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Comparative Effect of Contextualized Cubing and Teacher-Centred Conventional Instructional Strategies on Secondary School Physics Students' Academic Achievement

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ABSTRACT

In order to maximize students' classroom learning experiences, there is a need to consider the informal knowledge they bring into the classroom. The context of students' life plays an important role in the learning process. This study examined the comparative effect of contextualized-cubing and teacher-centred conventional instructional strategies on secondary school Physics students' academic achievement. The study also examined the moderating effect of numerical ability. The constructivist theory provided the theoretical foundation. The empirical investigation adopted a quasi-experimental design and involved 107 Physics students from selected secondary schools in Ibadan Metropolis, Nigeria. Quantitative data was collected through the administration of Physics Achievement Test (PAT) and Students' Numerical Ability Test (SNAT).Mixed model analysis was utilised by the study. The contextualised cubing instructional strategy was found to be effective in enhancing the students' academic achievement in Physics irrespective of students' numerical ability. The study, therefore, concludes that the contextualised-cubing instructional strategy is a suitable pedagogical strategy for Physics classroom instruction. Theoretical implications for contextually responsive pedagogy are discussed.

***Keywords**:* Contextual Learning, Cubing Instructional Strategy, Numerical Ability, Academic Achievement, teacher-centred conventional instructional strategy.

INTRODUCTION

Students' academic achievement in physics has been a source debate among science education stakeholders, and this has been attributed to the continuous utilisation of the teacher-centred conventional instructional strategy. Despite the call for the adoption of learner-centred strategies, the reliance on teacher-centred conventional instructional strategies such as lecture and note dictation strategies by most teachers has been highlighted as a major challenge facing Physics teaching and learning in Nigeria (Bello, 2012; Udoh, 2012; Aderonmu & Obafemi, 2015; Osondu, 2018). According to Akpoghol et al (2016), teacher-centred conventional instructional strategies such as lecture and note dictation neither allow Physics students to actively participate in the learning process nor foster critical and creative thinking abilities. As a result, Ntibi & Neji (2018) stated that Physics appear to be difficult and abstract to students. Fatokun et al (2016) identified teachers' lack of interest in adopting instructional strategies that incorporate students' out-of-classroom experiences and prior knowledge of informal Physics as another challenge affecting students' learning outcomes in Physics. Utilising the constructivist theory as the foundation, this study examined the comparative effect of contextualized-cubing instructional strategy and teacher-centred conventional strategy on the academic achievement and numerical ability of Senior Secondary School (SSS) Physics students.

Students' academic achievement

Academic achievement is a measure of the level of knowledge that learners gained in a stipulated course of learning. More specifically, academic achievement is the degree of an individual's accomplishment after exposure to a learning program (Bunkure, 2019). The academic achievement of students is considered a key criterion in the judgement of the attainment of objectives in every learning activity which is regularly assessed through examination results (Nuthana & Yenagi, 2009). Students' academic achievement is the main target of classroom instruction (Lewis, 2013). However, this target can be difficult to accomplish.

Students' academic achievement in science subjects such as Physics has been a cause of concern for stakeholders in science education. A report by Organisation for Economic Co-operation Development (OECD) stated that many countries encountered a significant decline in the performance of students in international assessments (OECD, 2018). As highlighted in the OECD report, Program for International Student Assessment (PISA) reported that although students showed interest in science subjects and recognised the important role of science in the world, they recorded poor performances which can be attributed to instructional strategies adopted by subject teachers. Similarly, Provasnik *et al* (2016) posit that the Trends in International Mathematics and Science Study (TIMSS) reported that no country demonstrated a meaningful improvement in students' academic achievement in Physics from 1995 to 2015, and only a small proportion of students reached the high benchmark. Physics is a subject that relies heavily on numerical representations to explain the interaction of different elements in the environment. This, therefore, suggests that numerical ability is necessary for students' success in physics.

