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Instructional strategies and middle basic education pupils' academic performance in basic science in Calabar education zone, Cross River state, Nigeria

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Abstract

This study investigated on effect of instructional strategies on Pupils' Academic Performance in Basic Science in Calabar Education Zone of Cross River State. The study raised four research questions and four null hypotheses. A quasi-experimental research design involving pre-test post-test of non-equivalent groups was used. The population of 8,259 pupils in public primary schools was used for the study. Purposive sampling technique was used to select 149 pupils from four intact classes. Basic Science achievement test was used for data collection. The instrument was subjected to face and content validity by experts in measurement and evaluation in Faculty of Education, University of Calabar. The reliability coefficient was determined using Kuder Richardson formular-20, which yielded a reliability estimate of 0.86. Data obtained from the study were analyzed using Dependent t-test, Analysis of Variance and Fisher's Least significant Difference test. The findings revealed that there is significant effect of hands-on-activities, guided inquiry and concept mapping instructional strategies on Middle Basic Education pupils' academic performance Basic Science. Based on these findings, it was recommended among others that primary Science teachers should be innovative in instructional processes using strategies like: hands-on-activities, guided inquiry and concept mapping to improve pupils' academic performance in Basic Science.

Keywords: Instructional strategies, Middle basic education pupils' academic performance, Basic science, Calabar education zone, Cross River state, Nigeria

Introduction

There is more to primary science and technology education than training pupils by means of telling them meaning of science concepts and memorizing same for test and examination. Primary science educational process requires conscientious effort of the teacher in mapping out strategies that will help pupils grow intellectually, skillfully, socially and emotionally.

In recent time, there has been a lot of concern about our education system and how it needs to be restructured to better the process and condition of teaching and learning. With the rapid global growth in science and technology, it is necessary that primary science teachers become pragmatic in their selection and adoption of strategies that will be effective for foundation laying in scientific studies among pupils.

Therefore, the challenge before primary science teachers should be how pupils can be actively involved in the learning process in order that lessons are not solely dominated by teachers' verbal expressions, which may not really cater for the needs of learners. Adebayo and Eze (2021) discussed how teaching in Nigeria continues to face numerous challenges such as poor funding, decaying infrastructure, and negative public perception, which hinder the full professionalisation and status of teaching despite its central role in education delivery. This is because teaching deals with humans who are usually fraught with problems.

To ameliorate these problems militating against teaching effectiveness, professionals in the field are consistently in a search for new and innovative ways of making the career effective. Consequently, making use of appropriate instructional strategies carefully

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planned by the teacher in line with the objectives of Basic Science instruction through harnessing resources within the environment of the pupils and setting up learner- centered activity approach could make the need to promote creativity and critical thinking in learner an achievable goal.

Instructional strategies are all educational behaviours of a teacher in using methods, techniques, tools, discipline and communication in order to achieve the objectives of instruction. They are plans of actions chosen by the teacher to bring about a desired outcome such as achievement of objectives of teaching and learning. Instructional strategies are mechanisms for presenting curriculum content in a way that will bring about a positive change in learners' thought, feelings and reflection on a topic. Recent Nigerian educational studies emphasize the necessity for teachers to adopt varied instructional strategies to improve classroom engagement and student outcomes, noting that reliance on a single pedagogical approach limits the ability to meet the diverse needs of learners and undermines effective teaching practice. Such research advocates for expanded pedagogical repertoires that include interactive, learner-centered methods responsive to contemporary educational demands (Charles, 2025**).** This implies that there is a paradigm shift in pedagogical approach from teacher –centered instructional approach to learner-centered activities approach.

Therefore, it is not enough for a teacher to merely master the subject and have clearly in mind what learners should learn, but a teacher should carefully plan the procedures to be used and the activities that learners will do. Primary science teachers are expected to do certain things in certain ways during the instructional process to lay a sound basis for scientific and reflective thinking and to give the children opportunities for developing manipulative skills that will enable them function effectively in the society within the limits of their capacity.

