

ENHANCING MATHEMATICS ACHIEVEMENT SCORES AND TEAMWORK SKILLS THROUGH STUDENT TEAMS ACHIEVEMENT DIVISIONS (STAD)

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ABSTRACT: Nowadays, more employers seek graduates who are not only good in academics but give more preference for essential skills, especially teamwork skills. Studies showed that emphasizing teamwork and cooperation can improve the way students learn mathematics. This study compared the effects of the Student Teams-Achievement Divisions (STAD) cooperative learning strategy and the Non-STAD cooperative learning strategy on the students' teamwork skills and mathematics achievement in high school. The study made use of two randomly chosen G10 sections under the K-12 EBEP curriculum who were given pretest and posttest using two validated instruments, the teacher-made test on grade 10 mathematics and the modified teamwork skills assessment tool adapted from the CATME-B Version. The study found that the students under the STAD cooperative learning strategy had significant gains in mathematics achievement and teamwork skills and showed consistent significant improvements in the six teamwork skills assessments over the span of eight weeks as compared to the Non-STAD group. Students exposed in the STAD cooperative learning strategy were better in giving a high-quality fair share of the team's work, kept commitments and worked cohesively with teammates, trusted each other and showed appropriate progress. Each member contributed to the team's excellent work and exhibited excellent knowledge, skills, and abilities in doing the team's work and in performing assigned roles. In STAD, team scores were based on improvement scores, with recognition and rewards to the winning teams and improving students which results to higher achievement in mathematics and enhanced teamwork skills among students.

Keywords: Teamwork Skills, Soft Skills, Student Teams-Achievement Divisions (STAD), Cooperative Learning

1. INTRODUCTION

The development of the students' teamwork skills while learning mathematics content is paramount. These are essential skills needed by them to work successfully with others when they enter the workforce in this highly competitive world.

Team skills are among the most important skills desired by recruiters, yet employers and scholars perceive that team skills are frequently deficient in graduates [1]. The Department of Education recognizes that "Mathematics is one subject that pervades life at any age and in any circumstance [2]. Thus, its value goes beyond the classroom and the school". Studies showed that emphasizing teamwork and cooperation can revolutionize the way kids learn mathematics [3]. As posted by Thomas [4], "one of the Top 10 soft skills that students need to develop today is Teamwork. It is the most essential skill required at every stage of one's career. Working together will always help in producing more. Students must understand the importance of unity". Hendrix [5] declared that "cooperative learning activities provide a foundation for instruction that increases positive interaction among students and allows them to explore and engage in learning. It is a strategy designed to meet both the cognitive and social needs of learners in a diverse and complex society".

However, teamwork skills development is sometimes underestimated on the premise that schools are responsible to help students learn the subject matter but not the social skills [6]. Also, considerable evidence claimed that there has been minimal research on directly observing student interactions during activities [7]. Most of the teachers just ignored the fact that in the usual group activities, only one or two individuals work hard for the group output. Some students

are just free-riders. These students do not have a proportional share of the work and yet they enjoy the same marks of the group. Teams often have problems, such as team members who work independently rather than collaboratively, poor communication, conflict, differences in team members' skills, motivation, and goal levels, and free-riding or social loafing [8].

The Student Teams-Achievement Divisions (STAD) were found to be the most successful cooperative learning technique at increasing student academic achievement but the bulk of the research on STAD had been conducted at the elementary level [9]. This cooperative learning approach consistently had positive effects on learning in many studies. However, only a few studies examined the effects of STAD in the 7-12 grade levels [9].

There is a dearth in the study of Student Teams-Achievement Divisions (STAD) in junior high school, particularly in the Philippines. There have been no results on its effects and how it influences the students' teamwork skills.

In Misamis Oriental General Comprehensive High School (MOGCHS), most of the students were struggling in Mathematics. Based on the 2014-2015 National Achievement Test (NAT) result, MOGCHS had a Mean Percentage Score (MPS) of 37.93% [10]. This MPS was closely similar in the previous school years. Evidently, the low achievement level in Mathematics is a recurrent problem not only in MOGCHS but also in many schools in Misamis Oriental Division and even in the country in general.

Hence, the researcher conducted a study that implemented the Student-Teams Achievement Divisions (STAD) cooperative learning strategy and the Non-STAD cooperative learning strategy in junior high school and compares its effect on the students' mathematics achievement and teamwork skills.

