

# Effects of using Teams Games Tournaments (TGT) Cooperative Technique for Learning Mathematics in Secondary Schools of Bangladesh

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## ABSTRACT

Games-based learning has captured the interest of educationists and industrialists who seek to reveal the characteristics of computer games as perceived by some to be a potentially effective approach for teaching and learning. Despite this interest in using games-based learning, there is a dearth of studies on the context of gaming and education in Third World countries. This study investigated the effects of game playing on performance and attitudes of Grade VIII students toward mathematics. The study implemented TGT technique for the experimental group and typical lecture-based approach for the control group. The same achievement test was employed in both pretest and posttest; an inventory of attitudes towards mathematics was applied for the pretest and posttest on TGT experimental and control group, an attitude scale on computer games was employed for the TGT experimental group, a semi-structured interview for the teacher and an FGD guideline for students were applied to serve the purpose of research objectives. After three weeks of intervention, it was shown that the TGT experimental group students had achieved a significant learning outcome than the lecture based control group students. Attitude toward mathematics differed to a certain positive extent in the TGT experimental group. Based on these findings, some recommendations were made to overcome barriers to integrating web-based game playing into the classroom.

**Keywords:** *Teams Games Tournaments, Web-based Game playing, Cooperative Learning, Game playing integration with learning.*

## INTRODUCTION

LOW math achievement, particularly in rural secondary schools, is a significant concern in Bangladesh. A study conducted by Morshed (2013) has identified from several national studies that secondary students' math performance was among the lowest of all school subjects. He further revealed that many secondary level students even failed to display sufficient competence on the basic mathematical skill set for primary level education in Bangladesh. However, the Bangladesh government had focused on the issue and initiated a Junior School Certificate exam in 2010 where everything from course curriculum to teaching techniques, teacher's module have been revised and changed according to international criteria. The government has emphasized most in creative questions rather than the just within-book typical set of questions. A report ("Report Casts Shadow", 2014) appearing just after the JSC exam held for 2014 noted that 60% of the mathematics questions were entirely creative.

Though the Government had come up with the creative question technique, some students are reaching, yet not exceeding math proficiency levels; they continue to achieve below the mathematics proficiency level. This underachievement among secondary students is attributed to several factors which may consist of improper preparation for teaching mathematics, teachers' lack of continued participation in

professional development and, most importantly, lack of implementation of effective instructional strategies in the mathematics classroom hence failure to get students sufficiently motivated for problem solving.

It had been studied from a few decades back that cooperative learning had a direct contribution to successful learning outcomes. But Wyk (2011) identified that educational practitioners are reluctant to carry out this technique on students. While cooperative learning as an instructional methodology is an option for teachers, it is currently the least frequently applied in the classroom. Teachers could no longer depend on direct instruction alone as a primary method of instruction; the expectation that young secondary school students thrive in a teacher-focused, textbook-centered classroom hour-after-hour and day after day is at the very least naïve.

In 2013, Tran noted that previous studies have been conducted in different settings of education, using different kinds of CL techniques. Such techniques are Learning Together (LT), Jigsaw Grouping, Teams-Games-Tournaments (TGT), Group Investigation (GI), Student Teams Achievement Division (STAD), and Team Accelerated Instruction (TAI). The Education For All Global Monitoring Report (2013/14) published that the digital classroom can enhance learning and bridge the knowledge and skills gaps among less qualified teachers. It further focused on the innovation in using technology that can support improved learning by enriching teachers' curriculum delivery and encouraging flexibility in pupil learning. In this study, the researchers tried to generate a small contribution to the literature by making students undergo the TGT cooperative technique to see if they come up with effective learning outcomes and enhanced attitude toward mathematics.

### **Statement of the Problem**

Although the Bangladesh Government had thought of integrating ICT into the classroom and placed a huge number of multimedia equipment in secondary institutions, there was still a stereotyped teacher-centric mathematics teaching-learning phenomenon carried out especially in rural areas. Therefore previous studies of TGT in a new setting -- computer gaming for mathematics learning in the rural context-- should give a valuable contribution to recognize the effectiveness of this cooperative learning technique.

### **Research Objectives**

The study was conducted to explore the effectiveness of one of the talked about instructional technologies -- TGT or Teams-Games-Tournaments -- in secondary schools of Bangladesh.