Instructional strategies that are learner- centered activities approach that constitutes the basic thrust of this study include: hands- on- activities, guided inquiry and concept mapping. These are sub-variables used for this study. Hands on activities are forms of experiential learning which involve activities that engage learners' minds and hands as they manipulate objects to gain knowledge and scientific skills. It comprises practical work having to do with observation, measurement, construction and discussion. These activities engage learners and allow them to test their own ideas and build their own understanding of the phenomenon or objects being manipulated.

Guided inquiry instructional strategy is one of the approaches to teaching where the teacher generates questions about a phenomenon or concept to be studied and provides steps, guide line or clues for finding answers to those questions raised. It is a systematic way of investigating a problem whose end product is to discover a solution. This approach gives ample opportunities to learners to find out things for themselves. Guided discovery methods significantly improve academic performance and knowledge retention, demonstrating that learner-centered engagement fosters more meaningful and long-lasting learning outcomes (Mgbomo et al., 2024; Okebe et al., 2025). Concept mapping instructional strategy is another instructional approach that involves structural presentation of scientific knowledge through basic element like: concept bores, lines between concept boxes, and labels of links. It is a diagrammatic representation of key concepts to show meaningful relationship. It is greatly useful to pupils learning primary science because primary science curriculum has thematically and spirally grouped topics taught across the nine (9) years of basic education.

Academic performance is significant to middle basic education pupils in Basic Science**.** Academic performance shows the extent to which learners; teachers and the school have achieved their educational goal. To assess teaching effectiveness, learning outcome in the aspect of academic performance is pivotal. Primary science instructional process requires active learning activities which occurs when learners are consciously involve in activities that engages their mental and physical energies so as to help them achieve academic performance in Basic Science instruction.

Ajadi & Ayanlowo (2025) opine that the dominant use of teacher-centered and conventional instructional methods in Basic Science classrooms is

linked to persistent low academic performance, indicating that instructional strategies significantly influence student outcomes. This could result in learners not understanding science concept and skills as they progress through their learning. Therefore, this present study is carried out to investigate the effect of instructional strategies (hands on activities, guided inquiry and concept mapping) on middle basic education pupils' academic performance in Basic Science in Calabar Education Zone Cross River State.

2. Statement of the problem

Primary science and technology are the foundation to any scientific and technological education. Poor knowledge and dislike among primary pupils can affect pupils' academic performance and contributes to phobia for science at post primary level of education. Despite the importance of primary science as bedrock to scientific education and development, pupils' keep recording failure in their external examinations in Basic Science. The fear to ameliorate this failure causes many schools to indulge in examination malpractices during external examination offering temporary solutions to pupils to scale through this hurdle. This sharp practice is detrimental to pupil's progress hindering their interest in science education in future.

Pupils' poor academic performance in Basic Science has contributed to learners not taking science related courses in higher institution. These further effects decrease in number of professionals in related courses such as medicine, nursing, survey, architecture and engineering leading to short fall in man power supply to the nation. Researches' literature has shown that teachers do not embrace activity – oriented instructional strategies like hands-on-activities, guided-inquiry and concept mapping to improve on lesson delivery on Basic Science. Rather, they rely on the conventional methods that are easy to implement in the classroom and most time inappropriate, leading to a dwindling and shortfall in the achievement of the objectives of Basic Science instruction.

In attempt to ameliorate this daunting trend in pupils' academic performance in Basic Science, curriculum developer has emphasized the use of learner-centered activity approach in teaching during instructional process in order to get pupils more involved in learning process for the attainment of better academic performance. In spite of this effort geared towards improving pupils' academic performance, researchers have also observed that many primary school pupils' do not usually perform academically in acquisition of scientific knowledge, critical thinking and development of scientific skills; though they are usually promoted to the secondary school level. It is against this background, that this study sought to investigate the effect of instructional strategies (hands- on- activities, guided inquiry, and concept mapping) on Middle Basic Education pupils' academic performance in Basic Science.

