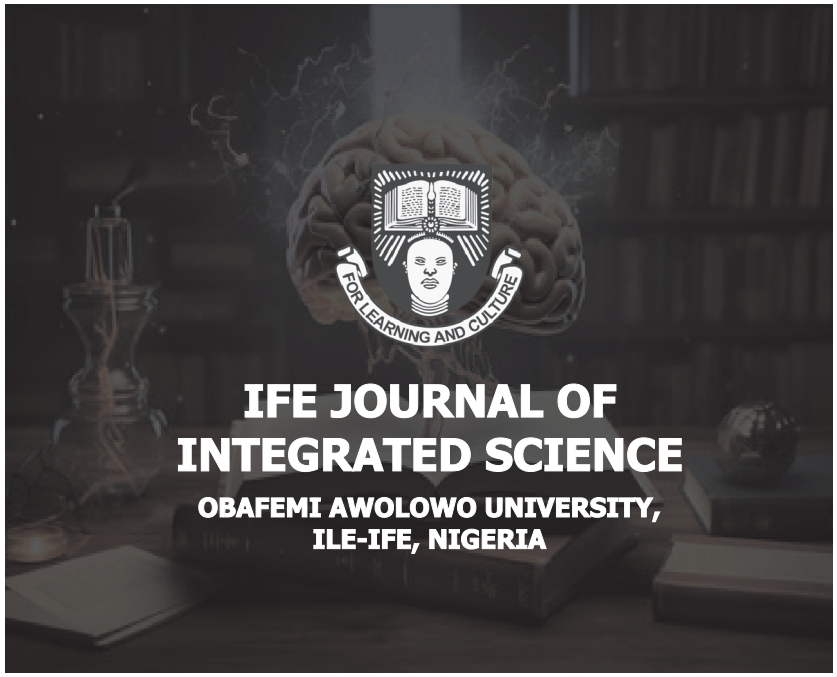

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TABLE OF CONTENTS

EFFICACY OF SELF-DIRECTED AND COLLABORATIVE CONSTRUCTIVISM INSTRUCTIONAL STRATEGIES ON JUNIOR SECONDARY SCHOOL STUDENTS' ENGAGEMENT IN BASIC SCIENCE AND TECHNOLOGY IN ADAMAWA STATE

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Abstract
The study examined the effects of self-directed and social collaborative constructivism instructional strategies on junior secondary school students' engagements in Basic Science and Technology in Jada Local Government Area of Adamawa State. The population for the study consisted of 20,625 JSS II Basic Science and Technology Students in Public Schools in Jada Local Government Area of Adamawa State. A quasi-experimental research design was utilized, conducted in field settings where random assignment impossible or absent. 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. Students' Classroom Engagement Observation Assessment (SCEOA, r=0.84) was designed, developed, validated and used by the researchers for the study. 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' engagements 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 there was significant effects in the students' engagements between students exposed to lecture, collaborative and self-directed constructivism instructional strategies (F=37.33; p<0.05). The finding also indicated that there was no significant difference in the engagement activities of male and female students (t=1.890; p>0.05) It was therefore recommended that Basic Science and Technology teachers should be encouraged to facilitate students' engagement activities using constructivism-based instructional strategies.

Keywords*:* Constructivism Instructional Strategies, Junior Secondary Schools, Students' Engagements, Basic Science and Technology.

Introduction

Science education which includes basic science and technology is fundamental to national development. It equips students with critical thinking skills, fosters innovation, and prepares them for careers in various scientific and technological fields. Investing in science education, nations can build a knowledgeable and skilled workforce capable of driving innovation and addressing complex challenges. Basic science and technology as defined by (UNESCO 2019) as an approach to teaching and learning of science in which concepts and principles are presented so as to express the fundamental unity scientific thought and avoid premature or undue stress on the distinctions between the various scientific field. However, traditional teaching

methods often fail to actively engage students' participation effectively, leading to poor learning outcomes and a lack of interest in science subjects (Winarno et al., 2020).

Classroom participation in Basic Science and Technology (BST) among Nigerian students has been a topic of interest for educators and researchers. Students' engagements in basic science and technology require the mental and emotional involvement of students in order for them to achieve their aims (Frymier & Houser, 2016). According to Byusa et al. (2020) encouraging classroom participation advocates higher levels of reflective thinking and problem solving, including application, analysis, synthesis, and evaluation, and that information learned through discussion is generally retained better than information learned through lectures. Students' engagement in classroom learning activities, for example, has been shown to have a major impact on critical thinking skills, problem-solving abilities, and enhanced student motivation (Serhat, 2023). Several reports have revealed low students' participation in Basic Science and technology among other factors, is because of poor teaching method such as the use of conventional method (Agbidye 2015).