Numerical ability

Physics is a subject that relies heavily on mathematical representations to explain the interaction of different elements in the environment. These representations are denoted as formulas and require students to have the ability to manipulate numbers. Numerical ability is a very important factor that enhances students' learning outcomes in Physics. Numerical ability is the capacity to fairly resolve academic challenges in numeral sequencing, competence to deduce multifaceted statistics displayed in several graphical configuration, make inferences that are mathematically precise by utilising superior numerical reasoning, breakdown statistics and make logical decisions (Ballado, Morales, & Ortiz, 2014).

Studies have established a strong association between numerical ability and performance in science subjects such as Physics. According to Obafemi and Ogunkunle (2014), numerical ability is vital for students' comprehension in Physics concepts such as sound waves, especially when taught using student-centred learning methods. The Chief Examiner's report for the May/June West African School Certificate Examination (WASSSCE) for 2014 and 2017 suggested that teachers should expose students to numerical questions (WASSSCE, 2014; 2017). Equally, the Chief Examiner's Report for the 2018 WASSSCE emphasized that Physics students struggled to handle appropriately calculations involving numerals expressed in standard form (WASSSCE, 2018).

The study conducted by Sheppard *et al* (2020) highlighted teachers' lack of pedagogical skills as a problem facing the standard teaching of Chemistry and Physics in the United States of America (USA). The study emphasised that many Chemistry and Physics teachers lack the basic pedagogical skills to successfully teach the subjects. Likewise, it has been reported that in Nigeria, students' academic achievement in national and regional certificate examinations such as the National Examination Council (NECO) and West African Senior Secondary School Certificate Examinations (WASSSCE) has been a source of concern for education stakeholders (Erinosho, 2013; Telima, 2018; Okafor, 2019). Analysis of the WASSSCE Chief Examiners' reports from 2013 to 2018 revealed that students' inability to relate classroom learning experiences to real-life situations is one of their major areas of weakness in Physics. The reports, therefore, suggested that teachers should not only state principles and laws of Physics but emphasise the possible application of these principles to everyday activities. The reports also advised that students should be encouraged to explain their knowledge of basic Physics concepts to enhance their ability to apply the fundamental principles of Physics to real-life situations (WAEC, 2015); students should be encouraged to study Physics and not memorise Physics content (WAEC, 2016); Physics instruction must discourage rote learning and fortify classroom instruction with appropriate demonstrations (WAEC, 2018). Consequently, the adoption of innovative student-centred instructional strategies for teaching and learning Physics is recommended.

Contextualised classroom instruction and conventional teacher-centred instruction

Learning takes place within a particular context. Context in this study is predicated on the link between content and students' prior (contextual) knowledge of Physics. According to Rivet and Krajcik (2008), instructional contextualisation is the utilisation of students' prior experience to enhance their classroom learning experiences (i.e., the utilisation of students' informal knowledge of Physics to enhance conceptual understanding of classroom Physics ideas). Various studies revealed that contextually responsive instructional strategy is very effective as it allows students to utilize their informal knowledge during classroom instruction (Rivet & Krajcik, 2008; Suryawati & Osman, 2018).

On the contrary, teacher-centred conventional instructional strategies such as lecture and note dictation neither allow Physics students to play active roles in the learning process nor foster critical and creative thinking abilities. The teacher holds the centre stage in teacher-centred instruction where s/he dictates and/or presents an already prepared lesson for students to copy. In other words, students are merely passive recipients of an already prepared lesson note (Akpoghol et al., 2016)

The advantage of contextualised instruction is that while the teacher-centred conventional classroom forces students to regularly toil to find links to abstractions, a real contextualised strategy assists the students to appreciate the relevance of knowledge and enables them to understand the materials. According to Rivet and Krajcik (2008), the success of contextual teaching and learning (CTL) has led many educational programs to embrace it as an instructional method. Mazzeo (2008) emphasised that CTL is a variedgroup of instructional strategies devised to effortlessly connect the learning of basic skills to scholastic or professional content by concentrating classroom instructional activities squarely on real-life applications in a precise setting that is of interest to the student. Ates and Eryilmaz (2011) stated that students can truly learn concepts in science and Physics when both practical opportunities, expertise and assistance to integrate and apply knowledge gained in earlier experiences to the concepts to be learned are provided for them.