3. Purpose of the study

The purpose was to determine the effect of Instructional Strategies on Middle Basic Education pupils' academic performance in Basic Science in Calabar Education Zone, Cross River State with regards to hands-on-activities, guided inquiry and concept mapping. Specifically, the study sought to:

i) Examine the effect of hands-on-activities instructional strategy on Middle Basic Education pupils' academic performance in Basic Science;
ii) Find out the effect of guided inquiry instructional strategy on Middle Basic Education pupils' academic performance in Basic Science; and
iii) Investigate the effect of concept mapping instructional strategy on Middle Basic Education pupils' academic performance in Basic Science.

4. Research questions

The following research questions were formulated to guide the study:

i) What is the effect of hands-on-activities on Middle Basic Education pupils' academic performance in Basic Science?
ii) To what extent does guided inquiry affect Middle Basic Education pupils' academic performance in Basic Science?
iii) How does concept mapping affect Middle Basic Education pupils' academic performance in Basic Science?

5. Research hypotheses

In attempting to answer the above research questions, the following null hypotheses were formulated to guide the study:

i. There is no significant effect of hands-on-activities on Middle Basic Education pupils' academic performance in Basic Science.

ii. Guided inquiry does not significantly affect Middle Basic Education pupils' academic performance in Basic Science.

iii. Concept mapping does not significantly affect Middle Basic Education pupils' academic performance in Basic Science.

6 Theoretical framework

The following theories were considered as the framework for this study.

6.1 Brunerian's Theory of Learning (BTL)

Brunerians' theory of learning was propounded by Jerome Bruner, an American psychologist in 1960. This theory is based on Constructivism. The theory posits that learning is an active process where pupils construct new knowledge based on prior understanding. Bruner emphasized that learners learn best when they discover information for themselves rather than passively receiving instruction. In relation to instructional strategies and Middle Basic Education pupils' academic performance in Basic Science, Bruner's theory provides a strong theoretical foundation. Learner-centered strategies such as hands-on activities allow pupils to construct knowledge through direct experience, reflecting Bruner's discovery learning principle. Guided inquiry enables pupils to explore problems and find solutions independently, promoting deeper conceptual understanding. Concept mapping helps pupils visualize relationships among scientific ideas, aligning with Bruner's emphasis on structured knowledge. These strategies actively engage learners, enhance retention, and support cognitive development in line with the spiral curriculum approach. Empirical evidence from the Calabar Education Zone indicates that pupils exposed to these strategies achieve higher academic performance compared to conventional methods. The integration of Bruner's principles into Basic Science teaching encourages creativity, critical thinking, and problem-solving among pupils. Therefore, learner-centered instructional approaches grounded in Bruner's theory are effective in improving both understanding and academic outcomes in primary science education

6.2 Gagne's theory

Gagné's theory, also known as Conditions of Learning, was propounded by Robert Gagné in 1965. This theory focuses on the systematic design of instruction to facilitate effective learning outcomes. The theory identifies five major categories of learning: intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes. Central to Gagné's approach is the concept of nine instructional events that guide the teaching-learning process, including gaining attention, informing learners of objectives, stimulating recall of prior learning, presenting content, providing learning guidance, eliciting performance, providing feedback, assessing performance, and enhancing retention and transfer. These events are designed to provide a structured framework that supports learners' acquisition of knowledge and skills in a sequential and meaningful manner, ensuring that instruction is both engaging and effective. In relation to instructional strategies and middle basic education pupils' academic performance in Basic Science in Calabar Education Zone, Gagné's theory provides a strong theoretical foundation for learner-centered approaches such as hands-on activities, guided inquiry, and concept mapping. Hands-on activities align with the "eliciting performance" and "enhancing retention" events by engaging pupils actively in practical exploration of scientific concepts. Guided inquiry supports "stimulating recall" and "providing learning guidance," as learners investigate phenomena, ask questions, and construct solutions independently. Concept mapping facilitates the organisation and presentation of content, consistent with the "presenting content" and "semantic encoding" stages, helping pupils relate concepts meaningfully. By applying Gagné's structured instructional events, teachers can enhance pupils' understanding, critical thinking, and problem-solving skills, thereby

improving academic performance in Basic Science while promoting deeper engagement and retention of knowledge.

