Effects of Cooperative Learning Strategy on Junior Secondary School Students Achievement in Integrated Science

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Abstract

The purpose of this study was to determine how the adoption of cooperative learning as an instructional strategy for teaching Integrated Science influences students' achievement and attitude towards studies. The study also determined how moderating variables like sex and ability affect students' achievement in Integrated Science when cooperative learning is used as an instructional strategy. To guide this study, five hypotheses were stated and tested at 0.05 level of significance. The design of the study was a 2x2x2x2 factorial, pre-test, post-test control group design. These included two instructional groups (cooperative and traditional classroom groups), sex (male and female), ability (high and low), and repeated testing (pre-test and post-test). The population of study was made up of 205 JS III students from where a sample of 120 students was randomly selected. The instruments used for the collection of data included: a Scholastic Ability Test in Integrated Science (SATIS), Students' Attitude Scale (SAS), and Integrated Science Achievement Test (ISAT). All the data collected were analyzed with analysis of co-variance statistic. The major findings of the study included: a significant higher achievement test scores of students in cooperative learning group than those in traditional classroom; a significant higher attitude scores of students in cooperative learning group than those in traditional classroom; a significant higher achievement test scores of all students of varying abilities in cooperative learning group than those in traditional classroom; a non-significant difference in achievement test scores between the male and female students in the cooperative learning group, and non-significant interaction effect between sex and ability, sex and method, ability and method and among method, sex and ability on achievement.

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Introduction

Borich (2004, p. 331) asked, "What good are critical thinking, reasoning, and problem-solving skills if your learners cannot apply them in interaction with others?" Cooperative learning activities instill in learners important behaviours that prepare them to reason and perform in an adult world (Adams & Hamm, 1996; Marzano, Pickering, &

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Pollock, 2001). Attitudes and values of learners are formed through social interaction. Borich (2004) noted that most of our attitudes and values are formed by discussing what we know or think with others. Continuing, in this manner, we exchange our information and knowledge with that of others who have acquired their knowledge in different ways. This exchange shapes our views and perspectives.

Our attitudes and values are among the most important outcomes of schooling (Borich, 2004). They provide the framework for guiding our actions outside the classroom. Cooperative learning is important in helping learners acquire from the curriculum the basic cooperative attitudes and values they need to think independently inside and outside of the classroom.

Academic achievements of students have been found to be enhanced by the use of cooperative learning (Lampe, Rooze & Tallent-Runnels, 1998; Johnson & Johnson, 1989; Slavin, 1990, 1991; Webb, 1989). Stevens and Slavin (1995) stated that, the fact that it has been linked to increases in the academic achievement of learners at all ability levels is another reason for its use. Bramlett (1994), Megnin (1995), and Webb, Trooper, and Fall (1995) in their contributions noted that cooperative learning activity engages the student in the learning process and seeks to improve the critical thinking, reasoning, and problem-solving skills of the learner.

While research efforts on cooperative-learning indicate that it enhances student achievement (Johnson & Johnson 1989; Slavin 1990; 1991; Webb 1989), Lampe, Rooze and Tallent-Runnels (1998) stated that peer interaction is central to the success of cooperative learning as it relates to cognitive understanding. They further noted that comprehension is facilitated. Lampe et al (1998) again emphasized that as learners, some of who might normally "turn out" or refuse to speak out in a traditional setting, become actively involved in the learning process through group interaction. Stahl and Vansickel (1992) noted that every cooperative-learning strategy, when used appropriately, can enable students to move beyond the text, memorization of basic facts, and learning lower level skills. This method which results in cognitive restructuring leads to an increase in understanding of all students in a cooperative group.

