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INTERNATIONAL JOURNAL OF CONTEMPORARY ISSUES IN INTEGRATED SCIENCE EDUCATION (IJCIISE)

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EDITORIAL

Dear Readers,

We are excited to announce the launch of International Journal of Contemporary Issues in Integrated Science Education (IJCIISE). This Association Integrated Science Educators' Association of Nigeria (ISEAN) play a vital role in promoting scientific advancement, supporting science education, informing science policy, recognizing science excellence and fostering community engagement. The desire to float this journal was borne out of the passion to organize a yearly conference of Integrated Science by the Integrated Science Educators' Association of Nigeria, of which selected scholarly articles will be published after a thorough review. The journal dedicated to advancing knowledge and fostering dialogue within. Our mission is to publish high-quality research, innovative ideas, and critical analyses that contribute to the understanding and development of Integrated Science. At IJCIISE, we believe in the power of interdisciplinary collaboration and inclusivity. We welcome contributions from scholars, practitioners, and thought leaders worldwide, providing a space for diverse perspectives and groundbreaking work. As we embark on this journey, we invite you to submit your research, engage with our content, and join us in creating a vibrant academic community. Together, we can push the boundaries of knowledge and inspire future generations. Thank you for your support as we launch this exciting new endeavour.

This edition moves around issues that border on **"Enhancing Quality Assurance in Integrated Science in Nigeria."** It is believed that diverse contributions from scholars and researchers expressed in this edition will provoke the understanding of issues that could foster education for societal transformations on a global scale
We look forward to your contributions!

For further information on future conference activities, visit **http://ijciise.org/index.php/ijciise**

Warm regards,
Professor O. S. Agboola
President, Integrated Science Educators' Association of Nigeria (ISEAN)

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EFFECT OF FLIPPED CLASSROOM INSTRUCTIONAL STRATEGY ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN CHEMISTRY IN OSUN STATE, NIGERIA.

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Abstract
The study investigated the effect of flipped classroom instructional strategy on Chemistry students' academic achievement and retention in Secondary schools in Osun State, Nigeria. Two research questions and two hypotheses were formulated to guide the study. A pretest-posttest and post posttest control group quasi-experimental research design was employed in the study. The population of the study comprised of all SSII Chemistry students in all secondary schools in Osun State. Purposive and simple random sampling techniques were used to select 102 SS II chemistry students. The experimental group were taught redox concepts using flipped classroom instructional strategy while the control group were taught the same redox concepts using lecture method of teaching. Chemistry Achievement Test (CAT) was the instrument used for data collection which was validated and tested for reliability. Mean and Standard Deviation were used to answer the research questions and the hypotheses were tested using independent sample T-test at 0.05 level of significance. The findings of the study revealed that the students taught redox concepts using flipped classroom approach have significantly higher academic achievement and retention scores than those who were taught using lecture method. Based on the findings, it was recommended among others that Chemistry teachers should adopt the use of flipped classroom instructional strategy because it is a student- centered learning strategy that improves students' academic performance.
Keywords: Flipped classroom, Academic achievement, Retention, Redox.

Introduction

The study of science in general and chemistry in particular has led to the improvement of life in every aspect of human endeavor. Chemistry is the branch of science concerned with the substances of which matter is composed, the investigation of their properties and reactions, and the use of such reactions to form new substances (Osuafor, & George, (2023).

Chemistry has it center influence to every filed of life. From the food we eat the clothes we wear, the book and paper we read, to the medication and transportation all have something or the other to do with chemistry. Chemistry has made tremendous contribution in the world; it has helped man to understand the complexity of his body, the environment, benefit and hazard of this world (Naidu, Biswas, Willett, Cribb, Singh, Nathanail, & Aitken, (2021)). It has been increasingly used

in providing solution to problems such as health, agriculture, food, shelter and manufacturing. There is scarcely a single area of our daily lives that is not affected by chemistry.

To study chemistry daily, in this modernized digital world, good teacher applies effective instructional mode to help learner construct their knowledge at anytime, anywhere, and at their own pace. The instructional mode should be appropriate for their developmental and era level, so that they will not only improve their academic achievement but also have positive attitude towards chemistry. That is why, Makinde, (2017) stated that, looking at advancement in modernization of the world, the Nigeria educational system requires learners who could have acquired the necessary attitude and skill of digital instructional modes in learning science, and chemistry in particular.

However, it is disheartening to note that chemistry students' academic achievement in the subject in senior secondary school certificate examination has remained poor in this digital era. This is supported by WAEC Chief Examiner's report (2020). The poor academic achievement in 2020 and 2021 assessments as asserted by, the Unified Tertiary Matriculation Examination (UTME) 2021, according to the Registrar of Joint Admission and Matriculation Board, Professor Ishaq Oloyede on National Television Authority (NTA) announcement, 2021 6th July, stated that candidate performed below expectation in 2021 JAMB compared to previous years for obvious reasons, especially the covid-19 pandemic leading to the closure of schools and emergency online learning.

