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Effects of Self-directed and Social Collaborative Constructivism Instructional Strategies on Junior Secondary School Students' Academic Achievement in Basic Science in Adamawa State

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Abstract
The study explored effects of self-directed and social collaborative constructivism instructional strategies on junior secondary school students' academic achievement in basic science and technology in Jada Local Government Area of Adamawa State**.** A 3 x 2 quasi experimental design with intact classes was adopted. Simple random sampling technique was employed to select 105 Junior Secondary School two students from three schools in Jeda Local Governments, Adamawa State, Nigeria for the study. Participants were randomly assigned to conventional lecture, self-directed and social collaborative constructivism instructional activities. The treatment lasted for 8 weeks. One main instrument was developed by the researchers, validated and used; Basic Science and Technology Achievement Test (BSTAT, r = 0.86.). Two hypotheses were raised to test the significant difference between lecture, collaborative and self-directed constructivism instructional strategies activities in basic science and technology and significant difference between gender and students' academic performance in basic science and technology in selected concepts. The two hypotheses were tested at 0.05 level of significance. Data were analysed using mean, standard deviation, Analysis of Covariance (ANCOVA) and t -test analysis. The study revealed that there was significant difference in the students' academic performance between students exposed to lecture, collaborative and self-directed constructivism instructional strategies. The finding also indicated that there was no significant difference in the academic performance of male and female students It was therefore recommended that basic science and technology teacher should be encouraged to promote academic achievement of learners by involving constructivism-based learning activities.

Keywords: Constructivism-based Instructional Activities, Junior Secondary Schools, Academic Achievement, Basic Science and Technology.

Introduction

Basic science and technology is a basic subject that lays the foundation for all the sciences (biology, chemistry, and physics) in the senior secondary classes. Basic science and technology as defined by (UNESCO 2019) as an approach to teaching and learning of science in which concept and principles are presented so as to express the fundamental unity of scientific thought and avoid premature or undue stress on the distinctions between the various scientific field. With the broad search for skills to drive the home-grown local technology in developing countries like Nigeria, Nigerian Educational Research and Development Council (NERDC, 2014) in the new Curriculum for Basic Science and Technology, encourages teachers to lead their students to identify entrepreneurial skills in Basic Sciences. With these laudable aims and significance of this core subjects at junior secondary schools in Nigeria, students' academic achievement has not been encouraging (Adamu, 2020).

The poor achievement in Basic Science and technology among other factors, is because of poor teaching method such as the use of conventional method (Agbidye 2015; Adodo & Ogundare 2016). Efforts made by educational stakeholders to address this challenge include recommendation of instructions as field trips, project teaching and learning approach, students-cetre teaching and learning strategies, among others. Mbonu and Okoli (2019) reported that despite the efforts by the government, Science Teachers Association of Nigeria (STAN) and other stakeholders to solve or overcome the problem of students' poor achievement, students' academic achievement in basic science and technology is still below average in both internal and external examinations. The persistent poor achievement in basic science which is because of poor method of teaching portrays that the current educational pedagogical model is weak (Mbonu-Adigwe, 2021).

Conventional method is the method of teaching that is characterized by the following: it is teacher entered. It inhibits active participation of students in the

classroom; it reduces students to mere note-taking and passive listeners and learners, perception and assimilation of the subject matter is slow. Educators are confronted with a paradigm shift in teaching and learning from behaviourism to constructivism denoting a transformation from teacher-centred to student-centred teaching and learning approach. Success in education results from effective teaching and learning processes. The value of a constructivist approach, which is based on real-life learning experiences, is uncompromising and apparent. Nireti and Anaun (2014) state that Constructivists' learning has been found to improve students' academic performance in different secondary school subjects from science and social sciences respectively. It is on this note, that the present study investigated the effects of self-directed and social collaborative constructivism instructional strategies on students' achievement in basic science and technology.