Contextualised Cubing Instructional Strategy (CCIS)

Contextualised Cubing Instructional Strategy is an adaptation of cubing instructional strategy to enhance the relevance of classroom Physics instruction. The strategy puts particular emphasis on the utilisation of students' contextualised informal knowledge of Physics concepts. The strategy has been used primarily for teaching language students about writing, and it is a flexible strategy which can simply fit into classroom instruction at various points (Adams & Pierce, 2021). It requires students to contemplate a concept from six (6) different viewpoints. Cubing is a strategy developed to assist learners to view a topic or an idea from varying perspectives, allowing them to analyse and synthesise the various components of a concept (Iskandar, 2017). CCIS was adopted in this study to afford students opportunities to construct their knowledge through the various steps provided by the strategy. Nazario et al (2013) suggested six elements of cubing strategy:

- DESCRIPTION encourages the students to imagine the topic, list details, merits, and features as they can.
- COMPARE OR CONTRAST encourages them to look for concepts that are similar or different from the topic.
- Make ASSOCIATIONS of the topic with concepts they see on daily basis.
- ANALYSIS encourages students to break down the topic to understand its constituent parts.
- APPLICATION encourages the students to find situations where the topic can be used and how.
- CREATION OF KNOWLEDGE requires the students to respond and make clarifications on some evaluative questions with the knowledge they gained during the learning process.

These six elements of cubing instruction, as highlighted above, are designed to enable the smooth integration of students' prior contextualised experiences of physics, which is the aim of this study; that is, instructional contextualisation.

In contextualised-cubing class, advance organisers were used to introduce the concepts/topics. The advance organisers also enable the possibility of linking the new topic to students' prior knowledge. According to Akinbobola (2015), the advance organiser is the material that is given at the commencement of an academic exercise which can enable the student to arrange and decode new evidence. It is a technique for associating and linking old knowledge to something new. Once prior knowledge is recovered, this representation offers a conceptual outline upon which new knowledge can be placed. Advance organisers are very useful in knowledge transfer. There are various forms of advance organisers, which are: *narrative* (story form), *expository* and *comparative.* The operations of the advance organiser strategy are both substantive and programmable. They can be programmed to meet the students' learning profile.

The conventional teacher-centred instructional classroom was characterised by presentation of already prepared instruction, which was presented by the teacher while the students write down what was presented and/or written on the board. Exercises followed worked examples and assignments were given at the end of the instructional activities. The differences between Contextualise Cubing Instruction and Teacher-Centred Conventional Instruction are outlined in Table 1 below.

Table 1: Difference between Contextualized Cubing Instruction verses the Teacher-Centred Conventional Instruction

Contextualise Cubing Instruction	**Teacher-Centred Conventional Instruction**
Contextualised-cubing instructional strategy enhances the utilisation of students' out of classroom, informal knowledge of concepts as the foundation for classroom instruction	Conventional instructional strategies do not give such allowance. Students receive, and assimilate whatever knowledge the teacher presents to them
The contextualised-cubing instructional strategy is student/learner centred	The conventional strategy is teacher centred; where the teacher dictates to students an already prepared lesson.
The contextualised-cubing instructional strategy enables students to play active roles in the teaching-learning	The conventional instructional strategy does not provide the platform for students' active participation in the teaching-learning activities
The contextualised-cubing instructional strategy utilises six (6) stages that requires students' active engagement in the teaching-learning process	The conventional instructional strategy require students' absorption of an already prepared lesson from the teacher and taking of notes of the lesson.

The passive involvement of students in the teacher-centred conventional instructional which has been highlighted in literature necessitated this study with the primary objective of examining the comparative effect of contextualized-cubing instructional strategy and teacher-centred conventional strategy on Physics students' academic achievement and numerical ability.