2. THEORETICAL AND CONCEPTUAL FRAMEWORK

This study was anchored on Vygotsky's Social Constructivism. It aimed to validate a statement that the use of STAD cooperative learning in the classroom instruction can influence the achievement scores of the students in mathematics. Kendall [11] cited Powell and Kalina that "Vygotsky based his work on the principle that knowledge is social and is constructed from cooperative efforts to learn, understand, and solve problems. Through scaffolding, Vygotsky posited that learning occurs more effectively when students have others to support them". According to Vygotsky (1978), if at least one student in the group has a deeper understanding than the others, then he or she has the potential to scaffold the learning of other group members and deepen their understanding [12].

Another perspective outlining this study was the Social Interdependence Theory by Koffka, Lewin, Deutsch, and the Gestalt school of psychology. Kendall [11] cited Johnson & Johnson stating that social interdependence exists when individuals work together to achieve a common goal and each group member ensures the success of the entire group by encouraging and assisting others. Slavin extended this theory to the study and development of several cooperative learning techniques for classroom use, one of which is the STAD [11].

The other view related to the study was the Behavioral Learning Theory which focuses on the impact of group reinforcers and rewards on learning. "Skinner, the father of Operant Conditioning, stated that positive reinforcement (praise, rewards, etc.) strengthens behavior or increases the likelihood that the behavior will be repeated. Skinner believed that everything a person does is related to his or her prior experiences of punishment and reward and future behavior can be shaped by appropriate use of operant conditioning" [13].

The Big Five Theory developed by Salas et al, as cited by Strode [14], was the other viewpoint related to the study. Strode [14] detailed that "the Big Five teamwork theory is one of the most influential teamwork theories. It has five components and three coordinating mechanisms as follow: Adaptability, Backup behavior, Closed-loop communication, Mutual performance monitoring, Mutual trust, Shared mental models, Team leadership, and Team orientation".

This study delved on the notion that STAD cooperative learning helps improve the students' achievement scores in mathematics and at the same time develops the different teamwork skills of the students needed in our society today.

3. METHODOLOGY

The researcher used the quasi-experimental pretest-posttest control group design. In this study, the independent variables were the two cooperative learning strategies. The experimental group used the STAD cooperative learning strategy while the control group used the Non-STAD cooperative learning strategy. The dependent variables were the achievement scores in mathematics and the five teamwork skills, namely: (1) Positive Interdependence- refers to the members' contribution to the team work

positively, complete a fair share of the team's work with high quality, keep commitments, complete assignments on time and work cohesively with each other; (2) Collaboration- refers to the students' interaction with their teammates like showing an interest in teammate's ideas and contributions, improving communication among teammates, providing enthusiasm to the team, and asking and using feedback to improve; (3) Interpersonal Relations- refers to the teammates giving specific, timely, and constructive feedback; watching conditions affecting the team and making sure that the teammates show appropriate progress and trust each other; (4) Individual Accountability- refers to the individual member's contribution to the team to do excellent work, considering that he/she is responsible for the team's success; and (5) Team Leadership- refers to the ability of an individual to coordinate a group to perform a task successfully, have excellent knowledge, skills and abilities to do team's work and able to perform other roles if necessary. The pretest scores were the covariate.

The participants of this study were the Grade-10 students of Misamis Oriental General Comprehensive High School (MOGCHS), the school year 2018-2019. Among the four sections handled by the researchers, two sections were randomly selected. One section was the experimental group and the other one was the control group with a class size of 51 and 48 students respectively. At the start of the experiment, the researcher formed the small intact groupings of the experimental group and the control group. The students were divided into heterogeneous groups of five members based on the random selection consisting of high, average or low performing students. The basis in the grouping was the first quarter grades.

In the Non-STAD group, the usual structure of cooperative learning was employed. The teacher gave a group activity after the lesson presentation and discussion; assigned a leader in each group to facilitate in doing the task given and to monitor the participation and the learning of the group members, and then required them to submit or present their group output. The whole group was given a uniform mark based on their final group output without examining the member's individual contribution to the output. In this group, members were given the tasks to be done and then the leader will assist. Different leaders were assigned per activity to give chance to others to act as leaders also. In the experimental or STAD group, unique features were added in the usual cooperative learning structure, namely: the use of pretest and posttest per topic to compute for the improvement score, the emphasis on team tutorials, the computation of the individual member's improvement score to calculate for the team score, the giving of recognition and rewards, and the rotating roles of the team members per topic. In this group, the team score was mainly based on the total improvement scores of all the team members. Hence, members worked both independently and collaboratively keeping in mind that their shared goals are accomplished best by mutual support. The 28-item validated teacher-made test on topics in grade 10 mathematics was given to both groups as pretest and posttest for mathematics achievement. The items were based on the K-12 curriculum guide provided to public schools for grade 10 students. The reliability test made yielded an