### **Specific Objectives**

The study had the following objectives:

- To identify effectiveness of TGT (Teams-Games-Tournaments) cooperative web-based game-playing for learning mathematics.
- To ascertain the attitudinal differences of students on mathematics after TGT cooperative web-based game-playing especially in mathematics
- To recognize the effect of students' attitude towards computer game on their learning outcome.

### Research Hypotheses

The following hypotheses were tested in the study:

**H<sub>01</sub>:** There is no significant difference between posttest scores of the control group and experimental group.

**H<sub>02</sub>:** There is no significant attitude difference toward mathematics between pretest and posttest of the experimental group.

**H<sub>03</sub>:** There is no significant effect of TGT technique on both Males and Females in the experimental group.

**H<sub>04</sub>:** There is no significant correlation between posttest score of the experimental group and their attitude toward computer games.

### Methodology of the Study

The study was basically a quasi-experimental (pretest-posttest) design in nature. But data were collected through mixed approach. Qualitative data were also collected to support the quantitative part and for triangulation. This section will discuss the research design, strategy, sampling, data collection method and tools, data collection and analysis procedure. Four types of tools were used to collect data according to the objectives determined previously. The tool categories are the Achievement Test, Opinion checklist, Focus Group Discussion (FGD) Guideline, and Semi-Structured Interview Schedule.

### Population and Sample of the Study

Grade eight students in secondary schools of all districts of Bangladesh formed the population of the study. The preference has been given to those students who are having basic computer operational skills and who have played with leisurely games before on the computer. Mathematics teachers of secondary schools are also the population of this study. As it was a small scale research, it was not possible for the researcher to take a sample from all over the country. Thus, the area of the study is one sub-district / Upazila. "Faizun-Nesa High School" has been selected as the sample. In this study, the sample group is the grade eight students with basic computer operational skills and mathematics teachers. The sample group consisted of two categories: Students in Grade 8 and Mathematics Teacher in Grade 8.

Eighty-six participants were drawn from two intact eighth-grade classes from "Faizun-Nesa High School". Participants were from two sections in the same grade of eight from which 'Section A' was drawn as the Experimental group and 'Section B' was selected as the Control group purposively. Participants from both sections were not varied by merit positions because both sections had students with the same roll number. Furthermore, participants were varied by gender (50% Female in the Experimental Group and 40% Female in the Control).

### Rationale of the study

Mathematics became one of the feared subjects for several students because several concepts in mathematics ask them to analyze and think abstractly (Purwanti, 2013). Grade Eight in the Bangladesh context is a period when students are about to explore their expertise in themselves and going to choose a major stream which will decide their future career. In this period, affection for Mathematics should keep forward as in future students from every stream will have to face and solve mathematical analytical tasks. TGT was selected because it was a cooperative technique using both group rewards and individual accountability (Ke, 2008). This study identified the effectiveness of TGT learning strategy incorporated with web based games in mathematics learning on grade eight students. The current study added to the literature by investigating the impact of CL in the Bangladesh context. Specifically, it reported the results of an

experimental study designed to determine if TGT cooperative learning was more effective than lecture-based learning in improving achievement and attitudes toward mathematics among grade eight students.

### Definitions of the Terms: Teams-Games-Tournaments (TGT)

Teams-Games-Tournaments (TGT) was originally developed by David DeVries and Keith Edwards (1972) at the Johns Hopkins University. It is a type of cooperative learning method. The students compete with members of other teams to contribute points to their team score. Students compete in at least three-person "tournament tables" against others with a similar past record in mathematics. After then a procedure changes table assignments to keep the competition fair. The winner at each tournament table brings the same number of points to his or her team, regardless of which table it is; this means that low achievers and high achievers have an equal opportunity for success. High performing teams earn team rewards.

### Concept of Cooperative Learning (CL)

Slavin (2011) defined cooperative learning as an instructional method in which teachers organize students into small groups, and they then work together to help one another learn academic content. In cooperative learning, students work together in small groups on a structured activity. They are individually accountable for their work, and the work of the group as a whole is also assessed. Cooperative groups work face-to-face and learn to work as a team. An empirical study conducted by Whicker, Bol, and Nunnery (1997) revealed the necessity of cooperative learning for fostering mathematics education. This learning pedagogy had been widely practiced around the whole world especially in developed countries. Studies have found positive effects on mathematics achievement of elementary and middle school students in one Israeli mathematics program that used cooperative learning strategies (as cited in Slavin, 2011).

