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Effects of Student Teams Achievement Division (STAD) on Academic Achievement, and Attitudes of Grade 9th Secondary School Students towards Mathematics

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Abstract

This study investigated the effect of cooperative learning on the academic achievement in mathematics and attitudes of 74 9th-grade mathematics students toward mathematics in a high school in Vietnam. Using a pre-test-post-test nonequivalent comparison-group design and t test for independent samples, it was found that after approximately 5 weeks students (n = 36) who were instructed using cooperative learning achieved significantly higher scores on the mathematics post-test than did students (n = 38) who were instructed using lecture-based teaching, t (72) = 2.68, df = 58.49, p < .05. The results of this study also reported that the experimental group had significantly higher scores than the control group on both Enjoyment and Value scales of attitudes toward mathematics (t (72) = 2.81, df = 53.68, p < .05; t (72) = 2.86, df = 55.58, p < .05, respectively). The study concluded that cooperative learning was effective in improving the academic achievement level of participating students, and in promoting the positive attitudes of students toward mathematics in the level of Vietnamese high schools.

Keywords: Cooperative learning, STAD learning, achievement, attitudes

1. Introduction

One of the major objectives of teachers is to effectively use instructional strategies to improve students' cognitive and affective outcomes. In recent years, studies involving cooperative learning, one kind of student-centered approach such as methods have emerged as an internationally important area of social science research among researchers (Slavin, 2011). Many studies have been conducted in different settings of education, using different kinds of cooperative learning 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). A series of research studies has found a appreciate relationship between the higher cognitive and affective outcomes and cooperative learning approaches (Johnson & Johnson, 2005; Tran & Lewis, 2012). In the setting of Vietnamese secondary schools lecture-based teaching, one kind of traditional approach has been still the most prevalent instructional approach (MOET, 2009; Harman & Nguyen, 2010). In comparison with cooperative learning, lecture-based teaching has been reported to be less effective to the demands of high rates of cognitive and affective outcomes (Johnson & Johnson, 2005). In order to engage students in learning and to improve students' cognitive and affective outcomes, an alternative to lecture-based teaching could be cooperative learning (Tran & Lewis, 2012a,b&c). In order to encourage students to improve their achievement and promote more positive attitude an alternative to lecture-based teaching could be Student Teams Achievement Divisions (STAD), one kind of cooperative learning approach (Slavin, 2011).

2. Literature Review

2.1 Definition of Cooperative Learning

Cooperative learning comprises *"instructional methods in which teachers organize students into small groups, which then work together to help one another learn academic content"* (Slavin, 2011, p.344). Cooperative learning consists of five basic elements: positive interdependence, promotive interaction, individual accountability, teaching of interpersonal and social skills and quality of group processing. Cooperative learning has demonstrated the academic, social, affective and psychological growth of students who work together in groups

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(Johnson & Johnson, 2008). Student Teams Achievement Divisions (STAD) is one of Slavin's cooperative learning approaches. To apply this approach, teachers should follow the basic steps: (1) form groups of four or five students, (2) identify the objectives and focus on outcomes of course expected, (3) explain the process, and present new information to students, (4) give students sufficient time to understanding the materials, (5) give worksheets to students so that students may help one another learn materials through quizzing and group discussions, (6) test students' understanding in both the individual student and group levels through quizzes to see the expected outcomes, (7) score the quizzes and give each individual student in each group an improvement score, and (8) add the individual improvement score to give a group score.

