrument is included in Appendix A.

Pilot Study

A pilot study was conducted prior to the actual study in order to test the reliability of the instrument. The instrument was pilot tested with a sample comprising 40 secondary students from Krishi Karigari ML High School in Natore. Krishi Karigari ML High School was selected by the District Education Officer of Bangladesh Government for the pilot study in which Section-I and Section-II were represented as the experimental and control groups respectively.

Each small group consisted of four students with low and high-ability in the experimental group. Both the experimental and control groups were guided by the same teacher who had more than twelve years of teaching experience in mathematics. Both the experimental and control groups had undergone mathematics instructions for fifty five minutes each for four weeks. All the students in the pilot test were administered pre-test and post-test. This ensures the reliability of the instrument in Bangladesh context. The researcher also assessed the suitability of group learning lesson plans used for the experimental group.

Content validity of the Mathematics Achievement Test (MAT) was determined through the consensus of the experts in the relevant field. The instrument in this study was content validated by the District Education Officer of Bangladesh Government; a Professor of IER, University of Dhaka; an Associate Professor of mathematics and Ex-Controller of Examination, BISE, Rajshahi; a professor and Ex-School Inspector of BISE, Rajshahi; and finally approved by an expert in mathematics education, Faculty of Education, Universiti Kebangsaan Malaysia.

Group Learning Implementation

The mathematics teachers who were assigned to implement group learning in this study were properly trained about mathematics teaching within group learning setting, about selecting groups and assigning group members. The selected four mathematics teachers who were trained on group learning were given seven-day training on group learning prior to the experiment. At the beginning of experiment, pre-test of students' mathematics achievement was administered and the students were informed that they would be exposed to group learning for 15 weeks. The teachers in the experimental group discussed the Learning Together Model and the process of applying this model to improve mathematics achievement ensuring students to work cooperatively within the group learning environment. The teachers explained about the importance of using Learning Together model in the mathematics classrooms. The Learning Together Model is a group learning strategy developed by Johnson and Johnson (1994) to improve students' academic achievement. Learning Together Model consists of five basic elements such as positive interdependence, individual accountability, face to face promotive interaction, interpersonal and small-group skills, and group processing. According to

Johnson and Johnson (1994), for the successful implementation of group learning in the mathematics classrooms the five elements are essential: 1. Positive interdependence - all members in a group cannot succeed unless everyone succeeds; 2. Individual accountability - everyone is responsible toward contribution of sharing his/ her part in the group; 3. Face-to-face promotive interaction - group members should play their role by praising, supporting, encouraging each other to reach a common goal; 4. Interpersonal and small-group skills - group members should be aware of decision making skills, group management, and trust building in case of any conflict for the benefit of greater success; 5. Group processing - group members should know the supportive action. Every group member should acknowledge each other's effort in the group work to achieve a shared group goal.

After the discussion on Learning Together Model, students were assigned into groups based on their ability. They were divided into high and low-abilities based on their pre-test scores in MAT. The median of the scores was the criterion of assigning students to the groups. Scores above the median were labeled as high-ability and below the median were labeled as low-ability. Each group was formed by randomly choosing two high-ability students and two low-ability students. Students were encouraged to share their knowledge among one another and solve the assigned mathematical problem in groups. The teacher paid little attention to the functioning of groups and the quality of its work. When the students faced difficulties during solving the problems, they asked for the teacher's help. So the teachers intervened when needed to help groups to solve their problems. The same teachers in the traditional classrooms teach in the usual manner. After both treatments, students were test using the MAT (post-test) in the last mathematics session of the experiment.

Data Collection

The study was conducted in one academic session for the duration of 15 weeks. In the beginning, the students in both the experimental and control groups took the MAT (as a pre-test) to assess their mathematics achievement. At the end of 15-week session, the MAT (as post-test) was given to the students in order to measure differences in mathematics achievement after the given treatment.

Data Analysis

Descriptive and inferential statistics were used to analyze the tests scores. Descriptive statistics such as mean and standard deviation were used to summarize the demographic information of the subjects. Inferential statistics were conducted to test the hypotheses. The specific inferential statistics used included independent-sample t-test and MANOVA with repeated measures.