### Learning Performance Difference of the Students

The first objective of this study was to determine whether there was any significant difference between the means of the achievement pretests of the students of the TGT-treatment and control groups. An independent *t*-test comparing the mean scores of the pretest and the posttest between the experimental group and control group was computed to determine if a significant difference existed. In order to reject or accept the hypothesis for this study, the *t*-test scores for both experimental and control groups were computed.

**Table 1 Mean Differences of Experimental and Control groups**

Group	N	Pretest Mean	SD	Posttest Mean	SD	Difference	<i>t</i> -value	2- tailed
TGT (Experimental)	43	11.85	8.58	24.56	8.42	12.71	-7.172	.000*
Lecture Method (Control)	43	7.90	7.00	9.65	5.81	1.75	-1.256	.213

\*  $p < .05$

Table 1 clearly shows a significant difference between pretest and posttest scores of the experimental group. From the descriptive statistics, it can be seen that on pretest they have  $M = 11.85$  whereas on posttest they have  $M = 24.57$ ,  $t(84) = -7.172$ ,  $p < .05$ . In this way, at the 95% confidence level the null hypothesis ( $H_{01}$ ) has been rejected. Therefore, the result revealed TGT is a more effective teaching technique compared to the lecture method for Mathematics education in grade eight.

Table 1 also shows no significant differences of pretests and posttests scores of the control group. On pretest they scored  $M = 7.90$  whereas on Posttest they scored  $M = 9.65$ ,  $t(84) = -1.256$ ,  $p > .05$ .

It was revealed that the experimental group (pretest mean of 11.85) and the control group (pretest mean of 7.90) have little similarity. After conducting the quasi-experiment, the reported posttest mean score for the experimental group was 24.56 ( $SD = 12.71$ ) compared to the control group of 9.65 ( $SD = 5.81$ ) which showed a remarkable and significant difference in scores. This showed that the experimental group had a 12.71 increase from pretest to posttest,  $t(84) = -9.66, p < .05$ . Further, from Table 1, the control group only showed a slight increase of 1.75 from pretest to posttest. When comparing the different means between the two groups, there was a (12.71 minus 1.75) or 10.96 difference between the increases of the experimental over the control group generally.

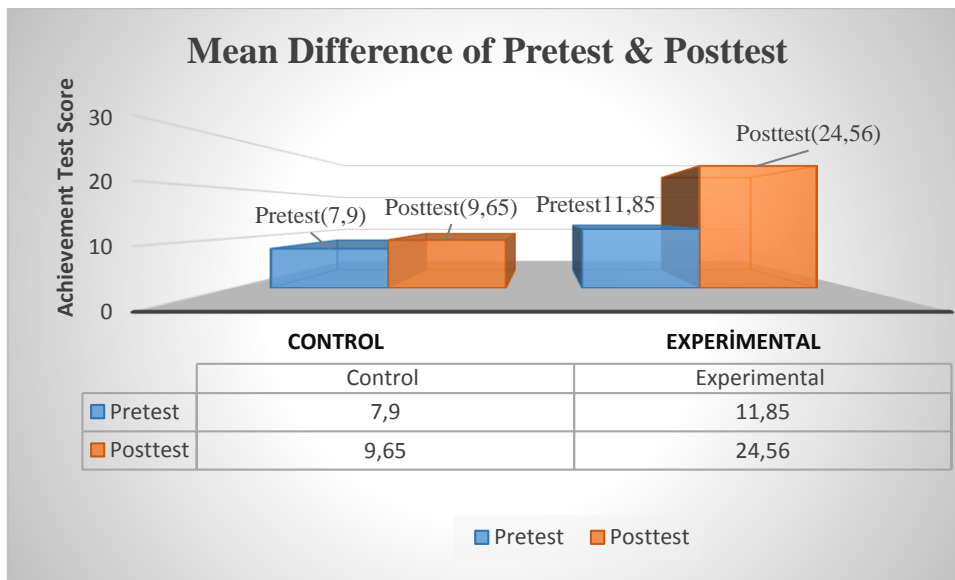


Figure 1. Mean differences of pretest and posttest of Experimental and Control group.

**Attitude Differences on Mathematics**

For measuring students’ attitude differences toward Mathematics before and after intervention of TGT instructions, the researcher tried to determine whether there was any significant difference between the means of the pretests and posttests of the experimental and control groups students. A paired *t*-test comparing the mean scores of the pretest and the posttest between the experimental group and control group was computed to determine if a significant difference existed.

