The Use of STAD Model in Teaching Chemistry: Its Effect to Students' Academic Performance

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Abstract: Students Team Achievement Division (STAD) model is one of the cooperative learning methods which is among the many student-centered strategies that is found to result a positive increase in learners' learning. This teaching strategy was endeavored to find out its effect on the academic performance of the first year students in General and Inorganic Chemistry. Two intact classes were the respondents: the control group and the experimental group. The comparability of the two groups was tested using Analysis of Covariance (ANCOVA). The result shows that achievement scores in chemistry of students exposed to STAD is higher in the adjusted posttest mean score than those in lecture-discussion method, yet their difference was found not statistically significant. However, students exposed to STAD have improved in answering high-order thinking skills (HOTS) questions of the various level of cognition such as comprehension, analysis, synthesis and evaluation much better than its counterpart. Hence, the study revealed further that cooperative learning method (STAD) is as effective as the traditional method (lecture-discussion) in affecting students' academic achievement in chemistry.

Keywords: academic performance, Chemistry, STAD Model, teaching strategies

I. Introduction

PREDICTION of student's performance in the classroom is an important area of education research. Its impact on educator's ability to identify students who may have difficulty grasping the material presented in a course is potentially very large. General chemistry courses, as well as other large science courses, serve an eclectic mixture of students with different social and educational backgrounds. Identifying students that are likely to have difficulties in such a course at the beginning of the semester is an important yet difficult task (Wagner, et.al, 2002).

Teaching to be effective requires a lot of time, talent and effort from anyone who wants to pursue this inspiring and very fulfilling task. Effective teaching is only possible if teachers would consider the understanding of the complexity of the classroom teaching and learn to develop strategies that will enable them to continually evaluate and improve teaching-learning effectiveness (Boiser, 2003).

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STAD model is student-centered which increase the students' chance of getting more involved in his/her learning thus, bring about better achievement. This method is generally understood to be learning that takes place in any environment where students in small groups share ideas and work collaboratively to complete academic tasks (Johnson and Johnson, 1994). In cooperative learning, students divide the work among themselves and help one another (especially the slow members). They praise and criticize one another's efforts and contributions, and receive a group performance score.

STAD model consists of four-member learning teams which are heterogeneous in performance level. Students study together but take tests independently and individual student's quiz, summed as team scores (Slavin, 1995).

Johnson and Johnson (1994) confirmed that cooperative effort resulted in higher level of reasoning, more frequent generation of new ideas and solution, and a greater transfer of what is learned within one situation to another.

This study utilized STAD model of cooperative learning and find out its effectiveness on the academic performance of the students in General and Inorganic Chemistry.

II. Literature Review

In cooperative learning, working with a partner with different modality strengths can help influence each other for the better. Each student is responsible for a part and for the whole activity. Through cooperative learning, the students learn more and they develop a sense of interdependence in the learners (Coloma, 1997).

Several studies confirmed the effectiveness of cooperative learning over other learning structures (Quinn, et.al, 1995, Johnson and Johnson 1994, Ahuja 1995, and Kemp 1994). Quinn, et.al revealed that cooperative effort resulted in higher quality problem solving than competitive structure. Johnson and Johnson (1994) also confirmed that cooperative effort resulted in higher level of reasoning, more frequent generation of new ideas and solution, and a greater transfer of what is learned within one situation to another.

Slavin and Cooper (1999) reviewed researches on cooperative learning and identified 52 studies conducted over periods of at least 4 weeks in regular secondary schools

(grades 6 – 12) that have measured effects of student achievement. These studies all compared the effects of cooperative learning with effects traditionally taught control groups on measures of the same objectives pursued in all classes. Teachers and classes were either randomly assigned to cooperative or control conditions, or they were matched on pretest achievement level and other factors. Of these studies, 63% were found to have significantly greater achievement in cooperative than in control classes.

Based on the findings of Pahila (1994), the performance of the students in modular individualized instruction in chemistry was better than those in modular cooperative learning group. She cited factors that could have hindered the success of modular cooperative learning method such as: lack of adequate training by the researcher; choice of group leader and the method is new to the students, hence, more time is needed to adjust with the method.