Apart from academic benefits, cooperative learning has been found to promote self-esteem, interpersonal relationship and improved attitudes toward school and peers (Johnson & Johnson, 1996). Lampe et al (1998) stated that in a competitively structured classroom, except for the few "Winners" or students who succeed, self-esteem can suffer. When competition is promoted, students may learn to value winning at all costs, and cooperation may be discouraged (Lampe, et al 1998; Conrad, 1988). Although the advocates of cooperative learning are not opposed to all competition, they do oppose inappropriate competition (Johnson & Johnson, 1996; Johnson & Johnson, 1991). Stahl (1992) stated that inappropriate competition tends to widen the existing differences and abilities, which, in turn, can widen negative perceptions of others on the basis of gender, race, or ethnicity. Studies by Glassman (1989), and Johnson, Johnson and Stanne (1986) and comments by Johnson and Johnson (1996) and Trowbridge and Bybee (1996) on cooperative learning found cooperative-learning groups to equalize the status and respect for all members, regardless of gender. Research by Klein (1985) noted by Lampe et al

(1998) revealed that competitively structured classrooms have the effect of favouring boys or reinforcing sex role stereotypes that may limit opportunities for girls. In cooperative learning this usually is not the case, where interaction among students is intense and prolonged and students gradually take responsibility for each other's learning (Borich, 2004).

A synthesis of researches on the influences of ability and gender on cooperative learning outcomes indicated similar findings in all. Studies by Stevens and Slavin (1995), Bramlet (1994), Megnin (1995), Webb, trooper and fall (1995), Glassman (1989), Johnson, Johnson and Stanne (1986) and Crosby and Owens (1993) found that cooperative learning gains are not limited to a particular ability level or sex but to all who engage in it. Stevens and Slavin (1995), for example, linked cooperative learning to increases in academic achievement of learners at all ability levels, while studies by Glassman (1989) and Johnson, Johnson and Stanne (1986) found cooperative learning to equalize the status and respect for all group members, regardless of gender. Again the study by Crosby and Owens (1993) found that different cooperative learning strategies can be employed to help low ability students to improve achievement, who had difficulties making success in the traditional classroom.

In general, cooperative learning can be said to lead to the formation of attitude and values, provision of models of prosocial behaviour, presentation of alternative perspective and viewpoints, building a coherent and integrated identity, and promotion of critical thinking, reasoning, and problem-solving behaviour (Borich, 2004; Stevens & Slavin, 1995; Abruscato, 1994; Zehin & Kottler, 1993). All these result in collaborative skills improvement, better self-esteem and increased achievement. (Johnson & Johnson, 1996).

Science teaching and learning today is to a great extent focused on activities by which the learner acquires facts, rules and action sequences (Kpangban & Ajaja, 2007). In a student-centered instructional approach like this, using student ideas means incorporating student experiences, points of view, feelings, and problems into the lesson by making the student the primary point of reference. A completely student-oriented lesson is always initiated by asking students questions and assigning specific roles to them on the content to be taught and their answers and dispositions would become the focus of the lesson. This approach, according to Borich (2004), is intended to heighten student's interest and to encourage positive attitude and feeling towards the subject. Research by Johnson and Johnson (1991) on learning together and alone showed that cooperative learning enhanced more positive attitude towards subject members and the teacher.

Evidences from research works in Nigeria indicated that very little research efforts had been directed at cooperative learning. This approach has been highly recommended for teaching at all levels, as stated by the Federal Government of Nigeria (2004) in the National Policy on Education. This, therefore, tends to suggest that as most teachers are not sensitized on the advantages of the use of cooperative learning, it is believed that the manner in which most schooling occurs may not be teaching students to become aware of their own learning, to think critically and to derive their own pattern of

thought and meaning from content presented through interaction as a result of cooperative learning. It was purely in an attempt to bridge the wide gap on the knowledge of the effects of cooperative learning on science students' achievement using our local environment that, this study was carried out. In the study attempt was made to find out the effects of cooperative learning on junior secondary school (JSS) students' achievement in integrated science, attitude towards their studies, and also determined whether it was sex and ability biased

