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Author(s)	Low Gek Chew, Goh Ngoh Khang, Lucille Lee Kam Wah and Chia Lian Sai
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CAN COOPERATIVE LEARNING STRATEGY IMPROVE ACHIEVEMENT IN SCIENCE?*

Low Gek Chew, Beatty Secondary School, Singapore

Goh Ngoh Khang, Lucille Lee Kam Wah & Chia Lian Sai,
National Institute of Education, Singapore

Introduction

One of the aims of science education is to develop in students skills of understanding and application of scientific concepts and principles. These skills are essential in a fast moving technological world. However, in our secondary schools many students find the studying of science rather difficult, because it contains many abstract and factual knowledge. Hence, there is a need to search for effective ways of teaching and learning science.

A study by Ebenezer and Zoller (1993) indicated that students perceived current practices in science classes as mainly the copying of teacher's notes. The students concerned preferred science teaching and learning in such an environment where they could take an active and responsible role. Therefore, an effective teacher should explore and keep up with current trend in structuring activities and instructional strategies that promote active learning as well as encouraging student participation and interaction. An instructional method known as cooperative learning has emerged as one of the alternatives to the traditional style of teaching.

According to Johnson and Johnson (1989), Hassard (1990) and Kagan (1992) cooperative learning strategies encourage active student participation and facilitate deep and

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meaningful learning. This approach appears to create classroom conditions that enhance social relationship and promote academic achievement.

Though extensive research on cooperative learning strategies have been done in some countries, such as the United States, such systematic research is somehow lacking in Singapore, especially in the area of science teaching. This study attempts to find out whether the cooperative learning strategy can improve science achievement of our secondary three students.

Cooperative Learning Concept

In a cooperative learning situation, students of different abilities work together in small groups of 4 to 6 members to accomplish shared goals. There is a positive interdependence in learning. When one student achieves his/her goal, all students with whom he/she cooperatively works with also achieve their goals (Johnson & Johnson, 1989).

Over the years, several models of cooperative learning have been developed. The better known models are: Student Teams-Achievement Divisions (STAD)(Slavin, 1989), Teams-Games Tournament (TGT)(Slavin, 1989), Jigsaw (Aronson et al., 1978), Team Assisted Individualisation (TAI) (Slavin, 1989), Learning Together(Johnson & Johnson, 1989), and Group Investigation (Sharan & Sharan, 1976). Although the models differ considerably from one another, they have certain elements in common. These elements are essential for students to work cooperatively in small groups. The two most important elements are group goals and individual accountability: Group members help each other to achieve their goals and the success of the group depends on the individual learning of every group member (Slavin, 1989).

Cooperative Learning On Achievement

Researchers in other countries have found that cooperative learning using small groups of students contributed significantly to student achievement at all grade levels, for all subject areas and for all tasks (Slavin, 1981; Johnson & Johnson, 1985; Kagan, 1992). Johnson et al. (1981) conducted a meta-analysis of 122 studies investigating cooperative learning. They concluded that cooperative goal structures promoted higher achievement compared to competitive or individualistic structured goals. This finding was supported by Slavin (1983). His review of 46 studies revealed that 63% showed cooperative learning to have significant effects on student achievement, 33% showed no difference, and 4% showed higher achievement for the control group. Humphreys, Johnson and Johnson (1982) indicated that cooperative learning experience promoted greater mastery and retention of materials taught. Students in the cooperative learning group had more positive attitudes towards learning. Thus, the outcomes shown by the above-mentioned researchers may imply that the incorporation of cooperative learning into the existing classroom could have certain impact on students' learning.

Methodology

The purpose of this study is to examine whether cooperative learning strategy can be used to facilitate the learning of science. The sample was drawn from the 1993 secondary 3 cohort of a neighbourhood school. Two intact classes were used. The experimental and control groups were randomly assigned by tossing a coin. The experimental group consisted of 40 pupils and the control group consisted of 37 students. The same teacher was responsible for the delivery of the same course content (Chemistry component of Science)

for both the two groups. Students in both groups were instructed identically except for the student activities.