PURPOSE OF THE STUDY

The determination of the effect of students' active participation in instructional process on their academic achievement in physics is the aim of the study. Particularly, the study tried to

- Establish the comparative effect of student-centred contextualised cubing and the teacher-centred conventional approaches to instruction on students' academic achievement in physics.
- Explore the effect of the interaction of treatment and numerical ability on the academic achievement of physics students.

RESEARCH QUESTION

The empirical investigation was guided by the following main research question.

1. *What is the comparative effect of contextualized cubing instructional strategy and teacher-centred conventional strategy on secondary school Physics students' academic achievement?*

2. What is the interaction effect of the treatment and numerical ability on students' academic achievement in physics?

THEORETICAL FRAMEWORK

The constructivist theory of Ackermann (2001) provided the theoretical foundation for this study. Constructivism is a theory that illustrates how learning takes place. It suggests that students construct knowledge out of their experiences. The theory emphasised that knowledge is constructed from and shaped by experience, and learning is an active process that involves individual interpretation of the world. The constructivist believes that knowledge formation is an active theme that generates cognitive structures as students interact with their environment. Cognitive interaction will take place as real-life occurrence is organised through the cognitive structure generated by the theme itself. It is vital that the cognitive structure is rearranged and modified to accommodate the requirements of the environment and the substituting body. The process of the modification happens constantly through the process of reconstruction.

The most important aspect of the constructivist theory is its emphasis on the students during the learning process. The theory postulates that students actively develop their own knowledge during the learning process, and not the teacher transferring ideas to the student. Therefore, the role of a Physics teacher is not just to transfer knowledge of Physics concepts to students but to play the role of a mediator and facilitator who assist students to construct their knowledge easily and effectively.

- Constructivist learning stresses the following:
- Prioritisation of actual learning in the appropriate context,
- Arrangement of the processes of knowledge acquisition,
- Enhancement of knowledge acquisition in the context of social encounters, and
- The confirmation that knowledge acquisition is done to construct experience.

Utilising the gains of constructivism in the learning process requires teachers to assess students' prior knowledge, which is an objective of this study. In this manner, teachers would be able to assist students to develop effective knowledge of the subjects taught. Students' opinions are considered, as students are granted time to contemplate and articulate their ideas, without being pressed for time. Therefore, studies suggests that teachers should prepare questions and Cues to stimulate students' active involvement during the learning process, implementation of concrete learning experiences, and utilisation of prior classroom experiences.

RESEARCH DESIGN AND METHODOLOGY

The research design and methodology are described below.

Research design

The study adopted the pretest-posttest quasi-experimental research design. Quasi-experimental research is characterized by the manipulation of an independent variable (Gopalan, Rosinger & Ahn, 2020).The authors further stated that in quasi-experimental research design, researchers seek to develop an acceptable hypothetical position, or what could have happened in the dearth of the intervention, to propose a baseline from which causal outcomes could be estimated better to comprehend the causal effect of any action. Quasi-experimental research designs utilise non-experimental variation on the primary independent variables of interest, replicating experimental settings where specific individuals are randomly exposed to treatment while others are not (Gopalan, Rosinger& Ahn, 2020).

Sample and Sampling Technique

The study involved purposively selected SSS Physics students in Ibadan Metropolis, Nigeria. The students were divided into two groups. Group A was exposed to Contextualised Cubing Instructional Strategy while Group B was exposed to Teacher-Centred Conventional Instructional Strategy.

A pilot study was first organised to ascertain the availability of qualified Physics teachers in public senior secondary schools in the Ibadan metropolis, and the schools' willingness to take part in the exercise. The pilot study also examined the level of coverage of the curriculum for senior secondary school Physics. This was done to ensure that participants with a similar level of Physics content knowledge are selected for the study, thereby reducing the chances of giving any group undue advantage. Other variables such as availability of instructional resources, functional Physics laboratory, and conducive learning environment were considered.