7. Hands-on-activities instructional strategy and learners' academic performance science

Hands-on-activity instructional strategy is an instructional technique where the teacher exposes the learners to practical work, experiment and other learning activities that encourage active engagement of learners' minds and hands as they manipulate objects to gain knowledge and scientific skills. The use of this strategy and it effects has been investigated by various scholars and researchers. Ekwu, *et al.* (2025) discuss that interactive, practical, and technology-supported approaches to science/STEM learning in Nigeria, reinforcing the value of engaging, activity-oriented pedagogy that fosters interest and deeper learning among pupils. Atiku, *et al.* (2025) argue that Nigerian education must move away from rote learning toward fostering critical thinking, analytical reasoning, and problem-solving to meet the demands of an innovation-driven society.

Ojo, *et al. (*2025) explain that Nigerian study showed that exposure to laboratory equipment significantly affected physics performance, but the comparison with conventional teaching highlights how lack of equipment (a common challenge in practical work) can undermine the effectiveness of experimental tasks in learning Physic. The author further argues that although practical work is a somewhat effective tool in getting the students to remember the practical aspects of an experiment, the ideas behind the phenomena are rarely learned and even more so recollected later on. Hands-on activities had a strong impact on classroom concentration, knowledge retention, creativity ability, and problem-solving skills among science and technical education students in Ekiti State, Nigeria, indicating that interactive practical engagement enhances multiple learning dimensions (Osuntuyi & Awodun, 2021).

Sowunmi, *et al*. (2024) conducted a study on hands-on activities on students' level of interest. Questionnaires were completed by a total of 141 students from four trade (Catering Craft, Garment Making, Computer Craft and Graphics Art) courses in five technical colleges in Lagos state, addressing their interest in the hands-on activities, their prior experience with each activity, and the quality of their respective experiences. The results of our study indicate that engaging in hands-on activities generally tends to enhance students' interest in experimenting, working with microscopes, dissecting, and classifying. This finding concurs that the use of a hands-on, activity-based strategy significantly improved students' interest in Basic Science topics (e.g., habitat) among secondary school learners in Kwande, Benue State, aligning with research that practical engagement boosts interest.

Oladayo & Diri (2024) carried out a quasi-experimental study to assess how hands-on activities influenced student performance in geometry among Upper Basic II pupils. Pupils exposed to activity-oriented instruction significantly outperformed those taught conventionally, demonstrating enhanced engagement and understanding through manipulative learning strategies. The study used a survey questionnaire and pre- and post- test as instruments for data collection. Findings from the study revealed that students had better result as they learnt and remembered better through hands-on-experiments. Also, participation in hand-on-experiments improved students' intrinsic motivation. This result is in line with Rudduck and Udu & Abughdyer (2025) in their emphasize that acknowledging students' varied learning styles and accommodating them through varied teaching approaches can enhance academic outcomes, implying that teachers need to identify learning preferences to tailor instruction effectively. Akinsola, & Aderonmu, (2025) express that learners construct meaning and retain science concepts better through experiences facilitated by constructivist activities than through traditional teaching

8. Guided inquiry instructional strategy and learners' academic performance in science

Guided inquiry instructional strategy is an instructional technique where the teacher generates questions and provides learners with clues and guides for finding answers to those questions. A teacher generates those questions based on the objectives of instruction in order to promote learners' critical thinking and acquisition of scientific

knowledge through scientific processes such as observation, identification, analysis and discovery. Olawuwo, *et al.* (2024) discuss that guided-inquiry, a learner-centered strategy, enabled pupils to ask questions, investigate concepts, manipulate data, and relate new ideas to prior knowledge demonstrating how student-led inquiry supports prioritizing key information for learning goals.