**Attitude Difference on Control group**

“Paired Samples Correlations” showed if the results found are consistent. Paired Sample Correlations for the control group showed that none of the 16 statements under four factors of Sense of Security, Values, Motivation, Enjoyment revealed any significant differences; which was found through the significant value that not showed  $p < .05$ . Therefore it can be said that participants from the control group are not behaving consistently as their scores on the pretest are not significantly correlated with the posttest taken after the 3-week-period, and there might be some differences in their attitudes during 3-week period.

Table 2 Paired Samples Tests (Control Group)

Statement	Mean	SD	t- value	df	Sig (2-tailed)
“I am always confused in my mathematics class” (Factor: Sense of Security, Statement: 02)	-.58140	1.65087	-2.309	42	.026

Table 2 shows the factor or statement where the significant difference occurred between pretest and posttest mean scores among 16 statements. It clearly showed significant difference between Mean of pretest and posttest only on the 2nd among 16 statements,  $t(42) = -2.309, p < .05$ .

**Attitude Difference in Experimental group**

While conducting paired sample  $t$ -test for the experimental group, it was found that, like the control group, on Paired Sample Correlations none of the 16 statements revealed any significant value of  $p < .05$ . Therefore it can be recognized that participants from the experimental group are not behaving consistently before and after as their scores in the pretest are not significantly correlated ( $p > .05$ ) with the posttest taken after 3-week-period of TGT.

**Table 3 Paired Samples Tests (Experimental Group)**

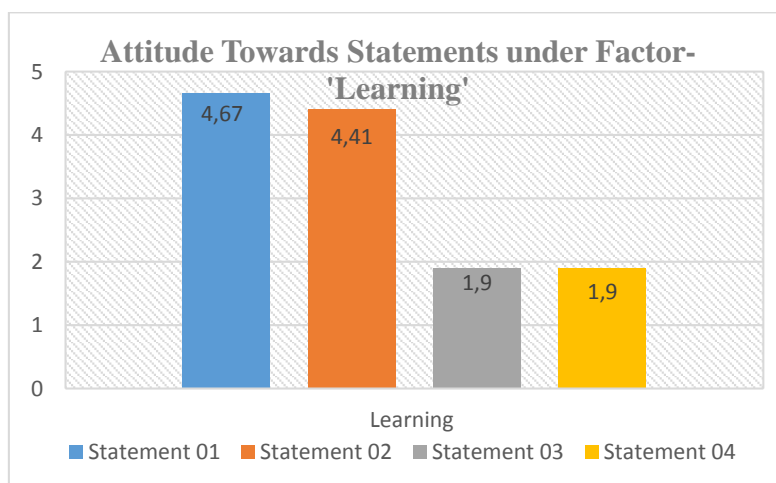
Serial	Statement	Mean	SD	t- value	df	Sig (2-tailed)
01.	“I like any other subject rather than mathematics” (Factor: Value, Statement: 02)	2.24	1.56	-8.491	45	.000*
02.	“I want to develop my mathematics skills” (Factor: Enjoyment, Statement: 04)	-1.96	1.57	9.697	45	.000*

\*  $p < .05$

Data in Table 3 indicate that two pairs had significant difference in their Mean Difference. Under the factor of Value, statement 02, it was clearly evident that  $p < .05$  and the column ‘Mean’ informed the difference between Mean scores of pretest and posttest (pretest minus posttest), and it was 2.24. Under the factor of Enjoyment, statement 04, it was clearly evident a significant difference existed since  $p < .05$ . And the column-Mean informs the difference between Mean scores of pretest and posttest (pretest minus posttest), and it is -1.96. Therefore, the Null hypothesis ( $H_{02}$ ) has been rejected.

**Attitude Toward Web-based Computer Games on Learning**

For the four statements under the factor of learning, it was clearly visible by the Mean of 4.67 that on the first statement students were very supportive of the instructional practices they had undergone for the past 3 weeks. They were directly supporting the fact their concentration would increase if they are used to game playing for learning purposes.



