

EFFECTIVENESS OF COOPERATIVE LEARNING AND RECIPROCAL TEACHING STRATEGIES ON JUNIOR SECONDARY SCHOOL STUDENTS' PERFORMANCE IN DIFFICULT BASIC SCIENCE AND TECHNOLOGY CONCEPTS

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ABSTRACT

This study investigates the effectiveness of cooperative learning and reciprocal-teaching in addressing the challenges associated with teaching difficult Basic Science and Technology concepts in senior Junior secondary schools. Traditional lecture-based methods often struggle to achieve desired learning outcomes in this domain. To address this issue, the researchers explored the impact of cooperative learning and reciprocal-teaching on students' achievement in Basic Science and Technology concepts. A quasi-experimental design was employed, involving 283 students from nine co-educational public Junior secondary schools in the Southern Education zone of Plateau State. Data was collected using a validated Basic Science and Technology Achievement Test (BSTAT) with a reliability index of 0.93. Analysis of covariance (ANCOVA) was utilized to test the hypotheses at a 0.05 level of confidence. The findings suggest that cooperative learning and reciprocal-teaching significantly enhance students' achievement in difficult Basic Science and Technology concepts. Based on these results, it is recommended that teachers in Plateau State, and indeed Nigeria, adopt these techniques to improve teaching effectiveness. Furthermore, there is a need to develop teachers' capacity in utilizing these methods to facilitate better learning outcomes in Basic Science and Technology education.

Key words: Cooperative Learning, Reciprocal-Teaching, Conventional Method, Achievement, Difficult Basic Science and Technology Concepts.

INTRODUCTION

Basic science and technology as an integrated science course combine all the science subject such as physics, chemistry, biology and health science, taught at the lower, middle and upper basic education levels. The general objectives of basic science and technology education is to enable learners observe and explore the environment using their senses and their hands. These objectives are enshrined in the basic science and technology curriculum derived from the national policy on education (Ogbu, 2013).

The design of curriculum is based on the idea of spirality of themes which are arranged from year one to year nine, that is beginning with the lower basic (elementary 1-3) to the middle basic (elementary 4-6) and to the upper basic (Junior Secondary 1-3). This is continuous across the 9-year of basic education in order to enhance the achievement of learners and promote a meaningful learning (Federal Republic of Nigeria (FRN), 2014).

The realm of Basic Science and Technology in junior secondary education presents a formidable

challenge to both students and educators alike. According to Tajudeen (2015), over sixty-five topics within this domain are widely perceived as difficult by students, a sentiment echoed by educators. These perceived difficulties not only hinder students' academic achievements but also dampen their interest in Basic Science and Technology as a whole. This lack of enthusiasm is reflected in both internal and external examinations, notably the Basic Education Certificate Examinations (BECE) of 2018, 2019, 2020, 2021, 2022, and 2023. Consistently, these examinations reveal troubling trends of poor performance among candidates, particularly in areas such as Habitat and Adaptation of living things, Uniqueness of man, Growth and Development, Chemicals, Work Energy and Power, Kinetic theory, Heat flow, Crude oil, Evaporation, Conduction, and Petrochemicals, among others. The repercussions of such widespread academic struggle extend beyond the classroom, contributing to various societal challenges including economic instability, low industrialization rates, job scarcity, food insecurity, and reduced enrollment in advanced education programme. This introduction underscores the urgent need to address these persistent challenges in Basic Science and Technology education to foster not only academic success but also societal advancement and well-being (Njoku, 2013 & Tajudeen, 2015) It is in view of this that this study investigate the impact of cooperative learning and reciprocal-teaching strategies on students' achievement in difficult Basic Science and Technology concepts drawn from the national junior secondary school curriculum.

Research Question:

One research question guided the study:

What are the achievement mean scores of students taught some difficult Basic Science and Technology concepts using cooperative learning, reciprocal-teaching and conventional teaching method?

Hypothesis

One null hypothesis was formulated and tested at 0.05 levels of significance in this study:

There is no significant difference in the achievement mean scores of students taught some difficult Basic Science and Technology concepts using cooperative learning, reciprocal-teaching and conventional teaching method.

Method

The methodology employed in this study utilized a quasi-experimental design, specifically the pretest-posttest nonequivalent control group design, due to the use of intact classes. The study focused on JSS two Basic Science and Technology students within the Jos Education Zone of Plateau State, Nigeria.

A sample of 283 JSS two Basic Science and Technology students from two intact classes across two junior secondary schools participated as research subjects. Of the population of 19,400 students Treatment conditions were randomly assigned to the intact classes, resulting in three experimental groups: cooperative learning, reciprocal-teaching, and a control group. Each treatment condition was implemented in three schools.

Basic Science and Technology teachers within each sample school were trained and acted as research assistants, guiding the teaching process. Prior to implementation, these teachers underwent a five-day training session to familiarize themselves with the treatment procedures. Lesson plans prepared by the researchers were strictly adhered to during teaching sessions.