Gideon Stella *et al.* (2025) found that integrated inquiry-based science teaching significantly enhanced Basic Science students' academic performance and promoted equitable outcomes, suggesting that students engage more deeply with scientific concepts through inquiry processes compared to guided instruction. Similarly, Anari, (2025) suggested that inquiry-based learning significantly increases student engagement and conceptual understanding in Chemistry classrooms compared to traditional strategies, explaining that active, student-centered processes foster deeper involvement and better learning outcomes in science education. Guided inquiry instructional strategies significantly enhance students' achievement, retention, and higher-order thinking in science education. For example, guided inquiry outperformed conventional lecture methods in facilitating students' understanding and retention of science concepts, indicating that students engage more deeply with subject matter through inquiry-oriented learning (Olawuwo, *et al.* 2024). This approach to learning is believed to allow learners to meaningfully develop knowledge, build their own concept about the nature of science knowledge and skills.

Guided inquiry-based learning significantly improved students' interest and achievement compared with conventional instruction, suggesting it promotes deeper understanding and engagement in science learning (Okpala et al.,2025).Hence, guided inquiry approach in teaching and learning sciences is more than a way of delivering concepts or body of knowledge; it is a way of long-life learning of concepts, skills and the nature of the scientific knowledge in relation to one's daily life like the scientist day-to-day works. However, "relying on increasing students' centeredness during inquiry activities can be executed as students' competencies becomes better. Else, it may be a source of distortion of the knowledge or misconceptions, at best, or at worst, a set up for failure. Danjuma, *et al.* (2024) conducted a study on the effect of integrated inquiry-based science teachers practice on basic education students' interest in Basic Science in Jalingo Education Zone, Taraba State Nigeria. The study adopted a quasi-experimental research design of non-equivalent research design of non-equivalent group. Intact classes were assigned to both the experimental group (Integrated Inquiry-Based Teachers Practice Instructional Strategy) and control group (guided Inquiry Instructional Strategy) using multi stage sampling technique. The sample for this study is 292 Basic Education students comprising of 139 boys and 153 girls from six public secondary schools. Based on the data collected and analyzed the following findings were recovered: there was significant different in the mean interest rating of students taught Basic Science using integrated-inquiry-based science teacher practice and those taught using guided inquiry instructional strategy.

Okpala, *et al.* (2025) posited that guided inquiry-based learning can also promote students' critical thinking and problem-solving skills. By using guided inquiry-based learning, teachers can create a learning environment that is engaging and challenging for students. With such instructional strategy, the learners become more aware of any contradiction between their pre-knowledge and the newly-learned concept through their own scientific explanations, which are gotten from the analysis of their data.Okpala, *et al*. (2025) guided inquiry-based instructional strategies, where teachers act as facilitators rather than sole knowledge givers, significantly enhance students' engagement, motivation and active participation in the learning process by allowing learners to explore, ask questions, and construct meaning with appropriate teacher guidance and scaffolding. For example, in a study of secondary schools in Enugu State, guided inquiry-based learning positively influenced students' interest and achievement in science subjects, with teachers guiding learners through inquiry activities that promoted autonomy, problem-solving and deeper cognitive engagement. This then enables them to reach self-conceived conclusions. Nevertheless, due to the need for thorough preparation and uncertainty of in-class activities resulting from students' response during

inquiry process, most teachers are likely to resort to direct instructional way of teaching. This is because some science topic requires careful planning and preparation through direct instruction by the teacher so as to minimize the difficulties arising from having to get student motivated for hands on activities and critical thinking means of acquiring knowledge through inquiry-based learning.

Omojemite (2025) concurs that interactive teaching methods where teachers structure and guide learning significantly improved student performance compared to traditional approaches, highlighting the effectiveness of guided instructional strategies over less structured learning experiences.