Also, poor achievement of students has been attributed to some students' factors such as; student sex role stereotyping, negative attitude towards chemistry and teacher related factor such as emergence on line instructional mode in covid 19, poor teacher preparedness and application of inefficient instructional modes (Osuafor & George, 2023). In Nigeria, efforts are been made by researchers, government organization to diagnose the problems associated with teaching and learning of chemistry in order to proffer solution that lead to better achievement. However, the WAEC chief examiners (2020) comments indicate that achievement in chemistry at secondary school remains poor. Again, there are some gender disparities towards the subject as Chemistry has always been seen as a very male dominated field leading to female students having a different attitude towards the subject. Overall, students' academic achievement in the subject has not significantly improved over the years (Konyefa & Okigbo, 2021). Could it be that teachers' modes of instruction in this era is not effective to improve student's achievement?

Effective teaching involves classroom teaching behavior/ interaction between the teacher, the students, the subject matter and combination of these three dimensions (Akuezilo in George, 2021). As it is understood, that for centuries teaching and learning in secondary schools in Nigeria generally tended to be conventional, through face-to-face communication techniques in the physical classroom based only. Since the dawn of the novel Coronavirus in 2020, the need of a technology-oriented learning has become inevitable. In Nigeria, the increase in

security issues, natural disasters like floods have proven to seriously disrupt educational activities. The challenges facing the education systems in Nigeria and Anambra state in particular continue to intensify. The activities of Unknown Gun Men (UGM) and the 2012 and the recent ravaging 2022 flood have affected school days in the state and educational system in Anambra state as in other states of Nigeria. The incessant disruption of academic activities and calendar has incited the need for a flipped classroom.

United Nation Educational, Scientific and Cultural Organization UNESCO (2020) stated that, eventually globalization of e-education is bound to happen just as we have witnessed globalization of e-mail, e-commerce and e-government. This implies that our nation's advancement in science depends to a large extent on its strong science education digital instructional mode in this era. Therefore, to achieve effectiveness, in teaching and learning of science in general and chemistry in particular in this digital era, teachers need to adopt some digital instructional mode. One of such mode could be flipped classroom instructional modes via google classroom (FCIVGC). Flipped classroom is an instructional mode and a type of blended learning that integrates physical classroom with online via digital tool developed by Jonathan and Aaron in 2012. It is a multimedia cognitive instructional mode that focused cognitive processes that the students used to learn, FCIVGC focuses on considering the students mind as a dual channel, limited capacity, and active processing system by presenting instruction as audio, video, narrations, text and graphics'. So that the learner can actively generate meaningful relationship between instructions in both classrooms and online, since students learn contents at home and practice working through it at school. A side benefit is that teachers can record lessons that emphasis on a given curriculum contents to achieve educational goals. It also allowing students to pause, rewind, review as well as creating already made library for students' review make work (The flipped classroom learning network & Sophia, 2014). This is unlike the physical classroom only based learning of conventional instructional modes, which ends in physical classroom teaching. Teacher talks, writes, and in fact does everything in the classroom.

There are several versions of flipped classroom learning model as proposed by many researchers like as Jonathan and Aaron (2012), Wesley Baker (2000), Walvoord and Anderson (1998), and Brame (2013). This study focuses on Brame (2013) model which is of Inverted Classroom Assignment Peer Instruction Based Model. This model according to Brame, helps students' learning problem solving, and reasoning skills to improve because they first encounter learning content at home and interacted with each other before physical classroom. Before peer instruction occurs in physical class, learners are first received their first learning exposure before class in new material, completing knowledge-based assignments before physical classroom. Here, the instructor coach rather than lectured and learners work on the processing aspect of learning, including the critical thinking processes of analyzing, problem solving, synthesizing, during class. It is an instructional mode with three instructional phases namely; before class, during class and after class. Flipped

classroom could be seen as a one useful instructional mode in this digital era that could improve academic achievement.

Academic achievement describes academic outcomes that indicate the extent to which a student has achieved their learning goals (Ejiofor & Osuafor, 2019). According to Konyefa & Okigbo (2021), academic achievement is the grade obtained through achievement test through which the teacher evaluates the extent to which instructional objectives have been achieved. Academic achievement or academic performance is the extent to which a student, teacher or institution has attained their short or long-term educational objectives. Students' achievement refers to performance in a school subject as designated by a score or mark obtained in an achievement test (Abd, Andi & Muhammad, 2020). It represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of education. Academic achievement is often measured through continuous assessments or examinations such as those of the West African Senior School Certificate Examination (WASSCE) administered by West African Examination Council (WAEC) Evidence from the WAEC Chief Examiner's report showed that from 20132016, there was a persistent decline in the percentage of those who made a credit pass from 72.34% in 2013, to 62.49% in 2014, to 60.6% in 2015 and 57.74% in 2016. From 2017 to 2019, reports on the worst performances of students in chemistry were observed (Appendix A, p. 98). Although, a lot of factors such as inadequate laboratory facilities, the abstract nature of the subject and lack of adequate teaching staff has been implicated, the instructional methods adopted by chemistry teachers stand out as the most prominent factor (Konyefa & Okigbo, 2021; Nwanze & Okoli, 2021).

Statement of the Problems

Science teaching and learning in Nigeria education system has been done conventionally, where the teacher is the principal instructor while the students are the recipient of the information. Students mostly are passively learning rather than been active in the classroom activities. Chemistry teaching and learning tends to be more teacher oriented than students oriented. Teaching and learning activities are as revolve around the teacher and most of the time students lose interest in the learning activities and most of the time see science and chemistry as an abstract subject. This has greatly affected the achievement of students in chemistry. As the chalk and board teaching and learning method are gradually phasing away in different quarters across the ends of the world, so many people are embracing the need for technology in teaching and learning. Technology is a good way to harness the interest of young minds toward learning new information. It makes them actively, passionate and can engage their time meaningfully towards effective learning, improved achievement.