2.2 Research on cooperative learning

The effectiveness of cooperative learning has received more universal attention because many positive research findings on cooperative learning are illustrated in the literature. Many different researchers in different academic fields undertook experimental studies to compare the effects of the cooperative learning pedagogy and the traditional learning pedagogy on student learning and other outcomes. These varied fields are as follows: social studies (Wheeler & Ryan, 1973; Lampe, Rooze, & Tallent-Runnels, 1996; Adeyemi, 2008); geography (Yager, Johnson, & Johnson, 1985); psychology (Thompson & Chapman, 2004); management education (Markulis, Strang, Gosenpud & Wheatley, 1994); mathematics and science (Humphreys, Johnson & Johnson, 1982; Webb, 1984; Mevarech, 1985; Okebukola, 1986; Nattiv, 1994; Jacob & Jan, 1997; Vaughan, 2002; Souvignier & Kronenberger, 2007); biological sciences (Lazarowitz, Baird, Hertz-lazarowits, & Jenkins, 1985; Slish, 2005); chemical bonding (Doymus, 2008a&b; Doymus et al., 2010); principles and methods of teaching (Kilic, 2008); economics (Abu & Flowers, 1997); and accounting education (Hwang, Lui & Tong, 2005).

In all levels of education students taught by the cooperative learning pedagogy achieved greater academic, social and psychological benefits (Kohler & Strain, 1999; Ross, Seaborn, & Wilson, 2002; Hwang et al., 2005). Whicker & Nunnery (1997) compared the effects of STAD and traditional teaching methods on 11^{th}- and 12^{th}-grade academic performance in a mathematics course in America. The results from achievement tests showed that students in the treatment group achieved higher on post-test scores than students in the comparison group (86.93, 40.13; 88.00, 38.24 respectively). The results of other research studies confirmed a strong relationship between the higher academic achievement of students and cooperative learning. In a 12-week research study, Vaughan (2002) used the single group pre-test/post-test to investigate STAD effects on achievement variables. Differences in achievement were carefully measured by comparing scores of pretest and post-tests. Results from data analysis using ANOVA showed that there is an increase in post-test scores in all cases after STAD was implemented.

In addition to the evidence pointing to the value of cooperative learning, Iqbal (2004) examined the effects of STAD on students' academic achievement in Pakistan and found that the STAD group attained higher achievement than the traditional teaching group. The treatment group outperformed the control group on the post-test scores (53.76 and 42.2, respectively). Hwang et al.'s findings (2005) supported this result when they utilized a 2 x 2 between-subjects experimental design to examine cooperative learning effects on outcomes of 172 accounting students in a major Hong Kong university. Results show that students taught by the cooperative learning technique significantly outperformed those taught by the traditional lecture technique. The results also point out that the students taught by the cooperative learning technique performed better in answering question types of indirect application than those taught by the traditional lecture format. The results and findings of the above research studies show a strong association between the higher academic achievement of students and cooperative learning methods. The findings of the above research studies have led to strong arguments by various authors that cooperative learning is an effective teaching pedagogy for schools.

Cooperative learning has been shown to promote more positive attitudes of students toward their own learning than do competitive (effect size = 0.57) or individualistic learning environments (effect size = 0.42) because students work together for shared goals (Johnson & Johnson, 2005). In a six-week experimental study in a secondary school in America, Whicker, Bol & Nunnery (1997) claim that the responses of most students in cooperative learning groups were favorable. Similarly, Vaughan (2002) suggests that students in the STAD group had positive attitudes toward mathematics after STAD was implemented. These results were supported by previous research studies (Johnson & Johnson, 1989; Mulryan, 1994; Cavalier et al., 1995; Nhu-Le, 1999) which showed a strong relationship between cooperative learning methods and the greater positive

attitudes of students toward their own learning. For example, Nhu-Le (1999) investigates the effects of cooperative learning on tertiary students' attitudes toward chemistry in Vietnam. The results showed that students liked working in cooperative learning groups, exchanging information and knowledge, working together, and assisting one another. Similarly, Mulryan (1994) and Mengeluo & Xiaoling (2010) investigated students' attitudes and showed that in cooperative situations, students believed that their teachers paid more attention to their feelings. Students also experienced that their peers liked to help one another and they were more motivated to learn.