interpretation skill, Spearman-Brown Prophecy of 0.898. For teamwork skills, the teamwork skills assessment tool adapted with modifications from the CATME-B Version developed by Ohland, Loughry, Woehr, et al (Academy of Management Learning & Education, 2012) was used as pretest and posttest. Its interpretation skills reliability, Cronbach's Alpha, was 0.839. Moreover, to know the trend of the students' teamwork skills, both groups did the teamwork skills assessment six times. This was done after the completion of each major topic in a span of 1.5 weeks per topic. Students' assessment was the average of self-assessment and peer-assessment per teamwork skill. The data gathered in the achievement scores and teamwork skills were analyzed using the mean, standard deviation and descriptive rating, and the One-way Analysis of Covariance (ANCOVA).

4. RESULTS

To determine the students' mathematics achievement scores before and after the experiment, the mean and standard deviation of the students' achievement test scores in grade 10 mathematics are shown in table 1 below.

Table 1. Mean and Standard Deviation of Students' Achievement Test Scores in G10 Mathematics

	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
Mean	6.92	19.98	6.40	18.15
SD	2.07	2.55	2.22	3.43

As presented in table 1, the pretest mean of the 2 groups had a difference of 0.52 in favor of the experimental group. The proficiency level is at the beginning level as described by the performance appraisal system of DepEd. As to the variability in the pretest, the SD of the control group is higher by 0.15. This means that the scores of the students in both groups have a similar spread.

In the posttest, the experimental group has a higher mean compared to the control group by 1.83. The proficiency level of the experimental group is now proficient, while the control group is approaching proficiency. As to the variability of the achievement scores in the posttest, the experimental group has lesser dispersion than the control group. The result reveals that the experimental group has increased their scores with less dispersion, while in the control group, the scores are more dispersed.

To test for a significant difference in the posttest, further analysis was done using One-Way Analysis of Covariance (ANCOVA) with pretest as the covariate.

Table 2. Summary Table of One-Way ANCOVA of Mathematics Achievement Scores

Source	SS	df	MS	F	P
Adjusted Means	82.9	1	82.9	9.06	0.003*
Adjusted Error	878.78	96	9.15		
Adjusted Total	961.68	97			

*significant at 0.05 level

Table 2 shows the result of the one-way Analysis of Covariance of the students' achievement scores in grade 10 mathematics. The analysis yielded an F-ratio of 9.06 and a $p = 0.003$, that is, less than the 0.05 level of significance. The result led the researcher to reject the null hypothesis that there is no significant difference in the students' mathematics achievement scores as influenced by the STAD and NON-STAD Cooperative Learning Strategies. This implies that the students in the experimental group who were exposed to STAD cooperative learning strategy had significantly improved their mathematics achievement compared to those who were exposed to the NON-STAD cooperative learning strategy. The STAD cooperative learning strategy is better than the conventional or the usual small-group work cooperative learning strategy in improving the mathematics performance of students. This finding supports the theory of Vygotsky's Social Constructivism, which claims that learning occurs more effectively when students have others to support them [11]. This agrees further with Thomas [15] who declared that a team helps in reaching goals and making achievements, much faster as compared to when people work alone. This result also agrees with the findings of Wyk [16] and Armstrong & Palmer [9] who claimed that STAD was the most successful cooperative learning technique in increasing students' academic achievement. It further agrees with the findings of Batton [17] who concluded that STAD had a positive impact on students' overall mathematics performance. This confirms Brown's idea that teamwork and cooperation can revolutionize the way students learn mathematics [3].

Table 3 displays the mean, standard deviation, and descriptive rating of the students' assessments on their teamwork skills.

The teamwork skills scores were derived from the average of the students' self-assessment and peer assessments. In the pretest, the differences of the mean in each teamwork skill for both groups are minimal. Both groups are comparable in the teamwork skills before the experimental period.

The descriptive rating in all the experimental group's teamwork skills was average, while that of the control group was high in Positive Interdependence and average in Collaboration, Interpersonal Relations, Individual

Accountability, and Team Leadership:. As to the variability of the responses, the experimental and control groups' standard deviation has a minimal difference. This means that the ratings of the students in the two groups have a similar dispersion.