The non-equivalent control-group design (Campbell and Stanley, 1963) was used to determine the effectiveness of the cooperative learning and individualistic learning on students' science achievement. The design was as follows:

$$O_1 \quad x \quad O_3$$
$$O_2 \quad - \quad O_4$$

In this design,

x : Cooperative learning in science lessons,

- : Individualistic learning in science lessons,

O₁ : Pretest used to measure science achievement of the cooperative learning group,

O₂ : Pretest used to measure science achievement of the individualistic learning group,

O₃ : Posttest used to measure science achievement of the cooperative learning group,

O₄ : Posttest used to measure science achievement of the individualistic learning group.

The experiment was carried out over a period of eight weeks. The first and last weeks were set aside for administration of pretest and posttest. Each class had a single and double periods of chemistry lessons per week. Normal lectures and discussions were conducted when it was a single period of 35 minutes. For double period of 1 hour 10 minutes, the teacher would teach for 35 minutes, 25 minutes would be spent on doing worksheet and the last 10 minutes on quiz. Rewards in the form of class recognition were given each week for individual and group performance. The quiz scores were not counted in the achievement scores. At the end of the experiment, a posttest was administered to the two groups to determine the effect of the treatment.

Test Instrument

The science achievement test was developed based on the topics of the Periodic Table and Reactivity Series of Metals which were covered during the experimental period of eight weeks. The test consisted of 26 multiple-choice questions in Section A and 6 structured questions in Section B. The questions were adapted from the GCE 'O' level past year examination questions and from assessment books and textbooks. These questions tested students on their knowledge, understanding and applications of the concepts taught. The Cronbach alpha for the test was determined to be 0.73.

Cooperative Learning Group

The cooperative learning method used in this study was adapted from the Student Teams-Achievement Divisions (STAD). Students in the experimental class were divided into heterogeneous groups based on their academic performance, sex and ethnicity. After the teacher had presented the lesson, students solved problems on the lesson through cooperation among team members. When students completed their assignments, a quiz would be administered to evaluate their understanding. Students took the quiz individually and they were not permitted to help each other. Team scores were computed by adding the individual score of each team member. The teacher would announce the team scores and indicate the ranking of each team within the class.

The Individualistic Learning Group

In the individualistic learning group, students were not subjected to any groupings. After the presentation of the lesson by the teacher, students had to solve the same problems,

as given to the cooperating learning group, in the worksheets through their own effort. The Chemistry textbook (Briggs, 1992) was used as a reference for getting the answers to the questions. After completing the worksheet, students took a quiz on the lesson individually. The teacher would announce the individual scores.

Results

The means and standard deviations of the science achievement in both the pretest and posttest are shown in Table 1.

Table 1 : Means and Standard Deviations of Students' Performance in Science Achievement

Group	n	Pretest	Posttest
Cooperative	40		
Mean		11.93	37.48
S.D.		4.83	6.62
Individualistic	37		
Mean		12.92	33.35
S.D.		5.10	9.30

Maximum score : 60

An independent 2-tailed t-test was carried out on the pretest scores to determine if there was significant differences between the experimental group and the control group with regard to achievement prior to the treatment. The results are shown in Table 2.

Table 2 : T-test to compare Cooperative Learning and Individualistic Learning on the Pretest Scores in Science Achievement

Group	n	Mean	S.D.	t-value	df	prob
Cooperative	40	11.93	4.83	0.879	75	0.614
Individualistic	37	12.92	5.10			

As shown in Table 2, the calculated t-value 0.879 is less than the critical value at 0.05 level of significance. This indicated that there was no significant difference in prior knowledge between the two groups before the treatment. After the treatment, the cooperative learning group performed better in the achievement test based on the posttest means shown in Table 1. An analysis of covariance (ANCOVA) was performance to determine if the achievement of the experimental group was significant. The results are presented in Table 3.