The studies of Dougherty, et.al. 1995 and Ferido, 1995 have determined the effectiveness of cooperative learning in enhancing the academic achievement in chemistry.

Dougherty, et.al. (1995) studied the effects of cooperative learning and enhanced communication on student performance, retention and attitudes in General Chemistry. This experiment involved three large lecture sections and is grouped into Control, U-coop (Unstructured Cooperative Model) and S-coop (Structured Cooperative Model). The researchers found out that structured cooperative learning has a strong positive effect on student's performance, retention and attitudes in general chemistry.

The study of Ferido (1995) revealed that cooperative learning provides an environment which facilitated the types of discussions necessary for conceptual change to occur. The increased participation of the students during cooperative learning ensured that all group members took an active role in problem solving, and achieved a sense of self-worth by knowing that their contributions were meaningful.

The studies reviewed reveal variables that positively influenced the use of cooperative learning include achievement, retention of information, problem solving ability, attitude and development of social skills. Cooperative learning methods applied specifically in science classes have shown to enhance learning, problem solving ability and other affective variable.

This present study is similar to the aforementioned studies because it also utilized STAD, a cooperative learning model and endeavored to find out its effectiveness on the academic performance of the students in Chemistry.

III. Methodology

This study utilized the quasi-experimental method in evaluating the academic performance of college students in chemistry.

Two intact classes were used. One class as the experimental group which explored the use of STAD model and another class was the control group using the traditional method (lecture-discussion) in teaching selected topics in General and Inorganic Chemistry. The teacher-researcher handled both classes to avoid variations in teaching style, level of competence and length of teaching experience.

A researcher-made achievement test was used which consists fifty (50) multiple choice items with four options in each item. The multiple type of test was the most preferred in this study because it is the most flexible, most valuable, and most generally applicable to all test forms. A table of specification was prepared to ensure that every topic was properly represented in the test. Seventy-five (75) multiple choice items were initially constructed. They were shown to all teachers handling chemistry. The test was pretested and validated to 43 freshmen students who were not involved in the study for item analysis. The purpose of the item analysis was to determine the goodness of the items. The difficulty index, the index of discrimination, and the effectiveness of the distractors were the factors considered in determining the goodness of the items. There were only 48 valid questions. Two (2) test items were revised based on the result of the item analysis so that the final form consisted of fifty (50) multiple choice items, which was the one used in this study.

Prior to the experiment, both groups were pre-tested. During the conduct of the study, the Faculty Enrichment Officer observed the researcher to ensure that both groups were treated equally. This study lasted for six weeks.

The design of the lessons of the two (2) groups of respondents was drafted by the researcher to ensure that they will received the same subject matter, budget of time/lesson but different teaching method used.

The control group was subjected to the traditional method (lecture-discussion) which aims to transmit knowledge mainly through lecturing and the use of visual aids. As part of this method, steps in problem-solving were presented to the respondents: first was identifying all the given data in the problem; second step was on determining what was being ask in the problem so that the equation or formula to be used could be derived; third was the presentation of the solution to the problem; and lastly, the final answer of the solved problem should be placed in a box. During the problem solving activities, the teacher-researcher followed the steps in problem solving and presented the solutions to the students. Similar problems were given and the students will solve it individually. As a follow-up activity, a volunteer student solved the problem on the board and discussed his solution to the class. Pen and paper evaluation followed after the generalization of the topic was given.

On the other hand, the experimental group used the STAD model of the cooperative learning method which has four

phases:

Phase I: Teach (Class Presentation). The class presentation was a teacher-directed presentation of the material: concepts, skills, and processes. Carefully written and planned objectives were stated and used to determine the nature of the class presentation, and the team followed. Key concepts were identified as well. The presentation was lecture, lecture/demonstration, or audiovisual.

The Teacher's Role. The teacher facilitated the group learning. This started with group organization, continued with teamwork building and cohesion within groups, and monitored to ensure that all students learned.