Results

The study was conducted on a sample of 168 students who were selected from four secondary schools. They were then assigned as control and experimental groups: 84 students for experimental group and the other 84 students for conventional group. The respondents' background was obtained from demographic data of students'

mathematics achievement test instrument (Appendix A). Table 2 illustrates the frequencies and percentages of respondents according to gender.

The respondents in the experimental group consisted of 84 students of which, 40 (47.62%) male and 44 (52.38%) female students. As for the control group, there were 43 (51.2%) male and 41 (48.8%) female students. Altogether, there were 83 (49.4%) male and 85 (50.6%) female students that made up the total number of student sample (168) for this study.

Table 2
Distribution of Respondents According to Groups and Gender

Gender	Experimental Group		Control Group	
	No.	%	No.	%
Male	40	47.62	43	51.2
Female	44	52.38	41	48.8
Total	84	100	84	100

Mathematics achievement, for this study, is the outcome which was acquired by the students after the learning process. In this study, mathematics learning has been measured through the mathematics achievement test instrument (MAT). Results of this study are presented based on the objectives stated earlier. The effects of group learning on mathematics achievement along with gender differences are reported.

To Identify the Effects of Group Learning on Students' Mathematics Achievement

To identify the effects of group learning on mathematics achievement, pre and post test mean scores of students in experimental and control groups were analyzed using independent-sample t-test. As pre-test mean scores of experimental and control groups are depicted in Table 3, the results indicate that the mean score for the experimental group was 25.26 (SD = 3.70) and that of control group was 25.38 (SD = 3.60). The difference between mathematics achievement pre-test mean scores of two groups [$t(166) = -0.21$, $p > 0.05$] is not significant at 0.05 alpha level. This suggests that performance of both groups were equivalent at the start of this study.

Table 3
Independent-Sample T-Test Comparing Means of Mathematics Achievement Pre-Test Scores Between Experimental and Control Groups

Group	n	Mean	SD	t	df	Sig(2-tailed)
Experimental Group	84	25.26	3.70	-0.21	166	0.83
Control Group	84	25.38	3.60			

Table 4 shows the experimental group scored post-test mean of 47.35 (SD = 2.64) which is higher than the control group with post-test mean score of 34.97 (SD = 1.99). The difference between these two post-test means was significant [t (166) = 34.25, $p < 0.05$] in favor of the experimental group which revealed that the performance of experimental group was significantly better than control group.

Table 4
Independent-Sample T-Test Comparing Means of Mathematics Achievement Post-Test Scores Between Experimental and Control Groups

Group	n	Mean	SD	t	df	Sig(2-tailed)
Experimental Group	84	47.35	2.64	34.25	166	0.00
Control Group	84	34.97	1.99			

Findings on mathematics achievement indicated that the treatment strategy of group learning had significant effects on students' mathematics achievement. Prior to the treatment, both the experimental and control groups were similar in their performance indicating a low overall scores on the MAT. After the treatment, experimental group students showed significant improvement in their mathematics achievement in comparison to control group students. The results suggests that the increase of the students' mathematics achievement during post-test mean scores for the experimental group was due to the significant effects of group learning treatment. On the other hand, the control group showed minimum changes in the students' mathematics achievement post-test mean scores.

The effects of group learning on mathematics achievement based on repeated measures of test performance over the 15 weeks of intervention period

The multivariate analysis of variance (MANOVA) with repeated measures was used to examine the main effect of group learning and different test-time as well as the interaction between them. The multivariate analysis of variance illustrated main and interaction effects on the variable identified at the 0.05 level of significance. Table 5 presents the overall multivariate test results.