9. Concept mapping instructional strategy and learners' academic performance in science

This is a diagrammatic presentation of concepts to show meaningful relationships that exist among them in line with the objectives of the instruction during instructional process. The visual nature of concept map provides learners with available materials to see and critically ponder about the information embedded in the visual which arouses learners' interest during the teaching and learning process and possibly enhance academic performance. Usman (2023) reported that concept mapping significantly improved chemistry students' comprehension and retention, demonstrating its effectiveness as a learning strategy for difficult chemistry content. Concept mapping was shown to significantly improve students' performance outcomes compared to alternative strategies, indicating stronger cognitive engagement and organized knowledge (Attah & Udu, 2025). Yahaya*, et al.* (2024) found that concept mapping instruction improved students' entrepreneurial skill acquisition and creativity in senior secondary science education, highlighting the value of structured graphic representations for linking concepts and developing higher-order thinking.

Akpoghol, et al. (2025) buttress that the use of concept mapping significantly improved students' interest and understanding in Basic Science, demonstrating how visually organizing concepts fosters meaningful learning beyond rote memorization. Students knew exactly what to do at the different points in the writing exercise because the ideas to input were made available with the help of concept mapping. Students were engaged in the writing exercise from the beginning to the finishing because they were directed by the map associated with the story (Attah & Udu 2025). Though focused on geography, this study demonstrated that concept mapping significantly improved students' performance over conventional strategies, reflecting broader Nigerian evidence for concept maps enhancing subject learning (Idris, 2024). Teachers gained more self-confidence about teaching thereby raising their effectiveness. The effectiveness of concept mapping in improving learning outcomes has been documented in science, health and agricultural education, but its integration into Basic Science remains underexplored, especially in rural educational settings (Agboola & Mustapha, 2021; Adeyemi & Adeyinka, 2023

Udobong, et al. (2025) carried out a study on concept mapping teaching methods on the academic performance of Home Economics students in Etinan Local Government Area of Akwa Ibom State, Nigeria. Specifically, it examined the effects of diagrams, hierarchical structures and charts on students' understanding and achievement. Three research questions and three corresponding null hypotheses guided the study. A survey research design was adopted and the population comprised 182 Home Economics students from eleven public secondary schools, including 116 females and 66 males. Purposive sampling was used to select75 students, consisting of 45 females and 30 males. Data were collected using a structured 5 item questionnaire on a 5-point Likert scale, which was validated by three experts and trial tested for reliability, yielding a Cronbach Alpha coefficient of 0.88. Descriptive statistics (mean and standard deviation) were employed to answer the research questions, while independent t-test statistics were used to test the hypotheses at a 0.05 level of significance. Findings revealed that the use of diagrams, hierarchical structures and charts as concept mapping teaching methods positively influenced students' comprehension and academic performance in Home Economics, with female students reporting slightly higher mean scores than male students.

According to Udobong, *et al*. (2025), concept mapping permits a visual representation of concepts concerning a topic and reveals the relationship among them as a whole. It is one of the active teaching methods that can help teachers to train students in solving academic problems. Concept mapping has gained widespread acceptance (evident in the number of past studies that have been conducted to establish its effectiveness). For example, Maikano & Kauna (2025) investigated the effects of concept mapping on students' achievement in Basic Science and findings from their study revealed that concept mapping fosters students' achievement in basic science than conventional method. It boosts the achievement of both male and female students in the subject. Concept Mapping is a pedagogy that helps learners to be able to use lines and arrows to break down concepts that are vast into a more meaningful learning and help learners learn independently. It helps develop in the students the ability to think logically by revealing connections and helping learners see how individual ideas or concepts form a larger idea. This strategy as observed by Novak serves as both learning tool as well as evaluation tools which encourage the students to use meaningful mode-learning patterns as cited in Tarim et al. (2022). A knowledge acquired through a meaningful way such as concept mapping allows learners to externalize visual and verbal information which help them improve their understanding of learning. Concept mapping teaching strategy is therefore advantageous as it allows learners to extract important information, relate ideas and represent them in a structured manner (Idris, 2024). Concept mapping offers a visual representation of knowledge that enhances comprehension by connecting ideas hierarchically (Oyeyemi & Azeez, 2024; Ribadu, et al.2025).