In addition, cooperative learning leads to a greater affective perception of others, greater positive attitudes, and more humanity. Recently, several other researchers (Le, 2010; Thanh-Pham, 2010a&b) investigated students' attitudes toward cooperative learning, and their attitudes toward subject matter in the Vietnamese setting of higher education. The results of these studies report that students working in the cooperative learning group believe that they enjoyed and liked doing cooperative activities and obtained more knowledge because cooperative learning improved their attitude toward their relationship with their peers, decreased conflict in the group; and enhanced their self-esteem. Also, students in the cooperative learning group felt more interested and less anxious, perceiving cooperative learning as a valuable way to effectively appreciate knowledge. The positive effects of cooperative learning, found in the literature, have led to the following hypotheses: (1) students who taught by STAD learning will have greater mathematics achievement than those taught through lecture-based teaching, and (2) students who taught by STAD learning will have positive attitudes toward mathematics than those taught through lecture-based teaching.

3. Research method

3.1 Design

The design used in this study was the pre-test-post-test non-equivalent comparison-group design (Table 1). This design was selected because it may help test the cause and effect relationship between the independent variable and the dependent variables. Since the subjects were not randomly assigned to treatment or control groups, some threats (selection bias, selection-maturation, selection-instrumentation, selection-regression and selection-history) to the external and internal validity were possible (Basit, 2010; Creswell, 2009). Accordingly, these threats will be considered. As both the experimental and control groups took the same pre-test (before the experiment) and post-test (after the experiment), and the experiment covered the same time period for all subjects, testing, instrumentation, maturation, and mortality are not internal-validity problems (Ary, Jacobs, & Razavieh, 2002). Also, the a mathematics teacher alone taught both the treatment and control group, therefore history is not a problem in this study, since differences among teachers cannot systematically influence post-test results although history may contribute slightly to retention test comparisons (Ary et al., 2002).

Insert table 1 here

3.2 Participants

This study used a "convenient sample" (Creswell, 2009) of 74 mathematics students from two intact classes in a secondary school in Vietnam. One class (n = 36) acted as the experimental group, and another class (n = 38) acted as the control group. In the treatment group of 36 students, there were 19 females and 17 males with a mean age of 16.33, while in the control group of 38, there were 21 females and 17 males. The two groups were pre-tested on Algebra and Geometry knowledge before the treatment. Examination of the means and a t test for independent samples ($p = .05$) showed there was no statistically significant difference on Algebra and Geometry pre-test scores between the treatment group ($M = 7.48$, $SD = 1.107$) and the control group ($M = 7.60$, $SD = 1.105$), with $p > .05$. The two groups were also pre-tested on attitudes toward mathematics. The results of a t test indicated significantly no difference on Enjoyment and Values scales of attitudes toward mathematics between the treatment group ($M = 3.83$, $SD = .643$; $M = 4.00$, $SD = .677$) and the control group ($M = 3.97$, $SD = .819$; $M = 4.13$, $SD = .670$), with $p > .05$ (Table 2). These results indicate that students in both the experimental group and control group had similar general knowledge on Algebra and Geometry, as well as the same attitudes before the experiment commenced.

3.3 Instrumentation and procedure

Pre-test and post-test on mathematics achievement

This study used a pre-test to measure mathematics knowledge to see whether if there were the differences in the academic ability between the groups before the treatment. This test comprised 40 items focused on the students' general knowledge of the Algebra and Geometry. A post-test comprising 40 items focussing on the basic knowledge of the Algebra and Geometry was used to measure academic achievement after the treatment. The 40 items in both tests commenced with the Algebra, consisting 20 items of algebra concepts, computation

and applications, proceeding to Geometry (20 items), consisting of 20 items of geometry concepts, problem solving and measurement and applications. The maximum score for the knowledge component of both tests was 10. All 40 items in both tests were presented in a multiple-choice format. Each item had four alternative choices for the correct answer. The content of both tests was carefully chosen to ensure that all items were based on concepts and principles of algebra and geometry. The content validity of both tests was checked and strengthened by two mathematics teachers. Both tests were piloted with mathematics students (N = 37) who had taken the algebra and geometry course the year before. Using Cronbach's Alpha, the reliability of the pre-test was .74, and .79 for the post-test. This was satisfactory because both tests had good reliability and discriminatory power.