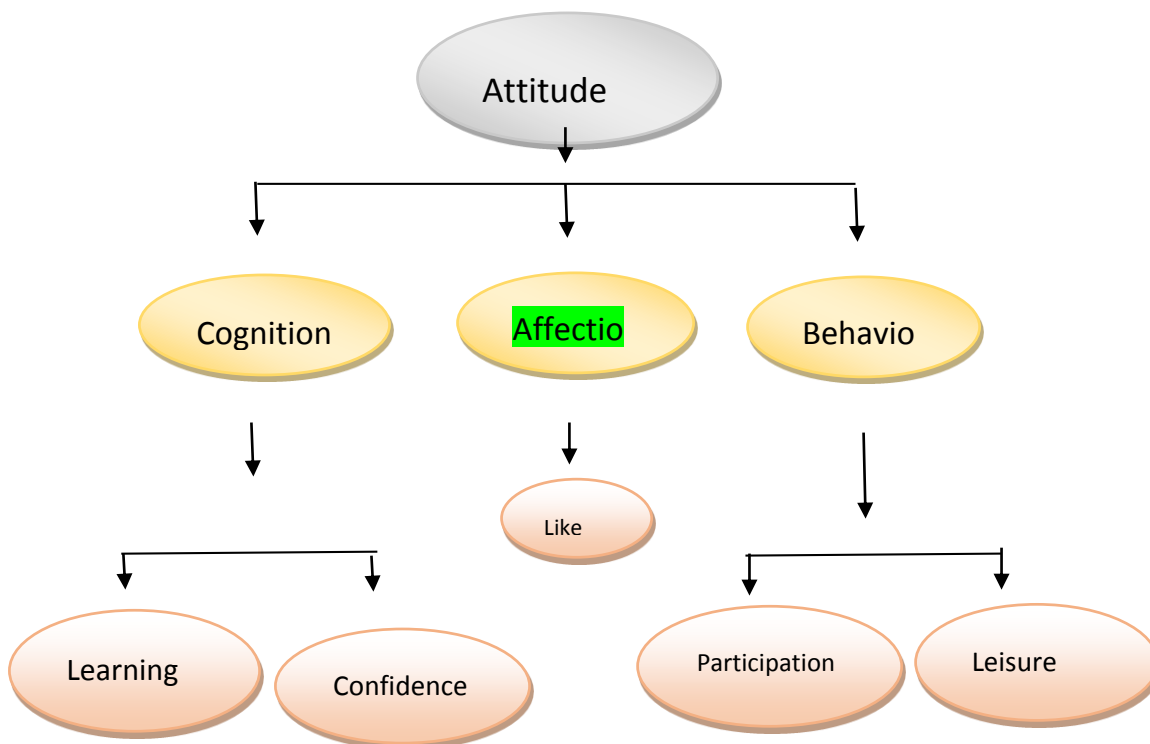
**Figure 2. Attitude toward Web-based computer games on Learning.**

Surprisingly, students disagreed (Mean of 1.90) on both statements 03 and 04. This indicated that they wanted games as a learning tool.

**Effect of TGT on Students' Attitude towards Web-based Computer Games**

An attitude scale toward Games as an instructional technology was put on to the students in the experimental group just after the 3-week period of TGT ended. As the scale consisted of 5 factors (Learning, Confidence, Liking, Participation, and Leisure) under 3 domains (Cognitive, Affection and Behavior) of attitudes with 20 statements within it, researchers were trying to run MANOVA (Multivariate Analysis of Variance) for identifying students' attitude toward games as an instructional tool. MANOVA would reveal if there were an effect of any group (e.g., gender) on the combined dependent variables of attitudes. It also disclosed the relationship between dependent variables (Hington, Brownlow, McMurray, & Cozens, 2004). In the current study, 20 statements each is a dependent variable.

While running MANOVA, Box's test revealed the significant level: 0.058 ( $p > .05$ ), so the result did not violate the homogeneity of variance assumption or homogeneity of covariance assumptions. Though the  $p$ -values were almost .05, value denoted that the variables under 3 domains would be acting in similar ways.



**Figure 3. Focusing attitude domains toward games as instruction.**

Table 4 informed the 20 variables under 5 factors of New Computer Games Attitude Scale were not together being influenced by the TGT cooperative learning method. In the table, Wilks's Lambda test was not significant, 0.265 ( $p > .05$ ), which indicated overall on every variable there was no significant effect of TGT technique on both Male and Female. Therefore, the null hypothesis (H03) has been accepted.

Table 4: Multivariate Test

Effect	Value	F	Sig.
Wilks's Lambda	0.490	1.300	.265**

\*\*  $p > .05$

Table 5 allowed looking at the homogeneity assumption for each of the 20 variables (Hington et al., 2004). A significant result indicated that the assumption had been violated. Four (4) among 20 variables revealed significant ( $p < .05$ ) results so on these variables of Learning-01, Confidence-03, Liking-04, Leisure-02 the assumption had been violated.