Constructivism instructional teaching method is a student-centered approach to instruction. This is based on constructivism learning theory that says that all learning is constructed from a base of prior knowledge. Constructivism is an epistemological view of acquisition of knowledge, focusing upon the construction of knowledge rather than the transmission of knowledge and the recording of information conveyed by others. The role of the learner is recognized as one for building and transforming knowledge. According to Cey in Akamobi (2019) constructivism teaching method is a teaching approach that present opportunities for students to analyze, investigate, collaborate, share, build and generate ideas based on what they already know rather than facts, skills and processes. Also, McLeod, (2024) stated that constructivist learning involves mastery of authentic task in meaningful and realistic situations that could enable learners build internal knowledge based on personal interpretation of experiences. This implies that learning through personal interpretation of experiences could bridge the existing knowledge gap that thus brings about learning. There are various kinds of constructivism teaching and learning approaches that could enhance students' outcomes**.** These includes cognitive constructivism, social

constructivism, radical constructivism, critical constructivism, constructionism, cultural constructivism and interactive constructivism**.** This study focuses on the impact of self-directed cognitive and social collaborative constructivism instructional strategies on JSS students' academic achievement in basic science and technology in Adamawa State, Nigeria.

Self-directed cognitive constructivists emphasize learning activities that are determined by students and are oriented towards self-discovery. Self-directed learning is one of the parts of cognitive approach which is defined as learning in which students are given the freedom to set their own learning goals, design their own learning process and techniques, make academic decisions, and engage in activities that help them reach their goals. This theory posits that individuals actively create meaning from their experiences and knowledge, rather than passively absorbing information from external sources. In this approach, learners take charge of their learning process by setting goals, identifying resources, and monitoring their progress. They are encouraged to reflect on their thinking and understanding, ask questions, seek new information, and connect new knowledge with existing beliefs. Self-directed cognitive constructivism also stresses the importance of metacognition thinking about one's own thinking. Learners are encouraged to become aware of their thought processes and learning strategies to enhance their problem-solving, critical thinking, and decision-making skills. Overall, this approach emphasizes the learner as an active participant in constructing their own knowledge and understanding, promoting independence, curiosity, self-regulation, and critical reflection as essential components of effective learning (Serhat, 2023)

Akpokiniovo, (2022) explored the relationship between self-directed learning skills and academic achievement in science courses among primary school students and results indicated a significant correlation between. McLeod, (2024) highlighted the relationship between self-regulation and online learning within blended contexts which resulted in increased student achievement

demonstrating the effectiveness of promoting autonomy within educational settings. The two most important components of online learning that are necessary to assist students in achieving high learning achievement are self-regulated learning (SRL) and cognitive engagement (Liu, *et al*., 2024)

Social collaborative constructivism instructional strategy upholds that knowledge develops as a result of social interaction and is not an individual possession but a shared experience**.** Ramashego, (2024) suggests that social constructivism could be applied in the classroom using such instructional methods as case studies, research projects, problem-based learning, brainstorming, collaborative learning / group work guide, discovery learning, simulations among others. Therefore, Collaborative learning is a type of social learning approach in which small groups of students of different levels of ability work together whereby each member in the group is expected not only to learn what is being taught by the teacher, but one student helps group mates study (Abdulwahab, 2016). Byusa (2020) stressed that some of the techniques that involve active learning include conceptual changes strategies, collaborative/cooperative learning, technology-enhanced learning, inquiry-based learning, discovery learning, and think-pair-share or peer instructional strategies The teacher could sometimes divide the class into groups or pair the students and then guide by prompting, questioning and directing the groups or pairs to discover concepts or gather learning experiences according to the intended objectives.