But the need for the application of digital instructional model was made relevant with the dawn of the novel corona virus and its effect which have seriously disrupted academic programmes and have led to poor academic achievement and poor attitude of secondary school students. There arises whether the instructional

model will be effective for improving achievement and enhancing the attitude of students towards science oriented subjects like chemistry. The researcher seeks to determine whether flipping the classroom via google classroom would improve students' achievement in Chemistry.

Objectives of the Study

This research work intends to:

i. determine the effect of flipped classroom approach on the academic achievement of students in red-ox concepts.
ii. investigate the retention ability of students when exposed to flipped classroom approach and lecture method of teaching red-ox concepts.

Research Questions

The following research questions were formulated to guide this study:

1. What is the effect of flipped classroom approach on the academic achievement of students in redox concepts?
2. What is the retention ability of students when exposed to flipped classroom approach and lecture method of teaching redox concepts?

Research Hypotheses

The following hypotheses were formulated to guide the research:

1. There is no significant difference in the academic achievement of students taught with flipped classroom approach and lecture method of teaching redox concepts.
2. There is no significant difference in the retention ability of students taught using flipped classroom approach and lecture method of teaching redox concepts.

Methodology

The study employed pretest-posttest and post-posttest control group quasi-experimental design. The design comprised of two groups; the experimental and the control groups. The experimental group was taught using Flipped Classroom Instructional Strategy (FCIS) while the control group was taught using Lecture Method of Teaching (LMT). The population of the study comprised of all SS II chemistry students in all Secondary schools in Osun State. The sample size for the study is 106 which were carefully selected from the selected secondary schools in the three senatorial districts in Osun State. The sampling techniques used in the study were purposive and simple random sampling techniques. Purposive sampling technique was used to select the experimental group since the criteria for being in the group lies on the possession of laptop computer, desktop computer or android smart phone device that has facilities to play mp4 video. 44 students met the criteria and therefore selected to constitute the experimental group. However, a simple random sampling technique was used to select 62 students to form the control group. The

instrument for data collection in this study was Chemistry Achievement Test (CAT). The CAT items were constructed based on SS II syllabus by the researcher on the concepts of redox. The instrument was validated and the reliability index was calculated to be 0.76 using Pearson Product Moment Correlation Coefficient. The data collection was conducted by the researcher and the research assistant(s). Both the experimental and the control groups were pretested by the researcher and the research assistant thereby establishing level of performance to ascertain equivalency. The main treatment for this study is the teaching of redox topic using FCIS for the experimental group and LMT for the control group. The treatments for both the two groups lasted for six weeks, after which a posttest was administered to both the two groups to ascertain the level of performance. After two weeks interval from the posttest, a post-posttest (retention test) was then administered to determine the retention ability of the two groups. The data that were collected for the study from both the two groups were analyzed using descriptive statistics of mean and standard deviation to answer the research questions, and inferential statistics of independent T-test to test the null hypotheses at 0.05 levels of significance.

Results

Research Question 1

What is the effect of flipped classroom approach on the academic achievement of students in redox concepts?

Table 1: Pretest and Posttest Mean Achievement Scores of Students Taught Using Flipped Classroom Instructional Strategy and Those Taught Using Lecture Method of Teaching

Group	N	Pretest X	Pretest SD	Posttest X	Posttest SD	Gained Mean
FCIS (Experimental)	40	13.82	4.90	22.95	6.08	9.13
LMT (Control)	64	13.90	4.64	18.03	4.18	4.13
Mean Difference		0.08	4.92	5.0		

Table 1 reveals that students taught using FCIS have pretest mean achievement score of 13.82 and posttest mean achievement score of 22.95 with gained mean achievement score of 9.13, while those in the LMT class have pretest mean achievement score of 13.90 and posttest mean achievement score of 18.03 with gained mean of 4.13. The students in the experimental group have higher posttest mean achievement score than those in the control group. The difference between the gained mean achievement scores of the two groups is 5.0 in favour of those who were taught using FCIS.

Research Question 2

What is the retention ability of students when exposed to flipped classroom approach and lecture method of teaching redox concepts?

Table 2: Mean Retention Scores of Students Taught Redox Concepts Using Flipped classroom approach and Lecture Method of Teaching.

Group	N	X	SD	Mean Difference
FCIS (experimental)	40	22.68	5.12	
LMT (control)	64	16.84	3.36	5.84

Table 2 presents the results of mean retention scores of students taught redox concept using FCIS and LMT. From the result students taught using FCIS have mean retention scores of 22.68 with standard deviation of 5.12 while those taught using LMT have mean retention scores of 16.84 with standard deviation of 3.36. The mean difference between the two groups is 5.84. This shows that students taught redox concept using FCIS have high retention scores than their counterparts in the control group.

Hypotheses Testing

The null hypotheses formulated for the purpose of this research were tested at 0.05 levels of significance.

Hypothesis 1

There is no significant difference in the academic achievement of students taught using flipped classroom instructional strategy and lecture method of teaching redox concepts.

Table 3: Independent Sample T-Test Analyses for Posttest Mean Achievement Scores of the Experimental and Control Groups.