Statement of Problem

There have been a lot of comments in books, particularly those written in Europe and America, which confirmed cooperative learning to be an effective way to structure learning activities. But there is surprisingly very little research effort, particularly in Nigeria, that emphasized cooperative interaction in science and even less that focused on integrated science at the junior secondary school level. Furthermore, no studies to our knowledge had investigated the effect of cooperative learning and its interaction with sex and ability on science achievement and attitude among junior secondary school students in Nigeria. The purpose of this study, therefore, was to specifically determine, among others, the effects of cooperative learning on students' achievement in integrated science, students' attitude toward their studies and to see if the effects were sex and ability-dependent. The statement of the problem, therefore, is; will the application of cooperative learning strategy in the teaching of integrated science produce differential achievement and attitude scores among junior secondary school students generally and specifically among students of varying abilities and sex?

Research Questions

This study was guided by the following research questions.

1. Is there any difference in achievement test scores between students instructed using cooperative learning strategy and those instructed using the traditional classroom teaching method?

2. Is there any difference in attitude scores between students instructed using cooperative learning strategy and those instructed using traditional classroom teaching method?

3. Is there any difference in achievement test scores between male and female students instructed with cooperative learning strategy?

4. Is there any difference in achievement test scores between high ability students taught with cooperative learning strategy and those taught with traditional classroom teaching method?

5. Is there any difference in achievement test scores between low ability students taught with cooperative learning strategy and those taught with traditional classroom teaching method?

6. Are there interaction effects among methods, sex and ability on achievement?

Research Hypotheses

From the research questions raised, five hypotheses were stated and tested at 0.05 level of significance.

Ho_1: There is no significant difference in achievement test scores between students instructed with cooperative learning strategy and those taught using traditional classroom teaching method.

Ho_2: There is no significant difference in attitude scores between students instructed with cooperative learning strategy and those taught using traditional classroom teaching method.

Ho_3: There is no significant difference in achievement test scores between male and female students instructed with cooperative learning strategy.

Ho_4: There is no significant difference in achievement test scores between students of varying abilities instructed with cooperative learning strategy and those taught with traditional classroom teaching method.

H05: There are no significant interaction effects among method, sex and ability on achievement.

Methodology

Design of the Study

The study employed a 2x2x2x2 factorial pre-test, post-test control group design. This design consisted of two instructional groups (cooperative group and traditional classroom teaching group) sex (male and female) ability (high and low) and repeated testing (pre-test and post- test). The main independent variables were exposure to cooperative learning strategy, sex and ability while the dependent variables were achievement and attitude.

Population and Sample of the Study

The test population consisted of 205 junior secondary class three (JS III) students in Abavo Mixed Secondary School, Abavo. Nigeria From the population of 205 students a sample of 120 students was randomly selected. The two sexes were equally represented in the sample. The sampled subjects were randomly assigned to four classes of 30 students each. Two classes formed the cooperative learning group while the remaining two classes served as the traditional teaching method group, which is the control group.

In distributing the subjects into two groups, all the JS III students were divided into three groups according to their scores in a scholastic ability test in integrated science.

Students in the middle ability group were not used for the study because of their ability to become either high or low ability subjects. Using the ability scores, students were randomly and proportionately assigned to the experimental and control group classes.

The researchers assigned two experienced teachers to teach the experimental and control groups and trained them on the basic skills of cooperative learning strategy before the commencement of treatment. The two teachers selected to teach the subjects had taught integrated science for the past ten years and both of them were graduates of integrated science. The two teachers had similar experiences on teaching skills based on their training as teachers. The two teachers were randomly assigned to the experimental and control classes using balloting. All the classes were taught by their respective teachers at the early hours of the day. All the lessons ended before noon.

Instruments

Test Materials: The test instruments used for this study included: Scholastic Ability Test in Integrated Science (SATIS), Students' Attitude Scale (SAS) and Integrated Science Achievement test (ISAT).

The SATIS used in this study is the one designed by Delta State Ministry of Education. The test items covered all the major topics in integrated science in the Nigeria National Curriculum on integrated science. The test consisted of 50 multiple choice items in order to test students' knowledge of integrated science at the end of JS III. The validation of the SATIS was determined when it was constructed by experts in Examination and Standards Department of Delta State Ministry of Education. The coefficient for the test was 0.82 using the Kuder-Richardson 21 formula. This value indicated a very satisfactory level of reliability.