Social collaborative constructivism instructional strategies have been shown to significantly enhance students' academic achievement in elementary sciences. These strategies emphasize active learning through social interaction, collaboration, and the construction of knowledge within a community of learners. Research indicates that social collaborative constructivism can lead to improved academic performance. For instance, a study by Ayaz and Şekerci (2020) found that constructivist learning approaches, compared to traditional teaching methods, positively affect students' academic achievement. According to Zajda

(2023), the effectiveness of constructivist pedagogy in the classroom is influenced by students' characteristics, self-concept, self-esteem, and social and cultural diversity. Implementing social collaborative constructivism in elementary science education involves several practical strategies. These include peer-assisted learning, group projects, and interactive discussions. Zajda (2023) highlights that these strategies not only enhance academic standards but also promote meaningful learning experiences by allowing students to construct knowledge through social interactions

Gender differences in science and technology remain a significant issue, with women continuing to be underrepresented in many STEM (Science, Technology, Engineering, and Mathematics) fields. Despite various initiatives to bridge this gap, disparities persist at multiple levels of education and professional careers. Studies indicate that gender differences in science achievement vary across different educational levels and contexts. For instance, a study by Jia *et al*. (2020) using data from the National Assessment of Education Quality (NAEQ) in China found no significant gender differences in science academic achievement among Grade 4 and Grade 8 students. However, the study noted that boys exhibited greater variability in their performance, with higher representation at both the top and bottom ends of the achievement spectrum whereby Jia *et al*. (2020) using data from the National Assessment of Education Quality (NAEQ) in China found no significant gender differences in science academic achievement among Grade 4 and Grade 8 students. Research by Workman and Heyder (2023) highlights that while females tend to outperform males in language and arts, they also show strong performance in natural sciences, challenging traditional stereotypes of male dominance in these fields. This shift is attributed to increased motivation, support from parents, and advocacy campaigns promoting women's empowerment in STEM

Statement of the Problem

The objectives of Basic science are clearly stated in the National Policy of Education (NPE, 2014). Federal Minister of Education (2020) noted that the objectives are still far from being achieved. Among the primary objective is students' understanding of basic scientific concepts that will promote learners' scientific literacy. This might account for the gap created by learning and teaching processes of basic science in Junior Secondary Schools (JSS) because of basic science teachers' curriculum delivery (Winarno, *et al*., 2020). The status of basic science education in schools in Nigeria show that basic science classroom activities are still dominated by teacher- centered methods of teaching, such as the lecture method which has been found to be ineffective in promoting meaningful learning science. Literature has indicated that various instructional strategies such as discovery, problem-solving, open-ended, field trips collaborative and laboratory among others had been employed to enhance learners' academic achievement in the basic science and technology curriculum instruction for several years, yet students' performance both in internal and external examinations is still below average. Hence, the researchers are interested in finding out whether self-directed constructivism instructional and social collaborative instructional strategies would facilitate learners' academic achievement.

Purpose of the Study

The purpose of this study is to examine the effects of self-directed and social collaborative constructivism instructional strategies on student's academic achievement in JSS basic science and technology in Jada Local Government Area of Adamawa. Specifically, the objectives are to:

1. find out the difference between academic achievement of students exposed to social self-directed cognitive,
2. collaborative constructivism and lecture instructional strategies,

3. to find out the difference of male and female students' academic achievement in basic science and technology.

Research Hypotheses

The following hypotheses are formulated and tested at 0.05 level of significance.

Ho_1: There is no significant difference between mean score academic achievement of students exposed to self-directed cognitive, social collaborative constructivism and lecture instructional strategies.

Ho_2: There is no significant difference between gender and students' academic achievement in basic science and technology.

Methods

The population of the study consists of all 20,625 JSS II basic science and technology students in public Junior Secondary Schools in Jada Local Government Area of Adamawa State. The study adopted a quasi-experimental design. A sample of 105 of JSS II basic science and technology students using intact class from three junior secondary schools randomly selected from Jada Local Government Area of Adamawa State, Nigeria participated in the study. From the selected schools, each school was randomly assigned to treatment group and using the intact class. One school was exposed to self-directed constructivism learning activities made up of 29 students, one school exposed to social collaborative constructivism learning activities comprised 24 learners and one school exposed to lecture method by the researchers comprising of 52 students made up of 57 male and 48 female participants.