Group	N	X	SD	df	t-cal	p-value	Remark
FCIS (experimental)	44	22.95	6.08				
LMT (control)	62	18.03	4.18	104	4.94	0.000	Significant

p=0.05

Table 3 shows the analysis of the independent sample t-test for posttest academic achievement scores of the experimental and control groups. The observed p-value was 0.000 which is less than the level of significance 0.05 with df=104. The null hypothesis one is hereby rejected and the reason for the rejection of the hypothesis is because the observed p-value (0.000) is less than the level of significance 0.05. Therefore, there is significant difference between the academic achievement scores of SS II Chemistry students taught redox concepts using FCIS and those taught using LMT, in favor of the experimental group (t-cal.= 4.94, df=104, p=0.000< 0.05).

Hypothesis 2

There is no significant difference in the retention ability of students when taught using flipped classroom instructional strategy and lecture method of teaching redox concepts.

Table 4: Independent Sample T-Test of the Mean Retention Scores of Students Taught Redox Concepts Using Flipped Classroom Approach and Lecture Method of Teaching.

Group	N	X	SD	df	t-cal	p-value	Remark
FCIS (experimental)	44	22.68	5.12				
LMT (control)	62	16.84	3.37	104	7.09	0.012	Significant

p=0.05

From Table 4, the observed p-value is 0.012 with df=104 which is less than the level of significance 0.05. Based on comparability of p-values, the null hypothesis two is hereby rejected. The reason for the rejection is that, the observed p-value is less than the significant level. Therefore, there is a significant difference in the mean retention scores of students taught redox concepts using FCIS and those taught using LMT, in favor of the experimental group (t-cal=7.09, df=104, p=0.012< 0.05).

Discussion of Findings

Based on the findings from this study, it was found that the mean achievement score of the experimental group was higher than that of the control group. It was further revealed that there is a significant difference in the academic achievement of SS II chemistry students taught redox concepts using flipped classroom approach and those who taught using lecture method of teaching, in favor of those taught using FCA. This result implies that the use of FCA in teaching redox concepts enhance the academic achievement of SS II students. This finding is in agreement with the findings of Akingbemisilu (2017), Makinde (2017), Ugwoke, Edeh and Ezemma (2018), Ayecicek and Yelken (2018), Efiuvwere and Fomsi (2019), Karagol and Esen (2019) who found that students learning activities based on FCA have higher academic achievement scores than students who were taught through the LMT. The findings of this study also revealed that, the experimental group has higher mean retention score than the control group. It was also found that there is a significant difference in the retention ability of SS II students taught redox concepts using flipped classroom model and those taught using lecture methods of teaching, in favor of the experimental group. This means that when FCA is used to teach redox concepts, it enhances the students' retention ability. This finding is in agreement with the findings of Makinde (2017), Ibrahim and Haruna (2017) and Sirakaya and Ozdemir (2018). This observation could be attributed to the fact that, learning material used in the FCA appeal to many different sensory organs, and this can be effective in ensuring more permanent learning for students in the flipped classroom.

Conclusion

This study investigated the effects of flipped classroom approach on SSII students' academic achievement and retention in redox concepts in secondary schools in Osun State, Nigeria. The result of the study revealed that there is a

significant difference both in the academic achievement and retention of students taught redox concepts using flipped classroom model and those who were taught using lecture method, in favor of the experimental group.

Recommendations

From the findings of this study, the following recommendations were made:

1. Chemistry lecturers/teachers should adopt the use of flipped classroom approach because it is a student-centered learning strategy that improves students' academic performance.
2. Teachers are encouraged to teach topics/courses that requires high students' retention ability using flipped classroom models

References

Abd, B., Andi, S. and Muhammad, A. I. (2020). Academic self-efficacy as predictor of academic achievement. *Journal Pendidikan Indonesia, 9*(1), 163-168.

Akuezuilo, E.O. (2021). Effectiveness of prior knowledge of behavioural objectives and study questions on female students, mathematics achievement. *Journal of STM Education I* (1), 1-6

Akingbemisilu, A. A. (2017). Effects of animation and video-based flipped classroom strategies on pre-degree students' learning outcomes in practical Biology in Southwestern Nigeria (Unpublished doctoral thesis). University Of Ibadan, Ibadan, Nigeria.

Ayçiçek, B., & Yelken, T. Y. (2018). The effect of flipped classroom model on students' classroom engagement in teaching english. *International Journal of Instruction, 11*(2): 385-398.https://doi.org/10.12973/iji.2018.11226a

Baker, B.(2001). The effect of Academic self-concept on ADHD and antisocial behavior in early adolescent. *Journal of Learning Disability.* Sept. 1, 2001

B. Jonathan., &S Aaron. (2012). Flip your classroom: Reach every student in every class every day. Eugene, OR: International Society for Technology in Education

Brame, C. (2013). *Flipping the classroom.* Retrieved from Vanderbilt University Center for Teaching. http://cft.vanderbilt.edu/guides-sub-pages/flipping-theclassroom/.

Brame, C. (2013). *Flipping the classroom.* Retrieved from Vanderbilt University Center for Teaching. http://cft.vanderbilt.edu/guides-sub-pages/flipping-theclassroom/

Ejiofor, M. A. & Osuafor, A. M. (2019) Effect of problem-based learning on achievement of secondary school computer studies students in Nnewi education zone. *International Journal of Innovative Research and Advanced Studies, IJIRAS, 8*(6), 93-97.