The Aiken Attitude Scale (ASES; Aiken, 1974)

Aiken's (1974) Two Scales of Attitude toward Mathematics (Table 1) were used to measure attitudes of students toward mathematics before and after the treatment. The first scale, called **Enjoyment of Mathematics** (E), contained 11 items (*I enjoy going beyond the assigned work and trying to solve new problems in mathematics; Mathematics is enjoyable and stimulating to me; Mathematics makes me feel uneasy and confused; I am interested and willing to use mathematics outside school and on the job; I have never liked mathematics, and it is my most dreaded subject; I have always enjoyed studying mathematics in school; I would like to develop my mathematics skills and study this subject more; Mathematics makes me feel uncomfortable and nervous; I am interested and willing to acquire further knowledge of mathematics; Mathematics is dull and boring because there is always a correct answer; and Mathematics is very interesting, and I have usually enjoyed courses in this subject*). The second scale combining 10 items (*Mathematics has contributed greatly to science and other fields of knowledge; Mathematics is less important to people than art or literature; Mathematics is not important for the advance of civilization and society; Mathematics is a very worthwhile and necessary subject; An understanding of mathematics is needed by artists and writers as well as scientists; Mathematics helps develop a person's mind and teaches him to think; Mathematics is not important in everyday life; Mathematics is needed in designing practically everything; Mathematics is needed in order to keep the world running; and There is nothing creative about mathematics; it's just memorizing formulas and things*) was called **Value of Mathematics** (V).

This scale consisted of two subscales; E scale (enjoyment of mathematics) and V scale (value of mathematics). The 11 items of the E scale and the 10 items of V scale were in a format of Likert type. The responses to each item on both scales were coded as 0 (Strongly Disagree), 1 (Disagree), 2 (Undecided), 3 (Agree), or 4 (Strongly Agree) – higher scores on the items of both E and V scales indicating a more positive attitude toward mathematics. The students' responses to the two scales were checked for internal consistency by computing respective Cronbach Alpha coefficients. Coefficient alpha for the V scale was .76, and for E scale was .80, high internal-consistency reliability.

Two intact mathematics classes at a secondary school in Vietnam were selected for the study before these classes were scheduled. One class was randomly chosen to receive lecture-based teaching and acted as the control group, and the other received STAD learning and acted as the treatment group in a mathematics course for five weeks. A pre-test on mathematics and a pre-test on attitudes of students toward mathematics were administered to both groups before the treatment. The mathematics course comprised two core subjects (two units of algebra involving the linear function and quadratic function; and three units of geometry involving the sum and difference of two vectors, the scalar multiple of a vector, co-ordinate axes). The same mathematics teacher taught both group. In the control group, the teacher instructed students to learn the mathematics content as a result of lecture-based teaching in logical steps, and students worked as a whole class group. In the treatment group, the teacher guided students to learn the mathematics content using the STAD technique. In this group, the teacher applied the following eight steps. Firstly, six groups of four students, and one group of five students were formed. Secondly, the objectives and outcomes of course were identified and focused. Thirdly, the instructor explained the process, and presented new information to students. Fourthly, worksheets were given to students so that students may help one another learn mathematics materials through quizzing and group discussions. Fifthly, when students completed their learning in their groups, the teacher tested students' understanding in both the individual student and group levels through quizzes to see the expected outcomes. Sixthly, the teacher scored the quizzes and gave each individual student in each group an improvement score. Seventhly, the teacher added the individual improvement score to give a group score. This whole process was repeated five times, once for each unit of work. Throughout the experiment both

groups could not meet at the same time as they were taught by the same mathematics teacher. Therefore, the treatment group was conducted on Wednesdays, while the control group was on Fridays. Both groups covered the same mathematics content and received mathematics instruction for the same amount of time in the mornings, and in the same room. All students in both groups participated in one instructional session of 180 minutes per week for each unit over the five weeks. After the treatment, both groups took a post-test measuring mathematics achievement and a post-test measuring the attitude of students toward mathematics.