The teaching approach known as the "conventional method" is teacher-initiated. Students' ability to actively participate in the classroom is hindered; they are reduced to becoming passive learners and note-takers; their perception and assimilation of the material is sluggish; and the technique is examination-oriented (Agbidye, et al., 2019). A fresh strategy for teaching and learning science in general, and basic science in particular, needs to be taken into consideration and implemented in order to address this issue. Constructivism has gained popularity as a teaching method and is often employed in the classroom to help students develop their problem-solving skills and examine difficult problems in the future.

Students studying elementary science respond better in the classroom when taught using constructivism techniques. Personalized learning, critical thinking and problem-solving, active learning, collaboration, motivation and engagement, and the development of higher-order thinking abilities are only a few

advantages and potentialities of using constructivism methodologies. An approach to instruction that is focused on the needs of the student is constructivism. Additionally, according to Ayaz and Şekerci (2020), constructivist learning entails mastering real-world tasks in meaningful contexts that allow students to develop internal knowledge based on their own interpretations of experiences. This suggests that learning through one's own interpretation of experiences may be able to close the current knowledge gap and facilitate learning. Constructivism encompasses a range of teaching and learning approaches that have the potential to increase student engagement. These include cultural constructivism, social constructivism, radical constructivism, cognitive constructivism, critical constructivism, constructionism, self-directed constructivism, and interactive constructivism. This study looked into how JSS students in Adamawa State, Nigeria, engaged with basic science and technology when using social collaborative and self-directed constructivism learning methodologies.

Instructional strategies based on self-directed constructivism emphasise the active role of students in creating their own knowledge and understanding through experiences that include self-regulation, active learning, prior knowledge, authentic tasks, and scaffolding (Ayaz & Şekerci 2020). Self-directed constructivism promotes student autonomy in the classroom by highlighting their active participation in the learning process. The rise in intrinsic motivation is one of its main outcomes. According to Deci and Ryan (2020), students who are empowered to take charge of their own learning tend to become more engaged with the subject matter and exhibit greater levels of interest in it.Students who get this type of instruction feel more empowered and are more willing to engage fully in group projects, class debates, and practical exercises. Additionally, self-directed constructivism-based active learning techniques encourage a higher level of cognitive involvement. Students must now absorb, evaluate, and apply what they learn in real-world situations rather than just being passive information consumers. Increased retention and comprehension are the outcomes of this practical,

problem-based approach (Kapur, 2021). Students' collaborative involvement improves and they feel more connected to their classmates when they work in teams to generate knowledge.

The educational pedagogical techniques known as collaborative constructivism instructional strategies place a strong emphasis on learning via social interaction and teamwork. These tactics stem from Bandura's (1977) beliefs, which held that social contacts are essential to theconnive development. These consist of peer teaching, the zone of proximal growth, scaffolding, collaborative learning, and dialogue and negotiation on real tasks. According to Brophy (2020), the implementation of these tactics fosters a dynamic and interactive learning environment in which students actively connect with both the subject and one another, resulting in increased comprehension and retention of knowledge. 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 (Alt, 2017; Abdulwahab, 2016). Furthermore, collaborative constructivism promotes peer learning, which enhances cognitive engagement. As students explain concepts to one another, they clarify their own understanding, thus deepening their learning (Gijbels et al., 2021). This peer-to-peer interaction helps learners process information more effectively, as teaching or explaining material to peers reinforces their own knowledge and engages them cognitively in the subject matter. Student autonomy and ownership, over learning are fostered in collaborative constructivist classrooms, leading to higher engagement but may be influenced by gender of the students.

Gender differences in classroom engagement, particularly within the context of collaborative constructivism, reveal nuanced patterns that can influence the effectiveness of this teaching approach. Research has shown that boys and girls may engage differently in collaborative settings, often due to variations in communication styles, group dynamics, and self-efficacy. Communication styles between genders can affect engagement in

collaborative constructivist environments. Studies suggest that female students tend to be more engaged in group discussions and collaborative tasks, as they often value social interaction and relationship-building during learning (Pomerantz et al., 2021). Girls typically engage in more cooperative behaviors, which can lead to greater participation in group discussions and collaborative problem-solving tasks. In contrast, boys are sometimes more competitive in group settings, which can either enhance or hinder their engagement, depending on the task and group structure (Zhan & Wan, 2020). Group dynamics within collaborative learning settings can impact gender-based engagement. Female students, in particular, tend to excel in smaller, more intimate group settings where collaboration and communication are encouraged (Boulton et al., 2020). As a result of these interactions, engagement levels are frequently higher because females are more at ease sharing their opinions and working with colleagues. However, males might gain more from mixed-gender groups because the various communication styles can work well together to improve group engagement and performance as a whole (Wilson et al., 2021).