Efiuvwere, R. A., & Fomsi, E. F. (2019). Flipping the Mathematics Classroom to Enhance Senior Secondary Students' Interest. *International Journal of Mathematics Trends and Technology, 65*(2):95-101

Walvoord E. & Anderson V. A., 1998. "Effective Grading: A Tool for Learning and Assessment in College" in, Estados Unidos: John Wiley Sons,

Flipped Learning Network & Sophia (2014). Growth in flipped learning: Transitioning the focus from teachers to students for educational success. Retrieved from http://www.flippedlearning.org/survey

Ibrahim, A., & Haruna, J. A. (2017). Effects of Flipped and Conventional Teaching Approaches on Performance and Retention Ability of Students in Advance Financial Accounting in Abubakar Tafawa Balewa University Bauchi, Nigeria. *Journal Psikologi Malaysia,31*(2):1220.

Karagol, I.& Esen,E. (2019).The effect of flipped learning approach on academic achievement: A meta-analysis study. *Hacettepe University Journal of Education, 34*(3),708-727. http://dx.doi.org/10.16986/HUJE.2018046755

Konyefa, B. I. and Okigbo, E. C. (2021). Effect of ethnochemistry instructional approach on secondary school students' achievement in chemistry in Bayelsa State. International *Journal of Education and Evaluation (IJEE), 7*(4), 16-22.

Makinde, S. O. (2017). Effects of a Developed Flipped Classroom Package on Senior Secondary School Students' Performance in Mathematics in Lagos, Nigeria (Unpublished doctoral thesis).University of Ilorin, Ilorin, Nigeria.

Naidu, R., Biswas, B., Willett, I. R., Cribb, J., Singh, B. K., Nathanail, C. P., ... & Aitken, R. J. (2021). Chemical pollution: A growing peril and potential catastrophic risk to humanity. *Environment International*, *156*, 106616.

Nwanze &Okoli (2021). Effects of computer animation and inquiry teaching methods on chemistry students' interest in Onitsha urban. International Journal of Innovative Research and Advanced Studies (IJIRAS), 8(2), 57-63. Ezeanyika, V. A. (2021). Effect of blended learning instruction

Osuafor, A., & George, P. C. (2023). Effect of Flipped Classroom instruction via google classroom on secondary school students' academic achievement chemistry in onitsha education zone. *UNIZIK Journal of Educational Research and Policy Studies*, *15*(3), 86-95.

Sirakaya, D. A. & Ozdemir, S. (2018). The Effect of a Flipped Classroom Model on Academic Achievement, Self-Directed Learning Readiness, Motivation and Retention. Malaysia Online Journal of Educational Technology,6(1):76-91.

Ugwoke, E. O., Edeh, N. I., & Ezemma, J. C. (2018). Effect of Flipped Classroom on Learning Management Systems and Face-to-Face Learning Environments on Students' Gender, Interest and Achievement in Accounting. Library Philosophy and Practice (e-journal),1875. http://digitalcommons.unl.edu/libphilprac/1875

UNESCO. (2020). Global education monitoring report, 2020: Inclusion and education: all means all. Paris: UNESCO

TEACHERS' STRATEGIES AND SCIENTIFIC INQUIRY SKILLS OF PRIMARY SCHOOL PUPILS IN OSUN STATE

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Abstract
The study examined the prevalent strategies employed by teachers in inculcating scientific inquiry skills in early basic class pupils in Osun State and determine the influence of teachers' strategies on pupils' scientific inquiry skills in the study area. The study adopted a descriptive survey research design. The population for the study was all teachers and pupils in the early basic classes in Osun State. One hundred and fifty (150) teachers of early basic classes and 750 early basic classes' pupils were randomly selected through multistage sampling procedure. Two instruments titled, 'Teacher Strategies for Scientific Inquiry Development Observational Schedule (TSSIDOS) and Pupil Scientific Inquiry Observation Rating Scale (PSIORS) were used for data collection. Data collected were analysed using percentage, mean, standard deviation and Analysis of Variance (ANOVA). The finding showed that recitation and explanation were the most frequently used strategies 139 (92.7%) respectively while experimentation was the least employed strategy 16 (10.6%). It also showed that the strategies used have significant influence on the development of pupils' scientific inquiry skills ($F= 2.944$; $p < 0.05$). The study concluded that though teachers employed majorly traditional otherwise referred to as conventional strategies, they still have positive influence on pupils' acquisition of scientific inquiry skills. It is therefore recommended that while teachers use traditional strategies, modern or strategies that are child –centred be adopted to make children engaged in the teaching - learning process. Training should also be organized for teachers to make them acquainted with modern or child-centred strategies.
Keywords: Teachers' Strategies, Scientific inquiry skills, Primary School Pupils

Introduction

Children are naturally curious as they explore the world around them. They like to know why things around them are the way they are. In showing their curiosity, children often observe and raise questions in a way that suggests the use of the scientific inquiry. Scientific inquiry in children involves exploring and questioning the world around them through observation, experimenting with things. It also refers to the process of investigating a question, formulating a hypothesis, conducting experiments and analyzing data to draw conclusions (National Science Association (NSTA), 2007). According to McComas and Olson, (1998), scientific inquiry in children includes developing a curiosity about natural phenomena, collecting evidence through various methods and constructing explanations based on evidences. From the definitions, it can be said that scientific inquiry is an important part of growth and development in children. Though, O'Connor, and Rosicka, (2020) citing Wilson (2007) explained scientific inquiry skills as the skills of 'sciencing' in the early years and interlinking with young learners' understandings of science content, providing the structure and processes for which science content can be covered. It is a skill or competence that should be addressed in children early so that they can develop a broad mind to life. In the light of this, it is one of the skills stipulated in the National Policy on Education in Nigeria (FRN, 2013) to be inculcated in children.