The Students' Attitude Scale (SAS) was constructed by the researcher by selecting and adapting some items in a section on disposition in an instrument – higher – order thinking and problem – solving checklist constructed by Borich (2004). The SAS consisted of 12 items on a 4 point Likert scale testing for student's attitude towards integrated science lessons and their fellow students and their groups. The 12 individual categories of student attitude in the SAS represented the fine structure details of students attitudes found in most science classrooms. Examples of some issues in the items of the instrument included: enthusiasm to learning, collaboration with others, sharing with others, flexibility and providing assistance to others. The instrument was validated by adopting the inter-rater reliability approach. The inter-rater reliability index for the instrument was put at 0.76.

The integrated science achievement test used for this study was constructed by the researchers. The test which consisted of 50 multiple choice items covered all the concepts in "you and your home". The battery of achievement tests were constructed by adopting a discrimination power (ability of the test to discriminate between low and high achievers) of 0.2 and above as being acceptable. Test items with discrimination power below 0.2 were removed and reconstructed. On difficulty levels, a difficulty level of item from 25-80% was accepted. Items with difficulty levels below and above the specified range were

removed and replaced. The reliability index of the instrument was found to be 0.81 using the kuder-richardson 21 formula. Recommendations by Thorndike and Hagen (1977), Wiseman (1999), Johnson and Christensen (2000) and Borich (2004) indicated that reliability has to do with accuracy and precision of a measurement procedure. a high reliability value of 0.70 or higher shows that the test is reliable (accurately), measuring the characteristics it was designed to measure. With this background information, all the test instruments were administered on the subjects.

Treatment Procedure

The two instructional groups compared, cooperative-learning (Experimental) and traditional classroom teaching method (control) groups, were identified on the basis of teachers' behaviours during classroom activities and simple laboratory exercises. The effects of cooperative learning strategy on the achievement and attitude of 120 integrated science students in junior secondary school classes three (JS III) was investigated in the controlled condition of classrooms. All the subjects were pre-tested before treatment.

The materials learned by the subjects from where the achievement tests were drawn, were a six week instructional unit drawn from "You and your home" in Science Teachers Association of Nigeria Integrated Science Book III. During the treatment period, students in the cooperative-learning classrooms were instructed by teachers who followed the guidelines learned during the training by the researchers. The teacher in the cooperative-learning group incorporated the basic elements of cooperative learning into the group's experience: positive interdependence, face-to-face interaction, individual accountability, social skill development, and group processing, as recommended by Johnson, Johnson and Holubec (1990). In addition, the teacher specified both the academic and social skill objective, explained the tasks and goal structures, assigned roles within the groups and described the procedure for the learning activities, as demonstrated by Trowbridge and Bybee (1996).

In the group taught with the traditional classroom teaching method, the whole class was taught the same content in "you and your home" by the teacher. The teaching of students in this group was still centred on the use of the recommended textbook. Instead of discussing the material, helping each other, or developing projects in groups, students read the assigned reading material silently, completed assignments independently at their seats, engaged in discussions with the teacher in response to the teacher's questions. The teacher teaching this group dispensed facts to the students. This is the most dominant method for teaching science in Nigeria, Ajaja (2002) found that the method of teaching science in all schools was lecture method. At the end of every week's instruction, post achievement test was administered to both the experimental and control groups. Also at the end of every week's instruction, attitude scores of the subjects in experimental and control groups were taken. At the end of the sixth week of instruction, the achievement test and attitude scores of the subjects in the experimental and control groups were averaged to arrive at the individual student's post-test and attitude scores.

Results and Discussion

Results

Table 1
Comparison of effects on achievement between cooperative-learning and traditional teaching methods of teaching integrated science.