Table 5
MANOVA With Repeated Measures (Main and Interaction Effects of Group Learning and Test-Time)

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power
Testtime	Wliks' Lambda	0.065	2373.307	1.000	166.000	0.000	0.935	1.000
Testtime* Method	Wliks' Lambda	0.310	369.802	1.000	166.000	0.000	0.690	1.000

The multivariate test indicates a significant main effect of time, Wilks' Lambda = 0.065, F = (1, 166) = 2373.307, p = 0.000, η^2 = 0.935; and a significant interaction effect of group learning by time, Wilks' Lambda = 0.310, F (1, 166) = 369.802, p = 0.000, η^2 = 0.690. Observed power for all factors was 1.000. There was a difference in the students' mathematics performance before and after exposure to group learning as measured and indicated by the pre-test and post-test scores of students' mathematics achievement test. The MANOVA with repeated measures indicated that there was an interaction between group learning and test-time. The multivariate test shows a significant main effect of time in affecting the students' mathematics achievement test scores and the interaction effect of group learning by time were also significant at 0.05 alpha level. Thus these findings imply that group learning intervention had significant impact in improving students' mathematics performance.

To Examine the Gender-related Effects of Group Learning on Mathematics Achievement

To examine the gender-related effects of group learning on mathematics achievement, pre and post test mean scores of male and female students in the experimental group were also analyzed using independent-sample t-test. Table 6 shows the pre-test mean scores for experimental group male students was 25.31 (SD = 4.01) and that of female students was 25.22 (SD = 3.44). The results reveal that the difference between pre-test mean scores of male and female students [t (82) = 0.10, p > 0.05] is not significant at 0.05 alpha level. This suggests that the performance of both male and female students in the experimental group were equivalent at the beginning of this study.

Table 6
Independent-Sample T-Test Comparing Means of Students' Mathematics Achievement Pre-Test Scores Between Male and Female Students in The Experimental Group

Gender	n	Mean	SD	t	df	Sig(2-tailed)
Male	40	25.31	4.01	0.10	82	0.91
Female	44	25.22	3.44			

As depicted in Table 7, the difference of the mean on mathematics achievement post-test score of experimental group male students was 46.68 (SD = 2.79) and that of the female students was 47.95 (SD = 2.36) was found to be significant [t (82) = -2.24, p < 0.05] in favor of the experimental female students. These findings show that the female students had significantly higher mathematics achievement scores than their male counterparts in the group learning treatment.

Table 7
Independent-Sample T-Test Comparing Means of Students' Mathematics Achievement Post-Test Scores Between Male and Female Students in The Experimental Group

Gender	n	Mean	SD	t	df	Sig(2-tailed)
Male	40	46.68	2.79	-2.24	82	0.02
Female	44	47.95	2.36			

Findings on gender differences indicated that group learning had significant effects on male and female students' performance after undergoing group learning treatment. The findings indicated that both male and female students showed significant improvement in their mathematics achievement in which female students significantly have done better than male students.

The effects of group learning on mathematics achievement between male students in the experimental and control groups

To determine the effects of group learning on mathematics achievement between male students in the experimental and control groups, an analysis of male students' pre and post test mean scores was conducted. Table 8 shows the pre-test mean scores for experimental male students was 25.31 (SD = 4.01) and that of conventional male students was 24.36 (SD = 3.53). The results reveal that the difference between pre-test mean scores of male students in the experimental and control groups [t (81) = 1.14, p > 0.05] is not significant at 0.05 alpha level. This suggests that the performance of male students in both groups were equivalent at the beginning of this study.

Table 8
Independent-Sample T-Test Comparing Means of Students' Mathematics Achievement Pre-Test Scores Between Male Students in The Experimental and Control Groups

Gender	n	Mean	SD	t	df	Sig(2-tailed)
Experimental male	40	25.31	4.01	1.14	81	0.25
Conventional male	43	24.36	3.53			

As shown in Table 9, the experimental male students scored post-test mean of 46.68 (SD = 2.79) which is higher than the conventional male students with post-test mean score of 34.59 (SD = 2.24). The difference between these two post-test means was significant t [(74.82) = 21.63, $p < 0.05$] in favor of the male students in experimental group which revealed that the performance of male students in experimental group was significantly better than the male students in control group.