A total of 107 students drawn from schools in Ibadan metropolis participated in the study. The participants comprise of Senior Secondary School II (SS2) students. Three Local Government Areas (LGAs) were selected from the five LGAs that made up Ibadan metropolis. Simple random sampling technique was adopted in the selection of the (LGAs). Afterwards, the purposive sampling technique was utilised to select a school from each of the selected LGAs with emphasis on the school's willingness to take part in the study, the presence of qualified physics teacher in the school, functional physics laboratory and the level of coverage of the SSS physics curriculum. The age range of the participants is between 14 – 17 years with a cumulative average age of 15.5 years.

Simple random sampling technique was also utilised in the selecting the students into the two groups. 51 of the participants were selected into Group A and exposed to Contextualised Cubing Instructional Strategy, while 56 were selected into Group B and exposed to Teacher-Centred Conventional Instructional Strategy.

Instrument for Data collection

The following four research instruments were utilised to collect data for the study. These instruments are categorized into two groups: Stimulus and Response.

1. Stimulus:
2. Instructional Guide for Cubing Instructional Strategy (IGCIS)
3. Instructional Guide for Conventional Strategy (IGCS)
4. Evaluation Form for Assessing Teacher's Performance during Training (EFATP)

Response:

Physics Achievement Test (PAT)
Students' Numerical Ability Test (SNAT)

ThePhysics Achievement Test (PAT) was devised by the researchers to evaluate students' level of comprehension of the content they were exposed to. The test has two sections (A and B). Section A comprises the demographic statistics of the students, which include the school name, class, gender, and age. Section B addressed multiple-choice questions that examined the achievement of student in Physics. The PAT contains 20 multiple-choice questions with four response options A – D, developed in line with a table of specifications on some selected Physics topics. The topics upon which the test was based are Mechanical Energy, Machines, and Linear Momentum. The specification of items that reflected the topics used in the study are presented in Table 2.

Table 2: Specification of Items for PAT

CONTENT	COGNITIVE LEVELS						
	KN	**COMP**	**AP**	**AN**	**SYN**	**EVAL**	**TOTAL**
MECHANICAL ENERGY	$^{6, 7}$(2)	^{10}(1)	-	-	-	^{19}(1)	**4**
MACHINES	$^{8, 16}$(2)	^{13} (1)	^{5}(1)	$^{15, 17}$(2)	-	^{14}(1)	**7**
LINEAR	^{1}(1)	^{2} (1)	^{18} (1)	$^{3, 9, 11}$(3)	^{12}(1)^{4}	^{20}(2)	**9**
TOTAL	**5**	**3**	**2**	**5**	**1**	**4**	**20**

Note: The numbers in the parenthesis signifies the number of items in each domain while the superscripts represent the serial number of the item in PAT

Students' Numerical Ability Test (SNAT)

The Students' Numerical Ability Test (SNAT) was designed by the researchers to assess students' ability to manipulate numbers. The SNAT was split into sections A and B. Section A covers the demographic information of the students, which includes school name, class, gender and age, while section B covers multiple-choice questions evaluating students' numerical ability. The SNAT contains 20 multiple-choice questions with four response options, A – D.

Validity and reliability of the instruments

The validity and reliability of the instruments were determined as follows:

The Instructional Guides: The instructional guides were designed by the researcher as a guide for the Teachers/Research Assistants on the steps involved in the strategies adopted for the study. Copies of the instructional guides were submitted to four specialists in Science Education for the evaluation of content and face validity. The validated instrument was subjected to a reliability test by subjecting the ratings of the instrument from the four raters to Fleiss' Kappa inter-rater reliability scale. The following reliability index was obtained for IGCIS (0.73) and IGCS (0.71), which were an indication of agreement among the four raters, making the instrument reliable for use.

The Evaluation Sheet: The evaluation sheet is an observation checklist designed by the researchers to assess teachers' possession of the requisite instructional skills needed for the instructional strategies in the study. Copies of the instructional guides were submitted to four specialists in Science Education for the evaluation of content and face validity. The validated instrument was subjected to a reliability test by subjecting the ratings of the instrument from the four raters to Fleiss' Kappa inter-rater reliability scale with a reliability index of 0.72.