Group	N	Unadjusted Mean	SD
Pre-test			
Cooperative-learning	60	26.23	7.05
Traditional teaching method	60	26.93	7.02
Post-test			
Cooperative-learning	60	58.11	9.60
Traditional teaching method	60	38.62	10.34

The cooperative learning group scored higher marks on the post-achievement test than the control group where Integrated Science was taught with the traditional teaching method as shown in Table 1.

Table 2
Summary of analysis of co-variance of achievement (post with pre) test scores on instructional method, sex and ability.

Source	Type III Sum of Squares	*df*	Mean Square	F	Sign F.
Corrected model	22,383.070"	8	2,797,884	1.758	.093
Intercept	15,630.291	1	15,630.291	9.823	.002
Pre-Test	474.929	1	474.929	.298	.586
Sex	1,817.725	1	2,710.887	1.704	.195
Method	10,602.501	1	10,602.501	6.663	.011
Sex * Ability	1,443.656	1	1,443.656	.907	.343
Sex * Method	1,433.070	1	1,433.070	.901	.345
Ability* Method	2,222.288	1	2,222.288	1.397	.240
Sex * Ability * Method	1,652.602	1	1,652.602	1.039	.310
Error	176,623.706	111	1,591.205		
Total	479,755.930	120			
Corrected Total	199,006.776	119			

a. R squared =112 (Adjusted R squared = .049)

A significant difference was found between the group taught with the cooperative learning strategy and the group taught with the usual and traditional method of teaching integrated science on achievement, as shown in Table 2 ($f = 6.663$, $p<0.05$). With this finding, hypothesis 1 was accordingly rejected.

Table 3
Comparison of effects on attitudes between cooperative learning and traditional teaching methods of teaching integrated science.

Group	N	Unadjusted Mean	SD
Pre-test			
Cooperative-learning	60	72.33	6.9
Traditional teaching method	60	72.50	3.4
Post-test			
Cooperative-learning	60	85.05	6.90
Traditional teaching method	60	73.7	3.73

The integrated science students taught with the cooperative learning strategy had higher attitude scores than those taught with the usual traditional teaching method on post-test, shown in Table 3.

Table 4
Summary of analysis of co-variance of attitude (post with pre) test scores on instructional method

Source	Type III Sum of Squares	*Of*	Mean Square	F	Sign F.
Corrected model	4,007.3689'[1]	2	2,003.684	67.706	0.000
Intercept	2,869.087	1	2869,087	96.948	,000
Pre-test	131.334	1	131.334	4.438	.037
Method	3,897.051	1	3,897.051	131.684	.000
Error	3,462.499	117			
Total	76,3358.000	120			
Corrected Total	7,469.867	119			

a. R squared = .536 (Adjusted R squared = .529)

A significant difference was found between integrated science students taught with cooperative learning strategy and those taught with the usual traditional teaching

method on attitude as shown in Table 4 (f=131.684, p< 0.05). Hypothesis 2 was, therefore, rejected.

Table 5
Comparison of achievement of male and female integrated science students taught with cooperative- learning

Group	N	Unadjusted Mean	SD
Pre-test			
Male	30	25.73	7.06
Female	30	26.73	7.133
Post-test			
Male	30	60.94	8.74
Female	30	63.29	10.6

Table 5 shows that on post-test, the male and female integrated science students in the cooperative learning classroom scored slightly different scores. The males had mean scores of 60.94 while the mean score of females was 63.29. To find out if significant difference existed between the males and the females, reference was made to Table 2 where a non-significant difference was found between the post-achievement test scores of male and female Integrated Science students in the cooperative classrooms (f=1.42, p>0.05). Hypothesis 3 was, therefore, retained.

Table 6
Comparison of achievement test scores of high-ability integrated science students taught with cooperative-learning and with traditional teaching methods.

Group	N	Unadjusted Mean	SD
Pre-test			
Cooperative learning	30	30.27	5.69
Traditional teaching method	30	32.00	5.26
Post-test			
Cooperative learning	30	58.50	7.54
Traditional teaching method	30	47.59	3.34

High ability Integrated Science students in the cooperative classroom scored higher marks on achievement test than their counterparts in the traditional method classroom, as shown in table 6

Table 7
Comparison of achievement test scores of low ability students taught with cooperative-learning and with traditional teaching methods.