Students were trained on how to participate in the study, with research assistants providing guidance on the features and practices of cooperative learning and reciprocal-teaching. In the cooperative learning group, students worked collaboratively within their groups, while in the reciprocal-teaching group, high-ability students served as teachers for middle and low-ability reciprocals. The control group continued with the lecture method. Two difficult concepts namely force and energy were randomly selected and thought from a pool of 65 concepts identified as particularly challenging.

To minimize contamination between groups, each treatment group remained unaware of the other treatment conditions. Additionally, all sample schools had one stream of JSS Two students, preventing any opportunity for students to switch between groups during the study period. The research question was answered using mean and standard deviation of the achievement scores. Analysis of covariance (ANCOVA) was used to test the hypothesis at 5% level of significant. The results of the study are presented in tables 1, 2 and 3 below.

Research Question

What are the achievement mean scores of students taught some difficult Basic Science and Technology concepts using cooperative learning, reciprocal-teaching and Lecture method?

Table 1: Achievement Mean Scores and Standard Deviations of Students in Basic Science and Technology

Treatment group	N	pretest	SD	Post-test mean x	SD	Mean Gain Score
Cooperative Learning	90	30.44	10.80	62.28	17.05	31.84
Reciprocal Teaching	100	23.00	11.33	55.62	14.99	32.62
Lecture Method	93	22.98	4.70	44.94	9.23	21.96

Table 1 shows that students taught using cooperative learning had the highest mean achievement score of 30.44 in the pretest. Students taught using reciprocal-teaching had mean achievement score of 23.00 in the pretest, while those taught using the lecture method had the least mean score of 22.98 in the pretest. In the post test, students taught using cooperative learning had the highest mean score of 62.28 followed by students taught using reciprocal-teaching with mean score of 55.62. Students taught using conventional teaching method had the least mean score of 44.94. The students gain mean score for the reciprocal- teaching group was 32.62. The students' gain mean scores for the cooperative learning and lecture method groups were 31.84 and 21.96 respectively. It is clear therefore that students in the reciprocal-teaching group scored the highest mean relative to those in the cooperative learning group and lecture method group in difficult Basic Science and Technology concepts. However, whether the difference among these mean scores is significant at 5% alpha level will be determined by hypothesis one. It should be noted that students' high mean achievement scores in the post test for the cooperative learning and reciprocal-teaching suggest that the two strategies may be effective in learning difficult Basic Science and Technology concepts. The better of these two strategies in terms of helping students achieve in the difficult concepts

would be determined by testing the hypothesis of this study.

Testing of Hypothesis

There is no significant difference in the achievement mean scores of students taught some difficult Basic Science and Technology concepts using cooperative learning, reciprocal-teaching and conventional teaching method.

Table 2: Analysis of Covariance of Students' Post Achievement ue to Treatment

Source	Type III sum of squares	Df	Mean square	F	Sig.
Corrected Model	19155.051 ^a	6	3192.509	17.332	.000
Intercept	63480.618	1	63480.618	344.634	.000
Pre achievt	4170.798	1	4170.798	22.643	.000
Treatment	9631.422	2	4815.711	26.144	.000
Error	50838.475	276	184.197		
Total	902148.000	283			
Corrected Total	69993.527	282			

R Squared = .274 (Adjusted R Squared = .258)

Table 2 shows that the differences in mean achievement scores among the three groups taught using the different teaching strategies is significant since the calculated F ratio of 26.144 is significant at $P < 0.000$ at 5% alpha level. The difference in the mean achievement scores between the treatment groups is therefore significant at $P < 0.05$. Therefore it can be concluded that the null hypothesis is rejected. The difference in the mean achievement scores of students taught some difficult Basic Science and Technology concepts using cooperative learning, reciprocal-teaching and conventional teaching method is significant, and therefore cannot be attributed to chance or error. However the direction of the observed difference among the group means was should be determined to show which mean is significantly different from others.

Table 3: Post Hoc Tests

Multiple Comparisons Dependent Variable: Post Achievement Scheffe

(1) Treatment groups	(j) treatment groups	Mean difference (ij)	Std.Error	Sig.
Reciprocal teaching	cooperative learning	-6.65778*	10.68452*	.006
Cooperative teaching	reciprocal lecture	-6.65778*	17.34229*	.006
Lecture, teaching	reciprocal cooperative learning	-10.68452*	-17.34229*	.000

Table 3 shows the post hoc test to determine the direction of difference among the mean

achievement scores of the cooperative learning, reciprocal-teaching and the conventional (lecture) method groups. Cooperative learning group scored significantly higher than the reciprocal-teaching group at $P < 0.006$. The reciprocal-teaching group scored significantly higher than the lecture method group at $P < 0.000$. Also cooperative method group scored significantly higher than the lecture method at $P < 0.000$. Therefore the research hypothesis is rejected. The three teaching strategies were significantly different in their effects on students' achievement in difficult Basic Science and Technology concepts. Cooperative learning was more effective than reciprocal-teaching while reciprocal-teaching was more effective than conventional method.