Table 9
Independent-Sample T-Test Comparing Means of Students' Mathematics Achievement Post-Test Scores Between Male Students in The Experimental and Control Groups

Gender	n	Mean	SD	t	df	Sig(2-tailed)
Experimental male	40	46.68	2.79	21.63	74.82	0.00
Conventional male	43	34.59	2.24			

The effects of group learning on mathematics achievement between female students in the experimental and control groups

To determine the effects of group learning on mathematics achievement between female students in the experimental and control groups, an analysis of female students' pre and post test mean scores was also conducted. Table 10 shows the pre-test mean scores for experimental female students was 25.22 (SD = 3.44) and that of conventional female students was 26.46 (SD = 3.40). The results reveal that there is no significant difference between pre-test mean scores of female students in the experimental and control groups [t (83) = -1.66, $p > 0.05$].This suggests that performance of female students in both groups were equivalent at the start of this study.

Table 10
Independent-Sample T-Test Comparing Means of Students' Mathematics Achievement Pre-Test Scores Between Female Students in The Experimental and Control Groups

Gender	n	Mean	SD	t	df	Sig(2-tailed)
Experimental female	44	25.22	3.44	-1.66	83	0.10
Conventional female	41	26.46	3.40			

As described in Table 11, the experimental female students scored a mean of 47.95 (SD = 2.36) which is higher than the conventional female students with post-test mean score of 35.37 (SD = 1.64). The difference between these two post-test means was significant [t (76.71) = 28.68, $p < 0.05$] in favor of the female students in experimental group which revealed that the performance of female students in experimental group was significantly better than female students in control group. Hence these suggest that the group learning treatment showed positive impact in improving female students' mathematics achievement.

In addition, Table 9 shows that experimental male students outperformed the conventional male students, and Table 11 indicates that experimental female students outdone the conventional female students. It was found that both experimental male and female students showed significant improvement in their mathematics performance in comparison to conventional male and female students. On the whole, Table 7 reveals that the experimental female students outperformed the experimental male students after group learning implementation.

Table 11
Independent-Sample T-Test Comparing Means of Students' Mathematics Achievement Post-Test Scores Between Female Students in The Experimental and Control Groups

Gender	n	Mean	SD	t	df	Sig(2-tailed)
Experimental female	44	47.95	2.36	28.68	76.71	0.00
Conventional female	41	35.37	1.64			

Results presented above suggest that there is significant effect of group learning on mathematics achievement, hence, a significant effect on gender-related differences in mathematics achievement. The results showed that the experimental students significantly improved their mathematics achievement in comparison to conventional students. The findings indicated that both the male and female students

enhanced their mathematical performance in which the performance of female students was significantly better than that of male students in the experimental group after group learning intervention.

For group learning effects, the post-test results of experimental and control groups in students' mathematics achievement showed remarkable differences. Experimental students significantly outperformed conventional students in learning mathematics. The findings of this study, therefore, are consistent with the results of similar studies, as shown by the studies of Johnson and Johnson (1994), Whicker et al. (1997) and Jacobs et al. (1996). The findings of this study are also consistent with studies by Effandi (2003), Lee (1999), Faizah (1999), Ozsoy and Yildiz (2004) and Zakaria et al. (2010). Zakaria et al. in their study concluded that student-centered approaches such as group leaning improved mathematics achievement, and teachers in schools who teach mathematics need to be aware of the benefits and importance of group learning and thus changing the practice of teacher-centered teaching method to student-centered teaching method. Findings of our study however, are in contrast to the findings by Mwerinde and Ebert (1995). Mwerinde and Ebert found that their conventional group did better than the experimental group. Baseline assessments showed that the experimental group is more mathematically experienced but the conventional group achieved higher grades. However, the composition of cooperative groups in the experimental group was not properly structured; hence this may lead contradictory results where students from the control group scored higher grades.

With regards to gender-related differences, the findings revealed that the female students outperformed the male students in the experimental group after group learning treatment. It was found that female students benefit more than male students from group learning and group learning is more effective for female students in comparison to male students. This finding is consistent with research by Joiner (1999) while it is in contrast to the findings by Kolawole (2007) who found male students performed better than female students in group learning.