Table 3 : Comparison of Posttest Means of the Two Groups by ANCOVA using the Pretest as the Covariate

Source	Partial SS	df	MS	F	Prob
Model	1188.52	2	594.26	11.11	0.000
Group	439.33	1	439.33	8.22	0.005
Pretest	861.25	1	861.25	16.11	0.000
Residual	3957.03	74	53.47		
Total	5145.55	76	67.70		

The test for difference in treatment effects on the two groups yielded significant $F = 8.22$ ($df = 1, p < 0.005$). Hence students in the cooperative learning group did

significantly increase their achievement scores over the individualistic learning group. Figure 1 shows differences in the students' performance in the science achievement means between the groups before and after the treatment.

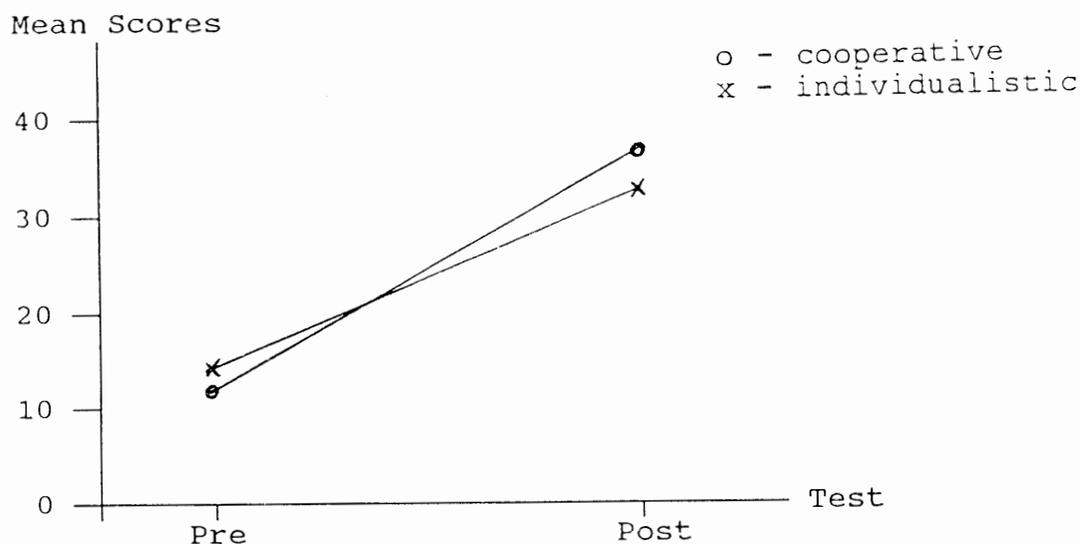


Figure 1 : Plot of Mean Pretest and Posttest Scores in Cooperative and Individualistic Learning Groups

The two groups had positive gradients illustrating achievement gains in both groups. The slope of the cooperative learning ^{group} was steeper than that of the individualistic learning group. Initially the means of the cooperative learning group was slightly lower. After treatment, the gain in science achievement in the cooperative learning group was much higher than those in the individualistic learning group. Therefore, the incorporation of cooperative learning technique had indeed facilitated the learning of science.

Discussion

The results of this study indicate that cooperative learning is more effective in enhancing students' performance in science than individualistic learning. The results also support most of the research evidence on the effectiveness of cooperative learning (Johnson

& Johnson, 1989; Johnson et al., 1981).

In this study, we found that the students in cooperative learning groups are more motivated to learn. When working in groups, they encourage and help each other to learn better through activities and discussion. The discussion among group members promotes frequent and oral repetition of information. This may also result in the use of higher-level reasoning strategies (Johnson & Johnson, 1989).

Implications For The Classroom Teacher

The greater achievement gains of the experimental group illustrate that cooperative learning using Student Teams-Achievement Divisions is an effective teaching strategy, which can be easily implemented into the existing science curriculum by any science teacher.

Cooperative learning is an alternative to competitive or individualistic learning, which is a disadvantage to slower students. Learning can be made more effective and interesting if the teacher incorporates cooperative learning approach into the on-going classroom instruction. Teachers should provide opportunities for students of mixed abilities to work together in small groups.

Cooperative learning may improve relationship between different ethnic groups. When students work together, they learn to trust, show respect for each other's strength and weakness, and develop friendships. This is essential for creating racial harmony in a multi-ethnic country like Singapore.

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