Table 3. Mean, Standard Deviation and Descriptive Rating of the Pretest and Posttest of the Students' Assessments on Teamwork Skills

	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
Positive Interdependence				
Mean	3.28	4.46	3.53	4.20
SD	0.47	0.35	0.46	0.44
DR	Average	High	High	High
Collaboration				
Mean	3.47	4.50	3.32	4.32
SD	0.45	0.36	0.42	0.43
DR	Average	Very High	Average	High
Interpersonal Relations				
Mean	3.33	4.46	3.17	4.09
SD	0.46	0.41	0.41	0.48
DR	Average	High	Average	High
Individual Accountability				
Mean	3.43	4.51	3.37	4.08
SD	0.45	0.34	0.42	0.57
DR	Average	Very High	Average	High
Team Leadership				
Mean	3.33	4.53	3.40	4.09
SD	0.51	0.39	0.40	0.45
DR	Average	Very High	Average	High

(DR – Descriptive Rating)

After the treatment, the experimental group had a higher mean in each of the five teamwork skills compared to the control group. The descriptive ratings in the experimental group were very high in collaboration, individual accountability and team leadership, and high in positive interdependence and interpersonal relations. In the control group, the descriptive ratings were high in all the five skills. As to the variability of the students' ratings, the experimental group had lesser dispersion than the control group.

To determine if there is a significant difference in the students' teamwork skills, further analysis was done using One-Way Analysis of Covariance (ANCOVA). The result is presented in table 4.

The analysis in table 4 yielded a $p < 0.001$ on the four teamwork skills, namely: Positive Interdependence, Interpersonal Relations, Individual Accountability, and Team Leadership. This means that there is a significant difference in the students' teamwork skills on these subskills. This led the researcher to reject the null hypothesis that there is no significant difference in the students' teamwork skills as influenced by the STAD and Non-STAD Cooperative Learning Strategies. This implies that the students in the experimental group who were subjected to STAD cooperative learning strategy had significantly improved their teamwork skills on Positive Interdependence, Interpersonal Relations, Individual Accountability, and Team Leadership.

Table 4. Summary Table of One-Way ANCOVA of the Students' Teamwork Skills

Source	SS	df	MS	F	P
Positive Interdependence					
Adjusted Means	2.28	1	2.28	15.52	0.00*
Adjusted Error	14.11	96	0.15		
Adjusted Total	16.90	98			
Collaboration					
Adjusted Means	0.57	1	0.57	3.76	0.06
Adjusted Error	14.54	96	0.15		
Adjusted Total	16.21	98			
Interpersonal Relations					
Adjusted Means	2.46	1	2.46	13.58	0.00*
Adjusted Error	17.37	96	0.18		
Adjusted Total	22.53	98			
Individual Accountability					
Adjusted Means	4.29	1	4.29	19.94	0.00*
Adjusted Error	20.66	96	0.22		
Adjusted Total	25.31	98			
Team Leadership					
Adjusted Means	5.12	1	5.12	30.41	0.00*
Adjusted Error	16.15	96	0.17		
Adjusted Total	22.01	98			

*significant at 0.05 level

However, the result of the students' teamwork skills on Collaboration yielded a $p = 0.06$. The probability value is slightly higher than the 0.05 significance level. This means that there is no significant difference in the students' teamwork skills in Collaboration. This result failed to reject the null hypothesis that there is no significant difference in this teamwork skill as influenced by the STAD and Non-STAD Cooperative Learning Strategies. Therefore, in Collaboration, the two groups are comparable. The use of the STAD cooperative learning strategy is better than the Non-STAD cooperative learning strategy in improving academic achievement as well as teamwork skills of Grade 10 high school students. The students in STAD who were taught using the pretest-posttest per topic, team tutorial, improvement scores, recognition and rewards and rotating roles per topic showed better performance in their mathematics achievement and teamwork skills than the students in Non-STAD who were taught using the conventional small group cooperative learning without the additional features present in STAD. These findings agree with the conclusions of Wyk [16], Khansir [18], and

Table 5. Mean and Standard Deviation of the Students Six Assessments on their Teamwork Skills