Group	N	Unadjusted Mean	SD
Pre-test			
Cooperative learning	30	22.20	5.92
Traditional teaching method	30	22.19	4.83
Post-test			
Cooperative learning	30	43.4	3.8
Traditional teaching method	30	31.0	6.3

Low ability integrated science students in the cooperative classroom scored higher marks on the achievement test than their counterparts in the traditional method classroom, as shown in Table 7.

Table 8a
Summary of analysis of co-variance of achievement (post with pre) test scores on high ability

Source	Type III Sum of Squares	*df*	Mean Square	F	Sign F.
Corrected model	2,192.546[3]	2	1,096.273	16.709	,000
Intercept	5,068.213	1	5,068.213	77.247	.000
Pre-test	7.273	1	7.273	.111	.740
Method	2,064.609	1	2,064.609	31.468	.000
Error	3,739.795	57	65.610		
Total	17,1065.930	60			
Corrected Total	5,932.342	59			

a. R square = .370 (Adjusted R square = .347)

Table 8b
Summary of analysis of co-variance of achievement (post with pre) test scores on low ability

Source	Type III Sum of Squares	*df*	Mean Square	F	Sign F.
Corrected model	2,791.452	2	1,395.726	50.863	.000
Intercept	3,536.902	1	3,536.902	128.891	.000
Pre-test	2.072	1	2.072	.076	.784
Method	2,766.124	1	2,766.124	100.803	.000
Error	1,564.137	57	27.441		
Total	84,648.690	60			
Corrected Total	4355,590	59			

a. R squared = .641 (Adjusted R squared = .628)

Significant differences were found between integrated science students of varying abilities in the cooperative-learning classroom and those in the traditional teaching method classroom, as shown in Tables 8a and 8b. In Table 8a, $f = 31.468$, $p<0.05$ while in Table 8b $f = 100.803$, $P<0.05$. Hypothesis 4, was, therefore, rejected.

As shown in Table 2, non-significant interaction effects on achievement were found between sex and ability, sex and method, ability and method and among sex, ability and method. With these findings, hypothesis five was retained.

Discussion

This study is most significant in that it has moved studies on cooperative learning a step further. The findings of this study have demonstrated the effectiveness of cooperative learning in the teaching and learning of science at the lower secondary school level of education. Initial research efforts on cooperative learning had been centred on the use of subjects at the senior secondary level. This study is also significant in that it demonstrated the effects of cooperative learning strategy on students' achievement and attitude in one single study. Again the study compared how sex and ability variations influence students' scores in cooperative classes. The combination of variables helped to determine the interaction between and among the variables in influence students test scores in science.

One major finding of this study is that students taught using the cooperative learning approach scored higher marks in science achievement test than those taught using the traditional classroom teaching method. This may have been achieved by the high level of students' participation in learning activities. All the students in the cooperative group performed specific roles in solving problems which are presented in

the classroom to the benefit of all members of the group. When learners are confronted with problems which they must solve, they are forced to reason and think critically in order to solve the problems. This finding agrees with the findings of Stevens and Slavin (1995), Lampe, Rooze and Talent-Runnels (1998) and Borich (2004). It is believed that when properly and carefully used cooperative learning activities engage the students in the learning process and seek to improve the critical thinking, reasoning and problem-solving skill of learners (Bramlett, 1994; Megnin, 1995; Webb, Trooper, & Fall,1995). Specifically, these research findings are hinged on certain principles which guided the studies. Bramlett (1994) hinged his study on the principle that cooperative learning enhances active engagement of students and critical thinking. Megnin (1995) based his study on the principle that cooperative learning enhances students' memory and creativity, while Webb et al (1995) anchored their study on the principle that constructive activity and collaborated learning are enhanced in cooperative learning classrooms.