The main instrument was developed, validated and employed for data collection. The instrument titled Basic Science and Technology Achievement Test (BSTAT) consisted of two sections, namely, section A and section B. Section A was on students' personal data consisting of questions on the name of the school, class and gender while the second section consisted of 20 multiple choice items. The Basic Science and Technology Achievement Test consisted of 20 multiple choice items with four options, A, B, C, and D each. Each of the items

provided carried one mark each giving to a total of 20 marks for the 20 items. BSTAT was used to test participants' academic achievement in basic science and technology in some selected concepts such as circulatory system, mixture, physical and chemical change and first twenty elements in the Periodic Table. Each correct answer earned the participant 1 mark and wrong answer earned the participant zero (0) mark.

The validity of the instrument was established using experts' judgement in the Department of Science Education, Federal University of Kashere, Gombe State to ascertain that the instrument measured learners' academic achievement in the selected concepts in basic science and technology. Kuder-Richardson 20 measure of internal consistency was employed to determine reliability for SPST multiple choice items yielding an alpha value of 0.86. Data collection comprised three stages: pretest stage lasted for one-week, experimental stage lasted for six weeks, and post-test stage lasted for one week respectively. Data collected were analyzed using mean and standard deviation inferential statistics such as Analysis of Covariance (ANCOVA) to determine the significant difference among the three groups and t-test to determine the significance difference participants' gender.

Results

Research Question One: What are the mean achievement scores of students taught Basic science using social and cognitive constructivism learning strategy and those taught with lecture method?

Table 1: Pre-tests Mean scores of basic science and technology students' achievement in Self-directed cognitive constructivism, collaborative social constructivism and lecture method

Experimental Group	N	Mean	Std. Deviation
Self-directed constructivism	29	9.31	1,892
collaborative constructivism	24	9.79	2.021
Lecture	52	8.25	2.858

Table 1 reveals the mean academic achievement of students exposed to Self-directed cognitive constructivism, collaborative social constructivism and lecture instructional strategies as 9.31, 9.79 and 8.25 respectively. This indicate that their performance is almost the same in the pretest.

Table 3: Mean Academic Scores of Basic Science and Technology Students exposed to Self-directed, Collaborative Constructivism and Lecture Instructional Strategies.

Experimental Group	N	Mean	Std. Deviation
Self-directed constructivism	29	14.38	1,892
collaborative constructivism	24	15.00	1.615
Lecture	52	11.19	2.096

Table 2: reveals the mean academic achievement of students exposed to Self-directed cognitive constructivism, collaborative social constructivism and lecture instructional strategies as 14.38, 15.00 and 11.19 respectively. The collaborative social constructivism instructional strategy had highest mean score of 15.00 followed by Self-directed cognitive constructivism instructional strategy with 14.38 and lecture method with the least 11.19. This shows that the collaborative social constructivism enhances students' academic performance better than others in basic science.

Ho_1: There is no significant difference between mean score academic achievement of students exposed to social collaborative, self-directed cognitive constructivism and lecture instructional Strategies.

Table 3: Summary of 3x2 Univariate ANCOVA of Post test Achievement Scores of Participants by Treatment and Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	324.257[a]	4	81.064	20.606	.000	.452

Intercept	852.116	1	852.116	216.603	.000	.684
Pre-achievement	2.495	1	2.495	.634	.428	.006
Gender	.979	1	.979	.249	.619	.002
Treatment	231.237	2	115.619	29.390	.000	.370
Error	393.400	100	3.934			
Total	18307.000	105				
Corrected Total	717.657	104				

a. R Squared = .452 (Adjusted R Squared = .430) * Significant at p < .05

Table 3 shows that there was significant effect of treatment on students' academic performance in basic science and technology ($F_{(2,100)} = 29.390$, $P < .05$), $\eta^2 = 0.370$. Treatment accounted for 37% variation of students' academic achievements in basic science. This was obtained by simply multiplying 0.370 by 100. Hence, hypothesis 3 is rejected.

Ho_2: There is no significant difference between gender and students' academic achievement in basic science and technology.

Table 4: t-test analysis of Mean scores of Male and Female Students Academic Performance to Conventional and Inquiry-Based Instructional Activities in Basic Science and Technology.