DISCUSSION

Table 3 shows that reciprocal-teaching yielded a significantly higher mean score in students' achievement in some difficult Basic Science and Technology concepts than conventional (lecture) teaching method. The Table also shows that cooperative learning yielded a significantly higher mean score in students' achievement in some difficult Basic Science and Technology Concepts than conventional (lecture) teaching. The implication is that either of the cooperative learning or reciprocal teaching strategies (both are student-centered) could be applied to achieve goals of Basic Science and Technology education in some difficult Basic Science and Technology Concepts. This is line with Nnaka (2016) who called for a shift from the conventional methods of teaching to innovative strategies in the teaching of Science, Technology and Mathematics for effectiveness. The two strategies are learner- centred and more activity oriented than the conventional (lecture) teaching method. Students can learn the difficult Basic Science and Technology concepts when they are actively involved (Conway, 2017). The result is also in line with the National Policy on Education which stresses that the teaching of Basic Science and Technology should be learner-centred for maximum self development and self fulfillment (FRN, 2014). The practical nature of most difficult Basic Science and Technology concepts demands active participation of the students which the conventional (lecture) teaching method does not usually provide. The conventional (lecture) teaching method encourages rote learning (Amaefule, 2022) which is not suitable for learning the abstract difficult Basic Science and Technology concepts. Therefore the abstract nature of most of the difficult concepts could be minimized in the process of learning those concepts by using more pragmatic and practical oriented effective teaching strategies such as the cooperative learning and reciprocal-teaching strategies. Higher mean score in students' achievement in the difficult Basic Science and Technology concepts of electrolysis and chemical equations than reciprocal-teaching strategy. This also buttresses the effectiveness of student- focused and active participation in the learning process when these difficult Basic Science and Technology concepts are tasks that are being learned. In the cooperative Learning strategy student's cooperation with one another, sharing ideas and information, support of the weaker students by the brighter ones, and the idea that if one person fails to learn or to pass, it affects the rating of the other members of the cooperative learning group, and the participation of each member of the group in learning the difficult Basic Science and Technology concepts, must have enabled the students in cooperative learning perform better than their counterparts in the reciprocal-teaching group. The reciprocal teaching group could not have been more effective in improving students' achievement in the difficult concepts because the very bright students whose roles was to help and teach the other members of his/her group may also be limited when the tasks are the difficult concepts in Basic Science and Technology (Tajudeen, 2015). Again students' participation may be limited by domination of the discourses by the leading

reciprocal teacher in the group thereby reducing the quality of participation of the members of the group. Thus the participation of learners in the reciprocal-teaching strategy is likely Impaired by the reciprocal teacher, who is in any case not a professional teacher. The implication of these is that cooperative learning strategy is superior to reciprocal teaching strategy in a number of dimensions, namely: students participation, linking of students' together to ensure mutual support, effective use of students spare time to discuss their classroom challenges by themselves etc. Cooperative learning strategy is more aligned with the nature the scientific enterprise where progress comes through collective and collaborative efforts and sharing of information and concerns by the member of scientific community. Thus through cooperative learning strategy, Basic Science and Technology students learn some of the science attitudes that have support the growth of science throughout history. Based on these superior characteristics of cooperative learning over reciprocal teaching strategies, it is reasonable to suggest that cooperative learning should be adopted more that reciprocal teaching when classroom lessons involve the difficult Basic Science and Technology concepts.

RECOMMENDATIONS

From the finding of this study, the following recommendations are made;

1. Teachers should adopt cooperative learning and reciprocal teaching strategies in teaching Basic Science and Technology concepts in Schools.
2. Cooperative learning and reciprocal - teaching should be emphasized and incorporated into the Basic Science and Technology - teacher education curriculum in tertiary teacher education institutions of learning.
3. Professional Associations like the Science Teachers Association of Nigeria (STAN) should popularize the effective use of cooperative learning and reciprocal strategies in teaching difficult Basic Science and Technology concepts through seminars, work-shops, conferences and publications.
4. The use of cooperative learning and reciprocal-teaching should be recommended in school Basic Science and Technology curriculum for teaching the difficult concepts. The effective use of the two teaching approaches should be reflected in the curriculum materials like the text books and other instructional materials.

CONCLUSION

In conclusion, both cooperative learning and reciprocal teaching have demonstrated effectiveness in improving students' achievement in the instruction of challenging Basic Science and Technology concepts. However, it is noteworthy that cooperative learning emerged as the more successful approach in this study. This underscores the importance of employing cooperative learning and reciprocal strategies to attain the educational objectives of Basic Science and Technology teaching in junior secondary schools.

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