Table 5 Levene's Test of Equality of Error Variances

Serial	Statement	F	Sig.
01.	"I would be more willing to attend classes if computer games were used in class" (Factor: Learning, Statement: 01)	14.855	.000*
02.	"I would be happy if my test is taken through computer games score" (Factor: Confidence, Statement: 03)	11.027	.002*
03.	"I feel no interest on computer games" (Factor: Liking, Statement: 04)	6.764	.013*
04.	"I talk about computer games with my friends in my spare time" (Factor: Leisure, Statement: 02)	5.898	.019*

\*  $p < .05$

### Students' and Teachers' Perception on Learning Mathematics

A Focus Group Discussion (FGD) was conducted for helping the twelve participants among which six were from the experimental group and rest from the control group. Girls and Boys were selected through a simple random sampling process where equal numbers (three boys and three girls from each group) were considered. A semi-structured interview was conducted with the mathematics teacher to get his perception of teaching and learning mathematics.

From the interview schedule conducted by the mathematics teacher in grade eight, it was found that he was not a graduate; rather he had only a Higher Secondary Certificate. Nevertheless, according to him, the headmaster used to send him to different training programs offered by NGOs and GOs. Though he had undergone a little pedagogic training, he still is following the traditional approach to classroom teaching. When the TGT 3-weeks period had finished, the teacher was still not motivated enough to follow up with the method. During the interview, the teacher mentioned that educational practitioners must be warned not to let students get used to only play games rather than solving problems in paper-pencil format. This finding makes evident the critical need for sufficient training opportunities for teachers and participants.

The mathematics teacher showed his opinion regarding how the game technique could be implemented in the classroom. But his proposed implementation was the same as instructed by the researcher before beginning the TGT method; the teacher apparently showed little interest in adapting the method to learner needs..



## MAJOR FINDINGS OF THE STUDY

From the analysis and interpretation of data, the major findings of the study are given in the following:

### **Challenges of Teaching-Learning Practices on Mathematics**

The study school was way behind ineffective teaching-learning practices on mathematics. The researchers came up with some significant findings according to the data found from researcher's own observation, FGD by Students and Interview Schedule by the teacher.

**Not having enough teachers:** The school had only one mathematics teacher for both sections in grade eight. He had to take classes in grade six, seven and eight. So it put much pressure on him to conduct effective mathematics classes for all the grades.

**Teacher's low pedagogic profile:** The mathematics teacher in grade eight had a very low pedagogic profile to conduct interactive classes to motivate students to their utmost satisfaction. The teacher was only a Higher Secondary graduate with insufficient pedagogic training. Hence, he used to give threat to students to manage the classrooms which ultimately led to immense chaos. Though the school already had a trained graduate teacher in mathematics, he only taught upper grade classes, namely grades nine and ten. Students were also aware of their math teacher's profile and wanted him to be replaced by a teacher who could integrate technology into learning.

**Minimal ICT Infrastructure set-up:** The whole school had only four laptops with only one modem which were completely insufficient for covering five classes (grade VI to X) and 10 sections (two sections for each class). Schools may need to ensure at least one computer with a modem is available in each classroom for the ideal use of ICT in regular teaching-learning.

**Schools position:** The school was quite remote geographically and was often called an island by the teacher. Thus, it had very low communication in terms of the vehicle, internet and regular contacts of NGOs or GOs. As the school was situated in a very rural area without satisfactory communication with mid-urban areas, it had very low network coverage by almost all the internet services provided in Bangladesh; thus it was difficult for stakeholders to be up to date with the current trend of teaching-learning.

**Lack of proper resource utilization:** Proper resource utilization was lacking. The school had already been provided with 4 laptops with a modem by an NGO. Teachers had been frequently called for the various Government-funded training programs, but they were reluctant to transfer the expertise gained from training to their classrooms even though students were willing to learn and practice ICT skills and integrate these skills with their subject knowledge.

**A huge number of students in a classroom:** Both the teacher and students in grade eight claimed this was one of the major problems. They had quite a large number of students in each section. It relatively hampers classroom management and concentration of students.