The Physics Achievement Test (PAT): Copies of the PAT were taken to experts in science education to ascertain both face and content validity. The experts made necessary modifications. Then, the researcher embarked on a pilot study to enable him to ascertain the reliability of the PAT. The PAT initially constituted 50 questions which were reduced to 20 after the pilot study. The index difficulty and discrimination index of the items were used as selection criteria for the items on the PAT. Items with a difficulty index between 0.45 – 0.65 were selected while the discrimination index of ≥0.27 was also used as an inclusion criterion. Kuder-Richardson 20 was used to verify the reliability of the instrument, which was (Kr20) = 0.78.

The Students' Numerical Ability Test (SNAT): The face and content validity of the SNAT was carried out by experts in mathematics education. The instrument was taken for trial testing and administered to 50 students who were not part of the study. Analysis of the items was carried out to establish the index difficulty and the discrimination index. Items with a difficulty index between 0.43 – 0.63 were selected while the discrimination index of ≥0.3 was also used. The reliability of SNAT was determined by Kuder-Richardson 20 which was (Kr20) = 0.80.

Experimental Procedure

Three qualified Physics teachers with over four (4) years of teaching experience participated engaged in the study. These teachers were chosen from an initial pool of six (6) teachers that took part in the training exercise organised for research assistants/teachers. Two evaluation sheets/instruments were designed and used during the training. Each of these instruments was used during the training session to evaluate the Physics teachers in the various groups (Contextualised Cubing Instructional Strategy and Teacher-Centred Conventional Instructional Strategy).The Evaluation Form for Assessing Physics Teacher's Performance during Training (EFAPTP) was used to assess the effectiveness of teachers in the use of the Instructional Guides provided for the study. So, each of the sheets indicated the skills teachers are expected to display during the teaching-learning process. These skills are presentation of concepts, introduction, lesson progression, communication, students' participation, classroom activities, use of instructional materials for activities, and subject mastery. The teachers were trained on the strategies and at the end of the training, the best three (3) out of the six (6) teachers that took part in the training exercise were selected for the study. This was done to eliminate the influence of teacher quality on the outcome of the study

The study lasted for 13 weeks. The schedule of activities is as follows:

Week 1 - Selection of schools

Week 2 - Training of Teachers and Pre-test Administration

Week 3 – 12 - Implementation of the interventions

Week 13- Post-test Administration

Aggregate = 13 weeks

Procedural fidelity

To measure the accuracy of the implementation of the intervention, teachers' performance data was collected through observation sheets. Three research assistants, who are doctoral students, were employed to observe and rate teachers' level of implementation of the steps in the instructional guide. The raters ticked [√] for accurately implemented items on the observation sheets. The numbers of ticked [√] items were dividing by the total number of items on the observation sheet and multiplied by 100%. That is,

Procedural Fidelity Score = Number of ticked [√] items x 100% / Number of items on the Observation Sheet

The observers' ratings were collated and the mean scores were computed for each of the interventionist. Based on the information collected by the observers, a mean fidelity score (95.75%) was obtained. This shows that the intervention was implemented to 95.75% accuracy.

Method of Data analysis

The mixed model analysis was adopted. This is due to the nested structure of the data. The utilisation of intact classes in the schools used for the study has implications such as the dependency of the observed cases on one another, and the nesting of the subjects. According to Tabachnick and Fidell (2014), and Mertler and Reinhart (2017), nesting occurs when levels of independent variables are restricted to only one level of another independent variable; that is, when students within a classroom are assigned to just one treatment group and, thus cannot be assigned to different treatment groups. In such design, the post achievements mean score of all the students in each classroom is obtained and used as the dependent variable. Such design is nested or hierarchical. Therefore, the mixed model analysis was adopted to address the error term associated with the random assignment of intact classes and the challenge of unequal sample size among the different classes.