Students' Role. STAD required that students become active and responsible for their own learning. This was accomplished by promoting within the group, peer teaching: students teach one another about the activity/lesson.

Phase II: Team Study. Each team was composed of four students who represented a balance in terms of academic ability and gender. To ensure that teams were similar in range and ability, students were ranked according to their obtained midterm grades, then were divided into quartiles. The highest achievers from the first two quartiles were paired with the lowest achievers from the third and fourth quartiles. The goal was to achieve parity among the teams in the class. Each team was more or less an average composite of the class. Team members worked together with worksheets prepared by the teacher and made sure that each member of the team answered all the questions. Students arranged their chairs in such a way that they face each other as a small team. To ensure a deeper understanding of the lesson/activity, students were made to share and explain with the group their answers. To facilitate this process, the teacher asked questions as she moved from group to group and encouraged students to explain their answers.

Phase III: Test. Students took individual tests and were not allowed to help each other. Individual ratings were summed up and the average was taken to represent the team's rating. In this study, the base score was based from the team's average midterm grade. Equal opportunity for success was one of the characteristics of cooperative learning and was accomplished by awarding the maximum of 15 points if they got perfect in the test regardless of their base score.

Table 1 shows how improvement points were awarded based on how students performed on a test or quiz compared to their base score.

TABLE I
AWARDING OF IMPROVEMENT POINTS

Improvement Points	Group% of Correct Answer
0	Below base score
+ 5	74% - 84%
+ 10	85% - 94%
+ 15	95% - above

Phase IV: Team Recognition. The teacher recognized the work of each team by means of a bulletin board that reported the ranking of each team within the class. In this phase of the lesson, praise and recognition of student groups on their improved performance was done.

In carrying out STAD, the researcher followed the guidelines suggested by Sawit (2000, p. 24) as follows: (1) arrange the classroom to promote cooperative goals; (2) present the objectives as group objectives; (3) communicates intentions and expectations; (4) encourage division of labor when appropriate; (5) encourage students to share ideas, materials and resources; (6) supply a variety of materials; (7) encourage the students to communicate their ideas clearly; (8) encourage supportive behavior; (9) provide appropriate cues and signals; (10) monitor the group as a whole; (11) evaluate the individual and the group by providing prompt feedback; (12) reward the group for successful completion of its task so that the individuals will come to realize that they benefit from each other's work

In transmuting the raw achievement scores into the level of achievement of the students, the standards set by the university was used. The student needs to get a score of fifty percent of the total number of items or better in order to pass the examination.

Table 2 shows how the student's raw achievement mean scores were transmuted to the level of achievement.

TABLE II
TRANSMUTATION OF THE MEAN SCORE TO THE LEVEL OF ACHIEVEMENT

Mean Score	Level of Achievement
15 – 19	Very Low
20 – 25	Low
26 – 29	Moderate
30 – 34	Satisfactory
35 – 39	Good
40 – 44	Very Good
45 – 50	Excellent

The comparability of the two groups was tested using Analysis of Covariance (ANCOVA) with pretest as the covariate. This statistical tool enabled the researcher to adjust the posttest scores on the dependent variable for each group to compensate for the initial differences between the groups on the pretest. How much the posttest mean scores must be adjusted depends on how large the difference between the pretest scores is and the degree of relationship between the covariate and the dependent variable.

The t-test for dependent samples was used to determine if there was a significant difference between the pretest and posttest scores of the experimental group and the pretest and posttest scores of the control group at 0.05 level of significance.

IV. Results and Discussion

Table 3 presents the data of the pretest mean scores of the students before the experiment. A summary data on the pretest mean scores of the control and experimental groups and result of statistical analysis are shown below.

TABLE III
PRETEST ACHIEVEMENT SCORES OF THE CONTROL AND EXPERIMENTAL GROUP IN CHEMISTRY

Group	Pretest Mean Score	Mean Difference	t–ratio	p-value
Control	24.97			
Experimental	23.51	1.46	1.40	>0.05

As shown in Table 3, the control group exposed to traditional method (lecture-discussion) obtained a pretest mean score of 24.97, while the experimental group exposed to STAD model obtained a pretest mean score of 23.51 with a mean difference of 1.46 in favor of the control group.