Variable	N	Mean	SD	SE	DF	t-value	P	Remark
Male	57	13.00	2.699	.358				
					103	.242 (2-tailed)	.809	NS
Female	48	12.88	2.565	.370				

Significant at $P \leq 0.05$

Table 4 reveals t-test analysis of mean scores of male and female students' academic achievement exposed to Self-directed, collaborative social constructivism conventional lecture instructional strategies. It showed that male

and female students' academic achievement had little or no difference (mean of = 13.00 and 12.88) respectively. The mean difference between the two groups was 0.125 and 95% interval for the estimated population mean difference is between 0.125 and 0.125. An independent t-test showed that the difference between the male and female students' academic achievement was not significant (t= 0.242, df= 103, p= 0.809, two tailed). Hypothesis 2 is therefore not rejected.

Discussion

The findings in this study revealed that learners exposed to constructivism strategies had better academic achievement post mean scores than of conventional lecture group. This may be because of the of the present opportunities avail tor students to analyze, investigate, collaborate, share, build and generate ideas based on what they already know rather than facts, skills and processes inherent in the constructivism-based strategies which involved active participation of learners, critical thinking, high cognitive task and challenges it demand. This also gives further empirical support to other findings which establish that constructivism-based learning activities are more effective in students' academic performance than the conventional methods (Royles 2013; Paas &Sweller, 2017).

The low performance of the conventional lecture activities method group in the post-test academic achievement in selected concepts in basic science and technology when compared with those in self-directed and collaborative constructivisms instructional strategies group may be traced to the fact that the group was taught with method that was teacher centred. Also, it may be linked to the fact of inadequate utilization of high cognitive level and inability of the learners to construct and build their knowledge by themselves which is one of the features of the conventional lecture activities. The conventional method does not seem to actively involve participants in teaching and learning processes. It encourages the learners to passively listen to the teacher with little or no interaction with the teacher and other students, thus making students to resort to

memorizing of facts. The poor performance of students in the conventional group supports the findings of Agbidye, Achor and Ogbeba, (2019) and Adodo and Ogundare (2016).

The result obtained equally showed that the academic achievement of male and female learners had no significant difference. The reason for this might be that the participants were exposed and subjected to the same teaching and learning conditions. Added to this, both male and female participants were given equal opportunity in the learning activities to use their high cognitive task, critical thinking and recalling of facts. The finding supports the results of Adamu (2016)) that discovered that there was no significant difference in students' academic performance of boys and girls in science subjects. However, the result negates the findings of Umar, (2016) which concurred that gender plays significant difference in the academic achievement performance of learners.

Conclusion

The study established the fact that collaborative constructivism-based instructional activities facilitated better students' academic achievement than self-directed-based and conventional lecture instructional activities. The reason for this was that learners exposed to social collaborative constructivism strategy in different groups of different levels of ability were able to work together whereby each member in the group was expected not only to learn what is being taught by the teacher, but one student helps group mates study (Abdulwahab, 2016). They were very inquisitive, share ideas, having realized that that they can discover and understand science concepts on their own, pose questions, participated in investigations and solve problems. The study also established that male and female participants performed almost the same because they were exposed the same learning conditions.

Recommendations

Based on the findings of this study the following recommendations are therefore made.

1. The collaborative and self-directed constructivism instructional strategies are recommended for teaching basic science and technology at junior secondary schools for better academic performance in basic science and technology.
2. At federal, state, and local government levels, seminars, conferences, symposia among others should be organized for service and in-service teachers on the use of constructivism-based learning activities.
3. Curriculum planners and developers should incorporate and emphasize constructivism-based learning in the curricula at all levels in Nigeria. Teachers should be encouraged to use them.
4. Students should be allowed to perform all tasks simple, complex or abstract with constructivism-based learning activities in basic science and technology classroom instructions.
5. Educational institutions saddled with the responsibility of training teachers should train and emphasize constructivism-based activities in curriculum instructions This will assist the teachers to apply them instructional strategies in teaching.

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