Several stakeholders can play a role in encouraging scientific inquiry skills in children. These stakeholders can help children to be inquisitive from one point to the other in their stages of growth and development. They include parents, peers, teachers and the community in which they live. Parents can support their children's scientific inquiry skills by encouraging curiosity, providing opportunities for exploration and experimentation at home, allowing them to ask questions while they will they will be ready to answer their questions correctly. However, because children spend many hours in school, teachers are key players in developing scientific inquiry skills in children. They can help by creating a learning environment and ask a lot of questions which can guide children through scientific investigations. Therefore, it can be said that fostering scientific inquiry in children is a collaborative efforts among parents, teachers and the community in which the children are growing.

Research has shown that engaging children in inquiry from a young age can have numerous benefits including fostering curiosity, creativity and problem-solving skills as well as improving achievement in science (Lee & Hand, 2005). It can also help children to develop lifelong interest in and a deeper understanding of the natural world by encouraging children to explore and investigate the world around them (NGSS Lead States, 2013).

Having pointed out the benefits of scientific inquiry skills, the strategies employ by teachers in the teaching – learning process may one way or the other have impact on the development of scientific inquiry skills in children. One study by Good et al (2013) investigated the strategies that teachers use to support scientific inquiry

in the classrooms discovered that teachers who emphasized hands-on experiments, open-ended questions and scaffolding techniques were more successful in promoting students' engagement and understanding of scientific concepts.

In another study, Park and Oliver (2008) explore the instructional strategies used by science teachers to promote scientific inquiry and found that teachers who provided opportunities for students to ask questions, design experiments and analyze data were more effective in fostering scientific inquiry skills in the students. Additionally, a study by Chin and Osborne (2008) examined how science teachers supported students' inquiry-based learning in the classroom and identified several key strategies, including modelling scientific inquiry, providing feedback and guidance and creating a supportive learning environment. Furthermore, Abdal-Hay et al (2020) examined kindergarten teachers' beliefs and practices of inquiry-based science education and how these strategies influence pupils' scientific process skills and their findings suggested that teachers' beliefs and practices significantly impact pupils' ability to engage in scientific inquiry. Several other scholars emphasised the role of teachers in the development of skills in children through various strategies – conventional (teacher-centred) and modern (child-centred)

In the Nigerian setting, scientific inquiry is a skill to be given attention in order to build productive citizens rather than consumers. When children inculcated the skill, it will help to build a sustainable society.

However, there is limited research on teachers' strategies for facilitating scientific inquiries, particularly in children in Osun State primary schools, hence, this study.

Purpose of the Study

The main purpose of this study is to investigate the strategies that teachers use for developing scientific inquiry skills of primary school pupils in Osun-State.

Objectives of the Study

The following objectives are generated for this study:

i. examine the prevalent strategies employed by teachers in inculcating scientific inquiry skills in early basic class pupils in Osun State.
ii. determine the influence of teachers' strategies on pupils' scientific inquiry skills in the study area.

Research Question

What are the prevalent strategies teachers used in primary schools in the study area?

Hypothesis

There is no significant influence of teachers' strategies on pupils' scientific inquiry skills.

Methodology

The study was a descriptive survey research with all teachers of early basic classes as the population for the study. One hundred and fifty (150) teachers of early

basic classes and 750 early basic classes' pupils were randomly selected through multistage sampling procedure. Two instruments titled, 'Teacher Strategies for Scientific Inquiry Development Observational Schedule (TSSIDOS) and Pupil Scientific Inquiry Observation Rating Scale (PSIORS) were used for data collection. Data collected were analysed using percentage, mean, standard deviation, Analysis of Variance (ANOVA).

Results

The results for the study were presented in line with the stated objectives.

Research Question: What are the prevailing strategies employed by teachers in inculcating scientific inquiry skills in early basic class pupils in Osun State?

Table 1: Percentage of Teacher Strategies Used

S/N	Items	Freq. Used	Seldomly Used	Not Used	Rank
1	Recitation	139 (92.7%)	11(7.3%)	-	1
2	Explanation	139 (92.7%)	11 (7.3%)	-	1
3	Demonstration	54(36%)	46(30.6%)	50(33.3%)	6
4	Collaboration	127(84.6%)	23(15.3%)	-	4
5	Discussion	32(21.3%)	26(17.3%)	92(61.3%)	7
6	Questioning	137 (91.3%)	8(5.3%)	5(3.3%)	3
7	Experiment	16(10.6%)	25(6.6%)	109(72.6)	9
8	Reading from Textbooks	27(18%)	31(20.6%)	92(61.3%)	8
9	Use of visual aids	125 (83.3%)	21(14%)	4(2.6%)	5

Results showed that recitation and explanation 139(92.7%), questioning 137(91.3%) and visual aids 125(83.3%) were the prevalent strategies employed by teachers among other findings.

Hypothesis: There is no significant influence of teachers' strategies on pupils' scientific inquiry skills.