FINDINGS

Effect of intervention and students' baseline knowledge (Pre-Achievement) on students' academic achievement in Physics

A multilevel model was built to explore the main effect of the intervention and baseline knowledge of the students on their academic achievement in Physics. The first stage involved a linear mixed model analysis of students' achievement, with the treatment as the only predictor in the model, as shown in Table 4 below.

Table 4: Tests of Fixed Effects

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	107	1636.718	.000
Treatment	1	107	117.629	.000

The outcome showed that the intervention significantly predicted students' achievement in Physics, $F(1, 107.00) = 117.63$, $p < 0.001$. The model was then built up to accommodate the baseline scores of the students; that is, the students' pre-test achievement. The outcome is shown in Table 5 below.

Table 5: Tests of Fixed Effects

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	107	163.089	.000
Pre-Achievement	1	107	15.218	.000
Treatment	1	107.000	116.943	.000

The outcome showed that the baseline knowledge of the students (measured as Pre-achievement), $F(1, 107) = 15.22$, $p < 0.001$ and the treatment $F(1, 107.00) = 116.94$, $p < 0.001$, have a significant effect on the academic achievement of the students.

Effect of intervention and interaction of numerical ability on students' academic achievement

Numerical ability was introduced into the model to evaluate the effect of intervention and interaction of numerical ability on students' academic achievement, as shown in Table 6 below.

Table 6: Tests of Fixed Effects

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	176.563	46.655	.000
Treatment	1	176.496	5.175	.024
Pre-Achievement	1	164.180	17.415	.000
Numerical_abillity	1	161.492	.298	.586
Treatment * Numerical_abillity	1	161.799	.111	.740

Dependent Variable: Post-Achievement

Results obtained from the analysis as shown in Table 6 above indicates that there were no intervention and interaction effect [$F(1, 161.50) = .298$, $p = 0.586$ and $F(1, 161.80) = .111$, $p = 0.740$] of numerical ability on students' academic achievement in Physics. However, the model still maintained a significant effect of the intervention, $F(1, 176.50) = 5.175$, $p = 0.024$ and baseline knowledge of the students (measured as Pre-Achievement), $F(1, 164.18) = 17.415$, $p < 0.001$ on students' academic achievement. Results obtained in Table 6 displayed a significant improvement on the academic achievement of the physics students. The direction and difference in the level of improvement in students' academic achievement is further demonstrated as displayed in Table 7. Results displayed on Table 7 shows that students exposed to the Contextualised Cubing Instructional Strategy recorded the highest post-achievement mean scores across the three schools (GCI, MGS and AHS).

Table 7:Descriptive statistics displaying the estimated mean of students' academic achievement

School	Treatment		No. of Students	Mean
GCI	Cubing Instructional Strategy (CIS)	Post Achievement	17	13.7059
	Conventional Strategy(CS)	Post Achievement	18	10.8889
MGS	Cubing Instructional Strategy (CIS)	Post Achievement	16	13.6250
	Conventional Strategy(CS)	Post Achievement	20	10.6000
AHS	Cubing Instructional Strategy (CIS)	Post Achievement	18	13.0556
	Conventional Strategy(CS)	Post Achievement	18	10.7778
Total	Cubing Instructional Strategy (CIS)	Post Achievement	51	13.4510
	Conventional Strategy(CS)	Post Achievement	56	10.7500

Results displayed on Table 7 shows that students exposed to the Contextualised Cubing Instructional Strategy recorded the highest post-achievement mean scores across the three schools (GCI, MGS and AHS).

DISCUSSION

The outcome of this study demonstrated that the intervention had a significant effect on the academic achievement of students in Physics. The estimate (b= -2.24) shows that the academic achievement of students skewed towards the cubing instructional strategy intervention. Further evidence of the superiority of the cubing instructional strategy intervention is shown in the descriptive statistics obtained from the mixed model analysis which showed that students exposed to the cubing instructional strategy recorded the highest achievement in Physics across the schools used for the study.This shows the superiority of student-centred cubing instructional strategies compared to the teacher-centred conventional instructional strategy.