Statement of the Problem

Despite the critical importance of Basic Science and Technology (BST) in fostering scientific literacy and technological competence among students, there is a noticeable decline in classroom participation in this subject. This issue is particularly pronounced in many educational institutions, including those in Adamawa State, Nigeria. Among the factors that could contribute to this problem, including lack of students' engagement because many students find BST topics uninteresting or irrelevant to their daily lives, leading to a lack of enthusiasm and active participation in classroom activities. Ineffective teaching methods is another factor such as traditional lecture-based teaching methods which dominate BST classrooms, often failing to engage students or encourage interactive learning. Students' attention is further lowered by the lack of practical applications and hands-on experiments. In the same vein, instructors with inadequate training, lack of passion, or

insufficient knowledge of BST may find it difficult to motivate and excite their learners. A comprehensive strategy that incorporates bettering classroom supplies, educating teachers, implementing interactive and student-centered teaching techniques, and fostering a welcoming and inclusive learning atmosphere is needed to address these problems. Therefore, this study looks at how well junior secondary school students in Adamawa State engage with Basic Science and Technology through self-directed and collaborative constructivism instructional methodologies.

Purpose of the Study

The purpose of this study was to examine the effects of self-directed and social collaborative constructivism instructional strategies on student's classroom engagement in JSS Basic Science and Technology in Jada Local Government Area of Adamawa. Specifically, the objectives are to:

a. determine the difference between classroom students' participation exposed to self-directed cognitive and social collaborative constructivism and lecture instructional strategies; and
b. find out the difference of male and female students' classroom participation in basic science and technology.

Research Question

Research Question One: What are the mean classroom students' engagement scores taught Basic Science and Technology using self-directed cognitive, social collaborative constructivism instructional strategies and those taught with lecture method?

Hypotheses

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

$H_0$1: There is no significant between mean score of students' classroom engagements exposed to self-directed cognitive, social collaborative constructivism and lecture instructional strategies.

$H_0$2: There is no significant difference between male and female students' classroom engagements in basic science and technology.

Methodology

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. 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 using quasi-experimental research design. Every school from the list of chosen schools was allocated at random to a treatment group while maintaining the entire class. Twenty-nine (29) students from one school participated in self-directed constructivism learning activities, twenty four (24) students participated in social collaborative constructivism learning activities, and fifty two (52) students, fifty seven (57)males and forty eight (48)females, participated in a lecture method conducted by the researchers in one school. The Students' Classroom Engagement Observation Assessment (SCEOA). consisted of five main areas of student engagement activities preparedness (5 marks), active listening (5 marks), contribution to discussion (15 marks), asking questions (10 marks), and correctly applying knowledge (15 marks)-were the basis for the creation of the instrument. The maximum possible score is fifty (50). SCEOA was verified by expert and peer review, and a reliability analysis employing the Kuder-Richardson 21 (KR21) measure of internal consistency yielded a coefficient of 0.84. The mean and standard deviation were used in inferential statistics, such as Analysis of Covariance (ANCOVA) to find the significant difference between the three groups and the t-test to find the significant difference in the gender of the participants, in order to analyse the obtained data.

Results

Research Question One: What are the mean classroom students'

engagement scores taught Basic science and technology using self-directed cognitive, social collaborative constructivism instructional strategies and those taught with lecture method?

Table 1: Estimated Marginal Means of Pre-tests Engagement Scores of Participants by Treatment

Treatment	N	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Self-directed Learning	29	29.586[a]	.481	28.632	30.541
Collaborative Learning	24	28.875[a]	.528	27.827	29.923
Lecture Method	157	28.808[a]	.259	28.096	29.519

Table 1 reveals that students exposed to Self-directed cognitive constructivism, collaborative social constructivism and lecture instructional strategies had adjusted pre-test mean scores as 29.59, 28.889 and 28.81 respectively. This indicate that their performance is almost the same in the pre-test.

Table 2: Estimated Marginal Means of Post-tests Engagement Scores of Participants by Treatment

Treatment	N	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Self-directed	29	40.107[a]	.635	38.848	41.367
Collaborative	24	40.761[a]	.697	39.378	42.144
Lecture Method	157	34.666[a]	.473	33.727	35.605

According to Table 2, students who were exposed to the collaborative constructivism strategy had the highest adjusted post mean score (40.76), followed by the self-directed cognitive constructivism method (40.11) and the lecture instructional strategy (34.67). This demonstrates that in fundamental science and technology classrooms, collaborative social constructivism improves student engagement and makes them more active participants in academic tasks.