Table 2: Analysis of Variance on the Influence of Teachers' Strategies and pupils' scientific inquiry skills.

ANOVA a

	Model	Sum of Sqs.	Df	Mean Sq.	F	Sig.
1	Regression	80.640	8	10.080	2.944	.005b
	Residual	482.834	141	3.424		
	Total	563.473	149			

a Dependent Variable: Skills

b Predictors: (Constant), Visual, Questioning, Collaboration, Discussion, Explanation, Texts, Experiment, Demonstration

Coefficients a

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.888	4.855	1.831	.069	
	Explanation	-.679	.902	-.091	-.752	.453
	Demonstration	1.107	.625	.475	1.771	.079
	Collaboration	-.641	.722	-.119	-.887	.376
	Discussion	.158	.353	.067	.448	.655
	Questioning	.506	.416	.108	1.216	.226
	Experiment	.453	.579	.157	.783	.435
	Texts	.244	.542	.09	.450	.654
	Visual	.873	.870	.206	1.004	.317a

Dependent Variable: Skills

Excluded Variables a

Model		Beta In	t	Sig.	Partial Correl.	Collinearity Statistics
						Tolerance
1	Recitation			.000		

a Dependent Variable: Skills

b Predictors in the Model: (Constant), Visual, Questioning, Collaboration, Discussion, Explanation, Texts, Experiment, Demonstration

Discussion of Findings

The study highlighted the most common strategies used by primary school teachers in Osun State to develop scientific inquiry skills in children. These included: Recitation and Explanation as the most frequently used by teachers. They are essential for conveying information and clarifying concepts. The frequent use of recitation and explanation aligns with traditional teacher-centered methods identified by Chin and Osborne (2008) in their study. However, their advocacy for a shift to inquiry-focused strategies (e.g., modeling inquiry and providing feedback) highlights the need for the teachers in Osun State to adopt more interactive approaches. The finding is also in support of Odora (2014) study that emphasized the need to help teachers gain good grip of explanation as a strong method to improve learners' competence and academic achievement. Tefertiller (2016), who revealed recitation to be a good strategy in teaching as there is nowhere, for learners to hide, and no opportunity for tricks to disguise a lack of knowledge. It is either the learner knows it or not. Trinitas (2022) also discovered recitation as a potent strategy in helping learners develop rhetoric skills and aiding skills of public speaking. However, it has to be pointed out that traditional strategies may still be effective in the teaching – learning process, they do not allow for active engagement of children in hands-on inquiry-based learning that will actively and effortlessly promote scientific inquiry skills.

The study showed that Questioning was employed largely by teachers in

stimulating curiosity and guiding scientific thinking of pupils. The finding is in accordance to Tofade, Elsner, and Haines (2013); Shanmugavelu, Ariffin, Vadivelu, Mahayudin and Arasi, Sundaram (2020) submission that questioning is a dynamic strategy to reckon with in the teaching – learning process of inculcating scientific inquiry skills in children. The study further elucidated Center for Innovation in Teaching & Learning (2024) submission of the efficacy of questioning on attaining a well – defined goals for students' learning. However, Tofade, Elsner, and Haines (2013) revealed that poor constructed questioning could have negative effect on learners' construction of knowledge. The implication is that when teachers use questioning well for learners, they tend to help learners operate at improved level in the learning process.

The finding also indicated that collaborative strategies were employed by teachers to foster scientific inquiry skills in children. This is in line with finding of Olowoniyi (2018) that revealed the effectiveness of Jigsaw collaborative instructional strategy on pupils learning outcomes. This implies that collaborative strategies would afford pupils opportunity to acquire knowledge from peers as they interact. Furthermore, visual aids were used by teachers in acquiring scientific inquiry concepts. The finding corroborated the works of Shabiralyani, Hasan, Hamad, & Iqbal (2015) and Davidova and Pavlovna (2022) that indicated the impact of using visual aids to enhance learning process of younger students in their study areas. The finding on the use of demonstration as a strategy by teachers was moderate, while discussion was less frequent in use by teachers. The implication of the finding is that teachers need to employ more active engagement approaches for children to inculcate scientific inquiry skills in them right from the formative age. From the finding of this study, experimentation is one of the least utilized strategies by teachers. The implication is that there is still a gap in applying practical inquiry methods to learners by teachers. This may be as a result of lack of capability or competence by teachers to adopt the strategy or lack of materials to work with. The finding corroborated Staris, Haniotis and Sguilla (2020) who indicated that teachers in their study area did not employ experimentation in the learning process due to their insecurity in their own disciplinary knowledge.

The finding on the hypothesis tested showed that teachers' strategies influenced pupils' scientific inquiry skills. The implication is that the teaching strategies teachers are employing had impact on pupils' development of scientific inquiry skills. While traditional methods remain the dominant strategies used by teachers, incorporating more interactive, inquiry-driven practices can significantly enhance pupils' curiosity, problem-solving abilities. The finding reiterated the study of Ivic (2016) that discovered that traditional teaching strategies still dominate Croatian primary schools. This implies that teacher – centric strategies are still being adopted in classrooms than learner-centred strategies.