The findings of this study substantiated the position of constructivist theory, which emphasises the importance of creating a platform for students to construct their knowledge. The most important feature of the constructivist theory is its position on the role of students in the instructional process. It maintains that students must be provided with the right platform to enable them to generate their knowledge and ideas. Students must be given the responsibility for their own learning. Learning is guided by practical exercises which are the adaptation of real-life issues grounded on solid experience in the classroom/laboratory. These practical exercises include interactions in the classroom which enable the exchange of ideas and development of new concepts. The constructivists believe that learning is not the transfer of knowledge from the teacher to the student. Rather, it is the active construction of knowledge by the student through involvement in platforms created by the teacher for the sole purpose of learning. The outcome of this study could be attributed to the active participation of students in the learning activities as well as the consideration given to the students' everyday experiences through the implementation of Cubing Instructional Strategy. This enabled the students to interpret the concepts in their way, making sense of the concept by employing their prior classroom/everyday knowledge of Physics. The outcome of this study is consistent with the findings of Zebua (2017) and Salha, Shawahany and Barakat (2017). The studies found significant improvement in the learning outcomes of 8^{th} grade English language students in SMP Swata NUPELA, Malaysia. Similarly, Salha, Shawahany and Barakat (2017) found a significant effect of Cubing instructional strategy on the academic achievement of Mathematics students in Qalqilya governorate, Westbank City of Palestine. The result also corroborates the finding of the study conducted by Iskandar (2017), which found a significant improvement in the achievement of students who were exposed to cubing instructional strategy.

The findings of the study did not reveal any significant, both main and interaction, effects of numerical ability on the academic achievement of students in Physics. This discovery contradicts the findings of Obafemi and Ogunkunle (2014) who observed that numerical ability had a significant relationship with the performance of students in Physics concepts such as sound waves especially when taught using student-centred learning methods. This finding could be attributed to the capability of the cubing instructional strategy to enhance students' active involvement in the learning process rather than the passive involvement of students in the teacher-centred conventional instructional strategy. This is corroborated by Alma and Milagros (2015) who found significant improvement in the achievement of Philippine students taught using Interactive Based instructional strategies. A study conducted by Iskandar (2017) revealed a substantial improvement in the result of students who were taught using cubing instructional strategy compared to students who were taught with the conventional teaching strategy.

CONCLUSION AND IMPLICATIONS

Findings of the study show that Physics students' academic achievement was greatly enhanced by the contextualised instructional approach. The contextualised cubing instructional strategy was observed to be effective in enhancing students' academic achievement in Physics irrespective of students' numerical ability. The study, therefore, concludes that the contextualised-cubing instructional strategy is suitable for Physics classroom instruction. This is because the strategy allowed the students to play active roles in the instructional exercises thereby enhancing their feeling of ownership of the learning process. The strategy also showed its capability to enhance students' conceptual learning of Physics, and hence, improve their academic achievement.

Many previous findings have reported the significant effects of contextually responsive instructional strategies such as cubing instruction on students' academic achievement. Studies conducted in Palestine, the Philippines, and Malaysia reported significant impact of cubing instructional approach on students 'academic achievement in various subjects and regions of the world. This, therefore, implies that this strategy is suitable for enhancing students' active involvement in the learning process as it provides a platform for the students' utilization of their prior classroom experience of informal knowledge. The implication of this study, which corroborates many previous studies, is that contextualised-cubing instructional strategy can be adapted to teach any subject.

RECOMMENDATIONS

The following recommendations are advanced according to the findings of the study.

a) The adoption of the contextualised-cubing instructional strategy in science classroom instruction especially in Physics instructional activities is imperative.

b) There is a need for the extension of research on contextualization of Physics instruction as a means of improving the students' achievement in Physics.

c) There is a need for further examination of other variables that can interact with the contextualised-cubing instructional strategy to enhance the academic achievement of students in Physics.

ETHICAL STATEMENT

This study observed all the necessary ethical/human subject requirements surrounding quasi-experimental research as stated and approved by the Ethical Committee of the University of Ibadan.

The authors state that there is no conflict of interest in this article.

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