### **Impacts of TGT Techniques in Classroom**

Researchers came up with some significant findings according to the data found from the achievement test, attitude surveys of ATMI & NCGAS by students:

**Student Learning Outcome:** Overall students from both experimental group and control group were same in their merit as both groups had similar roll numbers in the respective classrooms. But after the experimental group students had undergone the TGT method they showed tremendous learning outcome as expected. It clearly disclosed the effectiveness of the TGT method. Therefore, if both groups of students were being provided with this type of Instructional technologies, there would be a chance for them to gain accordingly.

**Students' Attitude toward Mathematics:** Students from the experimental group showed a positive attitude toward mathematics more than students from the control group. It also indicated that TGT game playing was effective for them. Students in the experimental group have relatively increased their positive attitude toward mathematics on all four factors of Sense of Security, Values, Motivation and Enjoyment.

**Students' Attitude toward Games:** Students in terms of gender (Male and Female) had no significant effect on TGT technique of game playing. But apart from multivariate statistics there has been found that three variables under three different factors (Learning, Confidence, and Leisure) were being correlated with posttest scores of the experimental group.

## RECOMMENDATIONS

Based on the research findings, the following are some recommendations:

- The study was continued for a 3-week period and students in the experimental group showed very little attitude difference on mathematics. But it could be suggested to extend the treatment period for at least 4-6 weeks in 4-6 different topics to reveal more attitude difference under different factors.
- It was found out that gender had no significant effect on TGT technique in terms of overall attitude toward game playing for learning purposes. Therefore, it might be suggested to put on the technique for at least 4-6 weeks to change the overall positive attitude toward game playing on both male and female.
- It was quite difficult to run this type of new technique through the direction of a teacher with improper pedagogic skill. Therefore, it might be recommended to recruit teachers with sufficient ICT skill as well as pedagogic skills for conducting the classes.
- Though it was estimated to complete each TGT cooperative method within single 40-minute class session, it was not possible for the teacher to complete it within the time frame; it took almost 60 minutes to complete whole session. So, as suggested by the students, TGT technique can be employed in an after school program so that other school subjects would not be affected.
- Goals and expectations needed to be clearly informed every time participants are to work in groups. In addition, the teacher needs to consider if the classroom activity justified the use of cooperative learning versus individual learning.

## CONCLUSION

Since the sample was limited to only 86 eighth-grade students and a teacher who had implemented three topics: "Measurement", "Algebraic Equations and Application" and "Algebraic Fraction" from the curriculum and for the duration of only 3 weeks, any generalizations drawn from this study should be considered with caution. The experimental group had a 12.71 increase from pretest to posttest. Since the control group had undergone the same traditional lecture method as before, they had only a 1.75 increase from pretest to posttest. There was a 10.96 difference between the increases of the experimental over the control group. It was obvious from the results of this investigation that there were significant differences in the achievement scores (mean 24.56) of students who were exposed to TGT as a cooperative learning teaching technique compared to the lecture teaching method.

In the present study no significant difference in attitude toward Mathematics from 16 statements in the paired-sample *t*-test was found from control groups except for the Second statement. It was a negative statement telling: "I am always confused in my mathematics". Though the mean difference of 0.58 is little from pretest to posttest, but it showed a significant difference leading students to less confusion in the classroom. On the other hand, only two pairs (Label: Value 02 and Enjoyment 04) showed a significant difference after the treatment period on the Experimental group. On value 02 the statement was: "I want to develop my mathematics skills" and on Enjoyment 04 the statement was Negative: "I like any other subject rather than mathematics". On the pretest participants scored a Mean of 2.65 on Value 02 variable but after the treatment it increased to 4.61. That means the TGT cooperative method made a 1.96 positive difference

on their perception. Furthermore, on Negative statement of Enjoyment 04 participants in experimental group scored a Mean of 4.67 on the pretest but after undergoing the treatment they had a relatively lower Mean of 2.43.

The mathematics teacher in the studied school had insufficient pedagogic skill to make the learning enjoyable and accessible to students. While mismanagement and chaos occurred in the classroom he used to misbehave with students to manage the classroom which ultimately led to an adverse situation. Though the study school had four laptops with a modem, these were not applied for teaching-learning practices; rather the equipment was usually used by the teachers for their personal tasks. Traditional teaching materials had been used for many decades but in this era of educational technology students should be involved in sustainable digital learning. The experimental group students from this study suggested some other subjects that could also be taught through TGT technique, for example, Science and Information and Communications Technology in all levels of education.

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