Conclusion

This study investigated the strategies employed by primary school teachers in Osun State to develop scientific inquiry skills among early basic class pupils. The findings showed teachers heavy reliance on traditional teaching strategies such as recitation and explanation, alongside frequent use of questioning and visual aids. However, hands-on experimentation, which is essential in inquiry-based learning, was notably underutilized. The study established the significant influence of teaching strategies on pupils' scientific inquiry skills, to align with global literature on the importance of fostering curiosity, critical thinking, and problem-solving abilities in children. While strategies like questioning and collaboration show promise, the underuse of experimental methods signals an urgent need to be addressed for teacher training and resource provision. This research therefore contributes to the existing body of knowledge by providing localised insights into the state of inquiry-based science education among early basic classes' pupils in Osun State.

Recommendations

Based on the findings, several actions are recommended that can enhance scientific inquiry skills among primary school pupils.

Teachers should integrate more experimentation and active strategies to foster spirit of inquiry in children. Regular workshops and seminars should be organized for teachers to focus on modern, inquiry-based teaching methodologies to reduce reliance on traditional strategies like recitation. Training resources should be prepared by educators on teaching strategies and their applications in the teaching – learning process. Education stakeholders especially the policy makers, school owners should ensure adequate resources and professional development opportunities for teachers to implement inquiry-based learning effectively.

References

Abdal-Hay, A., & Al Hussona, Q.M. (2020). Kindergarten Teachers' Belifs and Practices of Inquiry-Based Science Education and Its Impact on Children's ientific Process Skills. *Early Childhood Education Journal,* 48(1), 85-96.

Center for Innovation in Teaching & Learning (2024). *Questioning Strategies*. https://citl.illinois.edu/.

Chin, C., & Osborne, J. (2008). Students' questions: a potential resource for teaching and learning science. *Studies in Science Education*, 44(1), 1-39.

Good, R., Halverson, E.R, & Margenthaler, E. (2013). Supporting inquiry-based teaching in elementary education: Eploring pre-service teachers' beleifs and practices. *Journal of Science Teacher Education,* 24(4), 577-597

Ivic, S. (2016). Frequency of Applying Different Teaching Strategies and Social Teaching Methods in Primary Schools. *Journal of Education and Practice*, 7(33), 66 – 71. www.iiste.org

Lee, & Hand, B. (2005). *Inquiry-based science in elementary middle schools: A responsive approach to instruction.* New York: Routledge

McComasm, W.F., & Olson, J.K. (1998). The nature of scientific inquiries in children. *The Journal of Elementary Science Education,* 10(2), 57-71.

NGGS Lead States. (2013). *Next Generation of Science Standards: For States, By States*. Washington, DC: The National Academies Press.

Narkabilova, G. & Pavlovna, D. E. (2022). The Role of Visual Teaching Aids in The Formation of Educational Activities of Younger Students. *European International Journal of Multidisciplinary Research and Management Studies. 02(11):116-12. https://www.researchgate.net/publication/365686426.*

National Science Association (NSTA) (2007). *NSTA Position Statement: The Role of Inquiry in Sience Education*. Retrieved from: https://www.nsta.org/sites/files/documents/NSTApositionStatement_inquiry.pdf

O'Connor, G. & Rosicka, C. (2020). Science in the early years. Paper 2: Science inquiry skills. Australian Council for Educational Research. .

Odora (2014). Using Explanation as a Teaching Method: How Prepared Are High School Technology Teachers in Free State Province, South Africa? *J. Soc Sci*, 38(1): 71-81. DOI: 10.31901/24566756.2014/38.01.08. http://krepublishers.com/.

Olowoniyi, S. R. (2018). *Effects of Learning Activity Package and Jigsaw Instructional Strategies on Lower Primary School Pupils' Learning Outcomes in Cultural and Creative Arts in Ondo State*. Unpublished Ph. D. Thesis, Obafemi Awolowo University, Ile – Ife. Nigeria.

Park, S., & Oliver, J.S. (2008). Revisiting the conceptualization of pedagogical content of knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research in Science Education,* 38(3), 261-284.

Shabiralyani, G., Hasan, K. S., Hamad,N. & Iqbal, N. (2015). Impact of Visual Aids in Enhancing the Learning Process Case Research: District Dera Ghazi Khan. Journal of Education and Practice, 6(19). 226 – 233. www.iiste,org.

Shanmugavelu, G., Ariffin, K., Vadivelu, M., Mahayudin, Z. & Malar Arasi R.K. Sundaram,(2020). Questioning Techniques and Teachers' Role in the Classroom. *Shanlax International Journal of Education*, 8(4), 45 – 49. https://doi.org/10.34293/education.v8i4.3260.

Staris, C. Haniotis, S. Sguilla, S. (2020). Experimentation in primary school: discover and understand or verify what is expected? Journal of Physics Conference Series 1512(1):012010 DOI: 10.1088/1742-6596/1512/1/012010. https://www.researchgate.net/publication/342308939.

Tefertiller, M. (2016). *Recitation, Recitation, Recitation: Or, Three Reasons for Recitation*. Classical Latin School Association. https://classicallatin.org/exordium.

Tofade, T., Elsner, J. & Haines, S. T. (2013). Best Practice Strategies for Effective

Use of Questions as a Teaching Tool. *Am J Pharm Educ.*;77(7):155. doi: 10.5688/ajpe777155

Trinitas, (2022). *Why Recitation Should be Part of Every Child's Education*. https://www.trinitaschristian.org/trinitas.

Wilson, R. (2007). Promoting the development of scientific thinking. Early childhood News. Retrieved from http://www.earlychildhoodnews.com/earlychildhood/article_view.aspx?ArticleId=409.