3.4 Data analysis

Data analyzed comprised the scores on achievement tests, scores on attitude questionnaire. A t test was performed to compare the means of the pre-test scores and post-test scores on achievement and attitude measures of the groups before and after the treatment. All analyses were tested for significance at the .05 level.

4. Results and Discussions

4.1 Achievement in mathematics

As indicated, the results of the t test showed no statistically significant difference in mathematics pre-test scores of the experimental group (M = 7.48, SD = 1.107, N = 36) and the control group (M = 7.60, SD = 1.105, N = 38), t (72) = -.485, p = .629. However, the findings obtained from the t test on the mathematics post-test scores showed that the mean scores of the treatment group (M = 8.45, SD = .778) were statistically significantly higher (t = 2.685, df = 58.498, two-tailed, p = .007) than those of the control group (M = 8.01, SD = .860) (Table 2). The results showed that the treatment group, which had engaged in STAD learning, produced a higher overall improvement in scores on the mathematics post-test ($p < .05$) (Figure 1). The findings of this study are consistent with the findings of previous research (Whicker & Nunnery, 1997; Vaughan, 2002; Iqual, 2004) which indicate that STAD learning results in higher academic achievement. Results of this study also strongly support results of the existing research studies (Lucker, Rosenfied, Sikes & Aronson, 1976; Johnson, Johnson, Johnson & Anderson, 1976; Johnson, Johnson, & Scott, 1978; Sharan, 1980; Slavin, 1983; Johnson & Johnson, 1989; Slavin, 1990; Johnson & Johnson, 1991; Slavin, 1996; Lampe et al., 1996; Whicker, Bol, & Nunnery, 1997; Singhanayok & Hooper, 1998) which found the effectiveness of cooperative learning on the academic performance of students.

Insert table 2 here

4.2 Attitudes toward mathematics

As reported, the results of the t test showed no statistically significant difference in both E and V scales of attitudes on pre-test scores of the experimental group (M = 3.83, 4.00; SD = .643, .677) and the control group (M = 3.97, 4.13; SD = .819, .670), t (72) = -.818, p = .073, > .05, and t (72) = -.890, p = .843, > .05, respectively. However, the findings obtained from the t test on the E and V scale post-test scores showed that the E and V mean scores of the treatment group (M = 3.78, 3.81; SD = .498, .486) were statistically significantly higher (t = 2.81, df = 53.688, two-tailed, p = .009, < .05; t = 2.86, df = 55.586, two-tailed, p = .005 < .05) than those of the control group (M = 3.51, 3.54; SD = .273, .282) (Table 2). The results showed that the treatment group, which had engaged in STAD learning, produced a higher overall improvement in scores on both V and E attitude scales ($p < .05$) (Figure 2). These results are consistent with student responses to cooperative learning reported by other researchers (Mulryan, 1994; Nattiv; 1994, Whicker, Bol, & Nunnery, 1997; Vaughan, 2002; Johnson & Johnson, 2005; Sahin, 2010; Le, 2010; Thanh-Pham, 2011). These findings clearly support several previous studies which show that cooperative learning groups result in positive relationships among participants (Vaughan, 2002; D.W. Johnson & R.T. Johnson, 2005).

5. Conclusion

Cooperative learning advanced the academic and affective growth of a sample of Vietnamese secondary students because it provided an interactive approach for learning. This study claims that the frequent reciprocal interaction among participants in the treatment group stimulated cognitive activities, promoted higher levels of achievement and enhanced positive attitudes toward learning. This study supported the findings of previous studies from different cultures, and claims that cooperative learning is an effective teaching approach. In this study, the effectiveness of cooperative learning on students is compatible with the requirements of teaching innovation in Vietnamese higher education. The findings provide Vietnamese teachers with more empirical support for promoting productive changes in teaching methods to improve student learning and their attitudes toward learning. Therefore, cooperative learning is highly recommended as an alternative instructional pedagogy in the current wave of educational reform in Vietnamese schools, especially in relation to the aim of making the learning environment more stimulating for students. In order to identify radical changes in students'

attitudes, a more prolonged and extensive treatment may be needed. The attitudes of students towards cooperative learning can be detected not only by means of questionnaires but also by means of observations and interviews to achieve more conclusive findings. As only a few research studies have investigated the effectiveness of cooperative learning in Vietnamese secondary schools, the findings of this study are not sufficient to decide on the optimal use of cooperative learning at this level of education in Vietnam. Thus, a series of further studies on cooperative learning at the primary and secondary levels of Vietnamese education should be conducted.