Conclusions and Recommendations

In this research study, group learning had significant effects on students' mathematics achievement, and gender-related differences in the effects of group learning in terms of mathematics achievement was also significant. At the pre-treatment stage, both the experimental and conventional groups had low overall scores of students' mathematics achievement. The performance of both experimental and conventional groups was equivalent prior to the implementation of group learning. After the treatment, the experimental group showed improvement in their mathematics achievement as evidence, based on the increase in students' mathematical performance in the post-test. The results suggested that the increase of students' mathematical performance in the experimental group was due to the significant effects of group learning treatment.

Additional supportive findings also revealed that the students in the experimental group found their mathematics class to be more interesting after group

learning intervention and that they learned how to work cooperatively to achieve shared group goals. The data generated from the interview illustrated that the teachers were very positive with their comments toward the implementation of group learning in the mathematics classrooms. With group learning, students who were initially shy and quiet eventually gained confidence to speak and improve their confidence in mathematics class. The comments highlighted from the interview sessions showed that the introduction of group learning in the mathematics classrooms encouraged students to be motivated and had more ideas to discuss with their group members.

The findings also disclosed that overall performance of both the male and female students was significant while the female students outperformed the male students on mathematics achievement in the group learning mode. As such it can be concluded that group learning can make a significant difference in achievement for female students without negatively affecting male students' performance.

Since the findings of this study have shown a great improvement in students' mathematics achievement and the teachers' perceptions on the implementation of group learning are positive, therefore, the implications for this study are:

i. Group learning can successfully be used in secondary school context in Bangladesh with the aim to enhance students' mathematics achievement,

ii. Since the overall performance of both the male and female students was significant while female students outdone male students in the experimental group, group learning should be further use especially for the female students. Therefore, group learning may be a tool that can be professionally implemented to improve female students' performance in secondary schools in Bangladesh.

iii. Education authorities in Bangladesh should encourage secondary teachers to use group learning and teacher education institutions to make it part of their training curriculum content.

It is hoped that the results of this study would be significant to students, teachers, educators and policy makers in education. The research findings can offer an understanding of the strengths of the implementation of group learning approach from the view point of practicing teachers and students. Since the teachers and students are directly involved in the situation, they are the most appropriate persons to offer insights into the matter.

For educators, they can evaluate mathematics teaching methods that are suitable with students. Teachers may apply group learning in their teaching instruction in order to enhance students' performance in mathematics. This study can become an inspiration for teachers to motivate students to succeed in mathematics teaching strategies in secondary schools. For policy makers, it is hoped that this study can become their source of information with regard to new approach in teaching mathematics. Taking consideration into the findings of this study, they can also help

the education authorities to achieve the nation's goals and objectives in improving quality of mathematics education.

The findings of this study would also contribute some guidelines on prevailing mathematics teaching and learning strategies of secondary mathematics that will be beneficial for students, teachers, educators and policy makers including educational sector in Bangladesh. The findings of this study may assist policy makers and teachers to identify appropriate measures that could promote group learning in mathematics classrooms. This study may encourage future studies to examine closely the positive effects of group learning on students' mathematical performance and to develop a more adequate explanation of the effects of group learning.

Based on the conclusion, it is recommended that further comparative studies be undertaken not only on gender differences, but also between rural and urban learners, between different types of schools such as government and non-government schools. The present study was delimited to the area of mathematics learning only. Further study could be conducted for teaching and learning of English, Bangla, Physics, History, Geography and any other educational perspectives.

References

Ali, M.A. (1987). *Pathdan paddhati-o-sreni sangathan*. Dhaka: Bangla Academi.

Berg, K., & Latin, R. (1994). *Essential of modern research methods.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Board of Intermediate and Secondary Education (BISE).(2005). *Board summary of the secondary school certificate examination-2005* (Rajshahi). Dhaka: Ministry of Education.