	Assess 1		Assess 2		Assess 3		Assess 4		Assess 5		Assess 6	
	EG	CG	EG	CG	EG	CG	EG	CG	EG	CG	EG	CG
Positive Interdependence												
Mean	4.23	4.01	4.31	4.01	4.42	4.08	4.28	4.15	4.38	3.86	4.46	4.20
SD	0.49	0.60	0.47	0.52	0.43	0.65	0.48	0.57	0.45	0.62	0.35	0.44
Collaboration												
Mean	4.29	3.94	4.41	4.01	4.40	4.03	4.35	4.05	4.34	3.80	4.50	4.32
SD	0.48	0.59	0.48	0.52	0.43	0.64	0.50	0.49	0.47	0.57	0.36	0.43
Interpersonal Relations												
Mean	4.15	3.81	4.23	3.83	4.44	4.28	4.23	3.93	4.33	3.82	4.46	4.09
SD	0.57	0.58	0.46	0.63	0.42	0.42	0.50	0.49	0.49	0.51	0.41	0.48
Individual Accountability												
Mean	4.26	4.18	4.28	4.05	4.30	3.98	4.34	4.11	4.35	3.84	4.51	4.08
SD	0.43	0.53	0.42	0.55	0.49	0.59	0.51	0.56	0.49	0.65	0.34	0.57
Team Leadership												
Mean	4.21	3.96	4.24	4.11	4.23	3.86	4.20	4.04	4.42	3.81	4.53	4.09
SD	0.49	0.63	0.49	0.53	0.47	0.69	0.51	0.56	0.50	0.54	0.39	0.45

(EG – Experimental Group; CG – Control Group)

Kriswintari et al [19] which stated that STAD cooperative learning promotes a positive attitude among students and shows better achievements and is more effective in improving the students' thinking skill and social attitude.

To determine the trend of the students' teamwork skills within the treatment period, a total of six teamwork skills assessments were conducted. The assessment was done after the completion of each major topic in a span of 1.5 weeks per topic. The mean and standard deviation in each of the six assessments on teamwork skills are presented in table 5.

The trend of the students' positive interdependence skills is increasing. It significantly improved at the end of topic 6 with constant progress at the end of topics 1, 2 and 5. In collaboration, it improved significantly at the end of topic 6 with constant progress at the end of every topic. In interpersonal relations, the students had significantly improved at the end of topics 3 and 6 with constant progress at the end of topics 1, 2, 4 and 5; and also at the end of topics 2, 4 and 5. In individual accountability, the students had significantly improved in this skill at the end of topic 6 with constant progress at the end of topics 2, 3 and 5. As to team leadership, the result shows that the students had significantly improved in this skill at the end of topic 6 with constant progress at the end of topics 2, 3 and 5. Further analysis on comparing the trends between the groups revealed that the STAD cooperative learning group showed consistent significant improvements in the six teamwork skills assessments over the span of eight weeks as compared to the Non-STAD group. Students exposed in the STAD cooperative learning strategy were better in the member's high-quality fair share of the team's work, kept commitments and worked cohesively with teammates,

trusted each other and showed appropriate progress. Each member contributed to the team's excellent work and exhibited excellent knowledge, skills, and abilities in doing the team's work and in performing assigned roles

This study encouraged the students' independence and team learning, developed individual and group accountability practiced and developed different teamwork skills, and improved their achievement scores in mathematics. They became more aware of their responsibility in enhancing their teamwork skills while learning the mathematics content.

5. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study, the Student Teams-Achievement Divisions (STAD) Cooperative Learning Strategy is better than the Non-STAD cooperative learning strategy in enhancing students' mathematics achievement and is more effective in enhancing students' teamwork skills, specifically on positive interdependence, interpersonal relations, individual accountability, and team leadership. This approach encouraged the students' independence and team learning, developed individual and group accountability practiced and developed different teamwork skills, and improved their achievement scores in mathematics. They became more aware of their responsibility in enhancing their teamwork skills while learning the mathematics content.

High School mathematics teachers may employ the Student Teams-Achievement Divisions (STAD) Cooperative Learning Strategy in teaching mathematics to increase both the mathematics achievement and teamwork skills of the students. It is found to be better than the conventional small group cooperative learning strategy, especially in controlling common team problems like free-riders in a group. Thus, ensuring maximum participation of each team member. School administrators may provide opportunities for the dissemination of the research result and the proper employment of the STAD cooperative learning strategy to high school teachers in mathematics and to recommend it in their classes to help the students improve both their mathematics achievement and teamwork skills. Further studies may be conducted to investigate the effectiveness of STAD cooperative learning strategy in the development of the students' teamwork skills with a wider scope using different populations, setting and time. It may be conducted to more grade levels especially the heterogeneous classes for the whole school year and analyze the result every grading period.

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