The students in the cooperative learning classroom were found to exhibit better attitude towards the learning of science, as measured by their attitude scores, using an attitude scale. This seems to agree with the general notion that individuals can change their attitude and disposition through interaction with others in one way or the other. Borich (2004), for example, noted that cooperative learning is important in helping learners acquire from the curriculum the basic cooperative attitudes and values they need in the classroom and outside the classroom. The attitudes exhibited by students in the cooperative learning class may also be explained, at least in part, by the fact that interaction among students in cooperative learning groups is intense and prolonged.

In classes where cooperative learning approach is used for teaching, students gradually take responsibility for each other's learning. The better attitude exhibited by students in the cooperative learning classroom may have been achieved because feedback, reinforcement, and support come from students' peers in the group. Again, students in cooperative learning performing better in test of attitude towards studies may perhaps be because of imbibing of role expectations and responsibility, which are two very important features of cooperative learning.

In this study neither achievement nor attitude results were affected by sex. All students irrespective of their sexes benefited in about the same margin from the use of cooperative learning strategy. This perhaps may be the reason why no significant difference was found in achievement between the male and female students on the use of cooperative learning strategy. By definition, if one group changes in a similar amount as another group, there will be no significant difference between them. What matters most in cooperative learning is role expectations and responsibilities. Borich (2004) noted that the success of a cooperative learning activity depends on your communication of role expectations and responsibilities and modelling them where necessary. These, the teacher teaching cooperative classes with equal male and female students did by explaining the following: the assignment given, the collaborative goal to be achieved, individual student accountability, inter-group cooperation, criteria for success and specific cooperative behaviours expected. Once the students began work, the teacher observed the various groups and helped solve any problems that emerged.

Although non-significant interaction effects on achievement were found between sex and ability, sex and method, ability and method, and among sex, method and ability, it is believed that the higher thought processes as required for higher achievement, are induced by the interaction with one another more than with the traditional treatment from books and classroom teachers. This, again, may have contributed to the noticed significant difference in achievement scores between students in the cooperative classroom and those in the traditional classroom. Student-student interaction constitutes the majority of time and activity during cooperative learning. It is generally believed by researchers that an essential ingredient of cooperative learning is each learner's desire to facilitate the task performance of fellow group members.

Conclusion

It appears that cooperative learning, as described in this study, with strong empirical support for it and the fact that it makes sense for students' achievement and attitude towards studies, is a very viable option among other instructional methods for teaching science in secondary schools. We must, however, be careful not to over generalize since the method has the potential of making students believe that instructional problems cannot be tackled independently. The research into cooperative learning does not show that having students work together in a cooperative manner is a magic device that will solve all classroom problems. What it does say is that those problems probably have a better chance of being solved in cooperative than in competitive or an individualistic setting.

The pattern of teacher-student interaction during cooperative learning has implications for the teaching and learning of science in schools. The major purpose of teacher-student interaction during cooperative learning is to promote independent thinking. The exchanges between the teacher and students in the cooperative classroom focus on getting learners to think for themselves, independently of the text. This implies that science teachers must model their instructions to enforce collaboration with students since cooperative learning occurs in groups that share a common purpose and task, it, again, implies that the science teacher must broaden interactions to fit the zone of maximum response opportunity that is common to most group members in his classroom.

The interaction among students in cooperative learning groups is intense and prolonged. In cooperative learning groups, students gradually take responsibility for each other's learning. During cooperative learning, the feedback, reinforcement, and support come from student peers in the group. This implies that science teachers dividing their students into groups of four or five, working together in physical closeness promoted by a common task, will encourage collaboration, support and feedback from the closest and most immediate source-one's peers. The implication of this in teaching and learning of science is that science teachers should model their instructions to enforce student – student interaction.

Further research into cooperative learning could help us to understand the following: (i) what influence student's change of attitude in cooperative learning class; (ii) the relationship between cooperative learning and knowledge about the world; and

(iii) teachers' sex differentials and use of cooperative learning as an instructional approach.

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