Byrnes, J.P. (2005). Gender differences in mathematics: Cognitive processes in an expanded framework. In A. Gallagher & J. Kaufman (Eds.). *Gender differences in mathematics: An integrative psychological approach*. New York: Cambridge University Press.

Campbell, D.T., & Stanley, J.C. (1963). *Experimental and quasi-experimental design for research.* Chicago: Rand Mcnally College Publishing Company.

Davidson, N. (1990). *Cooperative learning in mathematics: a handbook for teachers.* CA: Addison-Wesley Publishing Company.

Effandi, Z. (2003).*The effects of cooperative learning on students in a matriculation mathematics class*. Ph.D thesis. Universiti Kebangsaan Malaysia.

Faizah, M. G. (1999).*Kesan Pembelajaran koperatif menggunakan alat ujian pencapaian dalam matematik*. Projek Penyelidikan Sarjana Pendidikan.Universiti Kebangsaan Malaysia.

Halpern, D.F. (1997). Sex-differences in intelligence: implications for education. *American Psychologist*, 52:1091-1102.

Hyde, J.S., Fennema, E., &Lamon, S. (1990). Gender differences in mathematics performance: A meta-analysis. *Psychological Bulletin*, 107, 139-155.

Hyde, J.S., Lindberg, S.M., Linn, M.C., Ellis, A., & Williams, C. (2008, July 25). Gender similarities characterize mathematics performance. *Science*, 321, 494-495.

Jacobs, D.L., Watson, T.G., Sutton, J.P., & Jones, B. (1996). Effects of cooperative learning method on mathematics achievement and affective outcomes of students in a private elementary school. *Journal of Research and Development*, 29(4): 195-202.

Johnson, D.W., & Johnson, R.T.(2004). *Assessing students in group*. California: Corwin Press.

Johnson, D.W., & Johnson, R.T. (1994).*Learning together and alone*. London: Allyn and Bacon.

Johnson, D.W., Johnson, R.T., & Smith, K.A. (1998). *Active learning: cooperation in the college classroom.* Edina, MN: Interaction Book Company.

Joiner, K. (1999). *Training and evaluating reform in calculus: a social, technological, psychological, instructional and curricular perspective on educational reform*. Ph.D thesis. Curtin University of Technology.

Kalimullah, K. (1996). *Secondary algebra* (class IX-X). National Curriculum and Textbook Board in Bangladesh, Dhaka.

Kolawole, E.(2007). Effects of competitive and cooperative learning strategies on academic performance of Nigerian students in mathematics. *Educational Research and Design*, 3:33-37.

Lee, G.E. (1999). *Pembelajaran koperatif dan kesannya ke atas pencapaian kemahiran penyelesaian masalah matematik teras tingkatan 4 di sebuah sekolah di Daerah Kota Setar.* Kedah, Malaysia.

Leedy, P.D.,& Ormrod, J.E. (2001). *Practical research planning and design.* New Jersey: Merrill Prentice Hall.

Linn, J.S. & Peterson, A.C. (1985). Emergence of characterization of sex differences in spatial ability: A meta-analysis. *Child Development*, 56, 1479-1498.

Mwerinde, P., & Ebert, C. (1995). An examination of the relationship between the problem-solving behaviour and achievements of students in cooperative learning groups. *Paper presented at the annual meeting of the North American chapter of the international grou for the psychology of mathematics education, Columbus, Ohio*. ERIC Document Reproduction. Service No. ED 389572.

Nurunnabi, M.K., & Kuddus, D.M. (1996). *Secondary geometry* (class IX-X). National Curriculum and Textbook Board in Bangladesh, Dhaka.

Ozsoy, N., & Yildiz, N. (2004).The effect of learning together technique of cooperative learning method on student achievement in mathematics teaching 7th class of primary school. *Turkish online Journal of Educational Technology*, 3:49-54.

Rimmerman, H. (2004).*Resources in cooperative learning.* San Clemente, CA: Kagan Publishing.

Samad, M.A. (2005). *Ganit shikkha-o-prashikkhon.* Dhaka: Samad Publication and Research.