The t-ratio obtained was 1.40 which is greater than 0.05 level of significance indicates that the pretest mean scores between the control and experimental groups are not significantly different. Therefore, hypothesis 1 is accepted which states that there is no significant difference between the pretest scores of the control and experimental group.

The collected data on the effect of the two teaching methods on the achievement in chemistry of the control and experimental groups are shown in Table 4.

TABLE IV
PRETEST AND POSTTEST SCORES OF THE CONTROL AND EXPERIMENTAL GROUP IN CHEMISTRY

Group	Pretest		Posttest		Mean Difference	Computed t – value	P - value
	Mean	S.D.	Mean	S.D.			
Control	24.97	5.41	34.23	5.06	9.26	14.191	< 0.001
Experimental	23.51	3.63	34.13	5.26	10.62	12.284	< 0.001

The control group achieved a posttest mean score of 34.23 as compared to its pretest mean score of 24.97 with a mean difference of 9.26.

In contrast, the experimental group achieved a posttest mean score of 34.13 as compared to its pretest mean score difference of 10.62 which is higher than the control group.

The results of this study showed that STAD model is as effective as the traditional method (lecture-discussion) in affecting students' academic achievement. Students taught with STAD performed equally well with students in lecture-discussion method.

The pretest-posttest mean score difference according to the level of cognition is shown in Table 5.

TABLE V
SUMMARY OF STUDENTS' PRETEST-POSTTEST MEAN SCORE DIFFERENCE IN THE ACHIEVEMENT TEST ACCORDING TO LEVEL OF COGNITION

Group	Pretest-Posttest Mean Score Difference According to Level of Cognition					
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Control	7.92	3.69	14.17	7.50	13.00	9.50
Experimental	7.48	5.69	12.50	12.00	15.00	11.00

Although STAD model was found equally effective than lecture-discussion method with respect to students' achievement in Chemistry in this study, yet the teaching method has improved students' skills in answering high level questions: comprehension, analysis, synthesis and evaluation much better than its counterpart. This improved performance can be attributed to the cooperative learning skills that were developed in the students during the experiment such as the ability to work with others within a group and developing interpersonal skills, improved behavior and attendance, and increased liking of school and classmates which were the behavioral changes observed by the researcher among students exposed to STAD.

V. Conclusions and Recommendations

Findings of the study showed that cooperative learning method (STAD) is as effective as the traditional method (lecture-discussion) in affecting students' academic achievements in chemistry. Students exposed to STAD model improved their skills in answering questions of the various level of cognition such as comprehension, analysis, and evaluation while students exposed to lecture-discussion method improved their skill in answering questions on application level as well.

To the future researcher/s who will be employing STAD model, the researcher recommends the following:

- Make use of another teaching strategy instead of the

lecture-discussion method which will be used as the control group.

- Conduct the study for more than six weeks to make the result more reliable.
- Consider the qualitative aspect of students' attitude towards the course after the intervention.
- Use this strategy to the science major students of the university.

VI. Acknowledgements

The researcher, with sincerity and faith, expresses her deepest thanks, appreciation and profound gratitude to the important persons: Dr. Beatriz A. Peñalosa, Dr. Rosalina H. Coral, and Engr. Dante Agner who have shared their invaluable time, unselfish assistance, effort and knowledge in preparing this study a real piece of work.

To the respondents of this study for their cooperation and participation that led to the provision of the needed data.

To her loving and supportive husband, Engr. Eduardo L. Lantajo, for always beside her through thick and thin, a lifetime gratitude; the jewels of her life, Czarina Rose, Justine Joy, Czar Eduard and Isabel Cassandra.

Above all to the ALMIGHTY FATHER and Mama MARY, the researcher's source of strength, wisdom, intelligence, patience and perseverance, a million thanks for without THEM, this work would not have become a reality.

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