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Table 1 The Pre-test-Post-test Nonequivalent Comparison-Group Design

Participants	Group	Pre-test	Treatment	Post-test
Two intact classes of the 10th grade high school students (74 students)	E One class = 36 students	O1 Achievement Attitudes (Dependent variable)	X1 STAD learning (Independent variable)	O2 Achievement Attitudes (Dependent variable)
	C One class = 38 students	O3 Achievement Attitudes (Dependent variable)	X2 Lecture-based teaching (Independent variable)	O4 Achievement Attitudes (Dependent variable)

E: Experimental Group
C: Control Group
X1: STAD learning
X2: lecture-based teaching
O1 O3: Pre-test on achievement and attitudes
O2 O4: Post-test on achievement and attitudes

Table 2 Means, Standard Deviation and t Tests for the Control and Experimental Groups

		Control Group (n = 38)		Experimental Group (n = 36)					
		Mean	S.D.	Mean	S.D.	t-value	Prob.	Alpha	No. of Items
Achievement									
	Pre-test	7.60	1.10	7.48	1.10	-.48	.629**	.74	40
	Post-test	8.01	.86	8.45	.77	2.68	.007*	.79	40
Attitude									
	Pre-test								
	E	3.97	.81	3.83	.64	-.81	.073**		
	V	4.13	.67	4.00	.67	-.89	.843**	.76	11
	Post-test							.80	10
	E	3.51	.27	3.78	.49	2.81	.009*		
	V	3.54	.28	3.81	.48	2.86	.005*		

Note:
**p>.05 *p<.05

Figure 1 Plot of the mean scores of pre- and post-tests on achievement

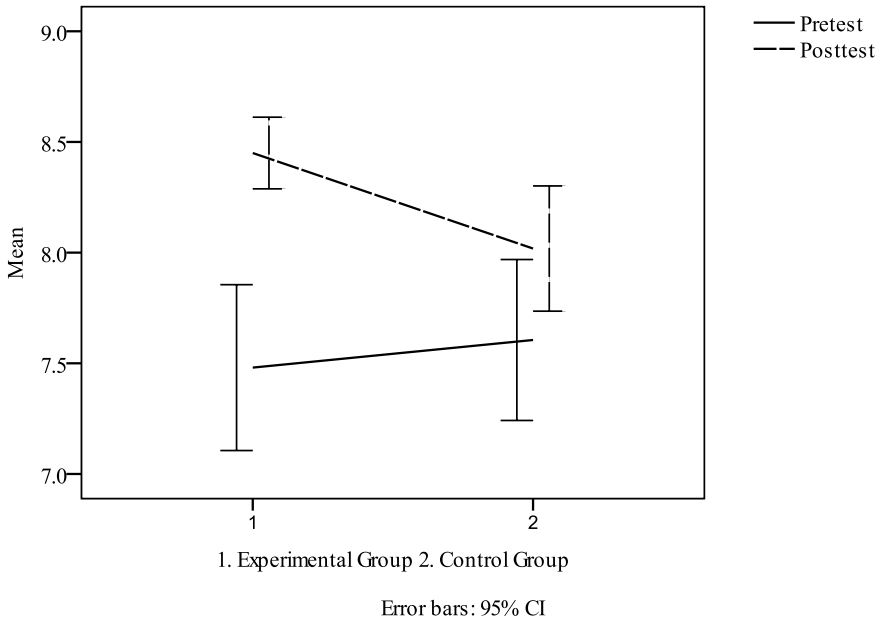

Figure 2 Plot of the mean scores of pre- and post-tests on attitudes