Sax, L. (2005). *Why gender matters: what parents and teachers need to know about the emerging science of sex differences*. New York: Doubleday.

Steinback, M., & Gwizdala, J. (1995). Gender differences in mathematics attitudes of secondary students. *School Science & Mathematics*, 95(1): 36-41.

Whicker, K.M., Bol, L., & Nunnery, J.A. (1997). Cooperative learning in the secondary mathematics classroom. *Journal of Educational Research*, 91, 42-48.

Zakaria, E., Chin, L.C., & Yosoff, D.M. (2010). The effects of cooperative learning on students' mathematics achievement and attitudes towards mathematics. *Journal of Social Science*, 6(2), 272-275.

APPENDIX A

MATHEMATICS ACHIEVEMENT TEST (MAT)

Part A: Demography

Please tick (√) the relevant responses:

i. Gender

___ Male

___ Female

ii. Roll No.

Part B: Mathematics Questions Full Marks: 50

1. If $x+\frac{1}{x}=\sqrt{3},$ prove that $x^3+\frac{1}{x^3}=0$

2. Analyze the following:

$$x^2-(a+\frac{1}{a})x+1$$

3. Prove that

$(i)\sin^2\theta+\cos^2\theta=1$

$(ii)\cos 3\theta=4\cos^3\theta-3\cos\theta,$ if $\theta=30^0$

4. Prove the following:

If $a+b=\sqrt{3}$ and $a-b=\sqrt{2},$ prove that $8ab\left(a^2+b^2\right)=5$

5. Analyze the following:

$(i)x^2+3x-a^2-a+2$

$(ii)a^3+b^3$

6. (i) ABC is a triangle, prove that AB + BC > AC

(ii) Construct a centre to a given circle.

7. Prove the following:

(ii) If $a+b=c,$ prove that $a^3+b^3+3abc=c^3$

(ii) If $x+y+z=0,$ prove that $x^3+y^3+z^3=3xyz$

8. Analyze the following:

$(i) ab+a-b-1$

$(ii) a^4+4$

9. Find the common factor:

$a^2-b^2-c^2-2bc,\ b^2-c^2-a^2-2ca,\ c^2-a^2-b^2-2ab$

10. Prove the following:

If $p=3+\frac{1}{p},$ prove that $p^4=119-\frac{1}{p^4}$

11. Analyze the following:

$a^3-9b^3+(a+b)^3$

12. Prove the following:

If $a+b=m, a^2+b^2=n, a^3+b^3=p^3,$ prove that $m^3+2p^3=3mn$

13. Analyze the following:

$(i)\ a^2-b^2$

$(ii) x^4+27x$

14. (i) If $\sin\theta + \cos\theta = a$ and $\sec\theta + \operatorname{cosec}\theta = b,$ prove that $b(a^2 - 1) = 2a$

(ii) Prove that $\cos^2 30^0 - \sin^2 30^0 = \cos 60^0$

15. Calculate the following:

$(i) a^3 - b^3$

$(ii)(a+b)^2 - (a-b)^2$

16. (i) ABC is a triangle, prove that $\angle A + \angle B + \angle C = 180^0$

(ii) Construct a square equal in area which area is given.

17. Simplify the following:

$$(4x + 7y - 3z)^2 + 2(4x + 7y - 3z)(7y - 4x + 3z) + (7y - 4x + 3z)^2$$

18. Show that $\left\{\left(\frac{x+y}{2}\right)^2 - \left(\frac{x-y}{2}\right)^2\right\}^2 = \left(\frac{x^2+y^2}{2}\right)^2 - \left(\frac{x^2-y^2}{2}\right)^2$

19. Analyze the following:

$(i)\ \sqrt{2}\ x + 2x^2$

$(ii)\ 2x^2 - 8y^2$

20. Prove the following:

If $\left(a+\frac{1}{a}\right)^2 = 3,$ prove that

$$a^3 + \frac{1}{a^3} = 0$$

Source: Kalimullah, 1996; Nurunnabi and Kuddus, 1996.