H_o1: There is no significant effects engagement score of students exposed to self-directed cognitive, social collaborative constructivism and lecture instructional strategies.

Table 3: Summary of 3x2 Univariate ANCOVA of Post-test Engagement by Treatment and Gender

Source	Type III Sum of Square	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	940.044[a]	3	313.348	26.916	.000	.444
Intercept	18224.274	1	18224.274	1565.442	.000	.939
Gender	82.607	1	82.607	7.096	.009	.066
Treatment	869.179	2	434.590	37.331	.000	.425
Error	1175.803	101	11.642			
Total	150260.000	105				
Corrected Total	2115.848	104				

a. R Squared = .444 (Adjusted R Squared = .428)

Table 3 indicates that there was significant effect of treatment on students' engagement in basic science and technology ($F_{(2,101)}$ = 37.33, P < .05), ?^{2} = 0.425. Treatment accounted for 42.5% variation of students' engagement in basic science and technology. This was obtained by simply multiplying 0.425 by 100. Hence, hypothesis 3 is rejected.

H_o2: There is no significant difference between male and female students' classroom engagement in Basic Science and Technology.

Table 4: t-test analysis of Mean scores of Male and Female Students Engagement exposed to Conventional, Self-directed Cognitive and Collaborative Social Constructivism

Variable	N	Mean	SD	SE	DF	t-value	P	Remark
Male	57	38.32	5.05	.669		1.89	.066	NS
Female	48	36.67	3.62	.523	103			

Significant at P $\leq$ 0.05

Table 4 reveals t-test analysis of mean scores of male and female students' classroom engagements activities exposed to structured, guided inquiry-based and conventional instructional strategies. It showed that male and female students' engagements had little or no difference (mean of = 38.32 and 36.62) respectively. The mean difference between the two groups was 1.65 and 95% interval for the estimated population mean difference is between -.873 and .849. An independent t-test showed that the difference between the male and female students' engagement was not significant (t = 1.89, df = 103, p = .066, two tailed). Hypothesis 2 is therefore not rejected.

Discussion of Findings

The findings in this study revealed that learners exposed to constructivism strategies had better classroom engagements post mean scores than of conventional lecture group. This may be because of the of the present opportunities avail to students 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 that are inherent in the constructivism-based strategies which involved active participation of learners, critical thinking, high cognitive task and challenges it demand. This also agrees findings of Byusaet al. (2020) which establish that constructivism-based learning activities are more effective in students' engagement than the conventional methods.When compared to the self-directed and collaborative constructivism instructional strategies group, the conventional lecture activities method group performed poorly on the posttest in selected basic science and technology concepts. This difference in performance may be attributed to the teacher-centered nature of the group's instruction. Additionally, it might have to do with how poorly high cognitive functions are used and how learners are unable to create and expand their own knowledge—a characteristic of traditional lecture activitiesThe low performance of students in the conventional group supports Agbidye's (2015) findings. The conventional method appears to

not actively involve participants in the teaching and learning processes. Instead, it encourages learners to passively listen to the teacher with little to no interaction with the teacher and other students, forcing students to resort to fact memorisation.

The result obtained equally showed that the classroom engagements 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 Ayaz and Şekerci (2020) that discovered that there was no significant difference in students' engagement of boys and girls in science subjects. However, the result negates the findings of Pomerantz et al., (2021) which concurred that gender plays significant difference in the engagement activities of learners.

Conclusion

It was determined that instructional activities based on collaborative constructivism were more effective in promoting student engagement than traditional lecture-based and self-directed approaches. This is because students who were exposed to the social collaborative constructivism strategy in various ability-level groups were able to collaborate, with the expectation that each member of the group not only learn what the teacher was teaching, but also assists other students in their academic pursuits (Abdulwahab, 2016). kids shared ideas, asked questions, took part in research, and solved issues. They were highly curious and had come to the realisation that kids could learn and comprehend science topics on their own. The study also found that while both genders were exposed to the same learning environments, the activities they engaged in in the classroom were nearly identical**.**

Recommendations

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

In order to support students' classroom engagement activities in basic science and technology, junior secondary schools should implement collaborative and self-directed constructivism instructional methodologies.

Seminars, conferences, symposia, and other events on the use of constructivism-based learning activities should be arranged for in-service and service teachers at the federal, state, and local government levels. Constructivism-based learning should be emphasised and included into Nigerian curricula at all levels by curriculum planners and developers. Instructors ought to be motivated to employ them.

In fundamental science and technology classroom instructions, students should be free to choose their own learning objectives, create their own learning strategies, make academic judgements, and participate in activities that support their learning.

The training of teachers is the duty of educational institutions, which should prioritise constructivism in their curricula. This will help the instructors implement their educational tactics in the classroom.

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