Udobong, *et al*. (2025) carried out a study on the effect of concept mapping instructional strategy on secondary school students' achievement in biology. Two research questions and three null hypotheses guided the study, and quasi-experimental research design was adopted. The sample for the study comprised two hundred and forty-one (241) students drawn from the population of study in three schools in Enugu Education Zone using multistage sampling technique. The instrument for data collection was Biology Achievement Test (BAT). Data collected from the research questions were analyzed using mean and standard deviation, and Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The results revealed that students taught biology using concept mapping

performed better than their counterparts taught using lecture method.

10. Research Methodology

This study adopted quasi-experimental research design. The design was considered most appropriate to determine the effects of experimental and control groups using pre-test post- test non- equivalent approach. The sub-independent variables were: hands-on-activities, guided inquiry and concept mapping while the dependent variable was pupils' academic performance in science. This was illustrated as shown below;

A	O_1	X_1	O_2
A	O_1	X_2	O_2
A	O_1	X_3	O_2
A	O_1	X_4	O_2

Where:

A = Assignment of subjects to treatment and control groups

O_1 Pretest for both treatment and control group

X_1 = Group that received the treatment (hands-on science-activities)

X_2 = Group that received the treatment (guided inquiry)

X_3 = Group that received the treatment (concept mapping)

X_4 = Group that did not receive treatment.

O_2 = Post test scores for the four groups.

The population for the study comprised all the primary five pupils in public primary schools in Calabar Education Zone, Cross River State, Nigeria. Statistics from the State Ministry of Education revealed that there are three hundred and twenty-four (324) public primary schools having two

hundred and fifty- nine pupils (8,259) in Calabar Education zone (Cross River State Universal Basic Education Board, CRSUBEB,2025). The Purposive Sampling technique was used to select one hundred and forty- nine (149) pupils from four public primary schools. The researchers creditably selected this sample size using intact- classes based on the fact that the characteristics of the population were homogenous and considering the number of elements for collection of reliable data. The instrument used for data collection was Basic Science Achievement Test (BSAT). Both experimental groups and control group were given pre-test and post-test.

The test comprised 30-multiple choice items to measure pupils' academic performance in Basic Science. Each question has one correct answer and three 'distracters. The test was teacher- made based on the table of specification. The table was organized with two (2) topics from the 9-year Basic Education Curriculum for Basic Science and Technology (Primary 4-6). The topics were: (a) Environmental change (pollution): pollutants and sources, effects of pollution and control and (b) wastes and waste disposal: types of waste, waste disposal and recycling. Each correct question carried one (1) mark and zero (0) for any wrong answer. The 30-item multiple choice objective test had four options lettered. A, B, C and D. Each pupil was expected to circle the letter for the correct option in the objective test. No special answer sheet was given to pupils. The pupils were given code numbers instead of pupils' names.

To ensure that the items used for the structured achievement test were capable of producing data relevant for the study, the face and content validity was done. The researchers presented the structured Basic Science Achievement Test to two science teachers and two experts in measurement and evaluation department in University of Calabar, Calabar, Cross River State, Nigeria. The researchers ensure that their comments and corrections given on the instrument were strictly adhered to and were incorporated in the final instrument for data collection.

A table of specification (test blue print) for a 36-item test in Basic Science and Technology was prepared to guide the researcher in constructing the items and six items were dropped while 30 items were used for the study after the preliminary assessment. This was to ensure that the test items adequately covered the behavioural domains: like remembering, understanding, applying and analyzing which was measured in relation to the content areas (revised Bloom's taxonomy Anderson, 2001). These four level were used for the test considering the age and level of maturity of the pupils and the skills to be learnt during the instructional process. The construction of this test was made with conscious consideration of revised Bloom's taxonomy (digital).Items: 1, 2, 14, 17 and 20 on the Basic Science Achievement Test (BSAT), formed questions on remembering level, items: 3, 4, 5, 8, 9, 12, 13,18, 19 and 29 were at the understanding level, while items 6, 10, 11, 15, 16, 24, 25, 28, where at applying level. Items: 7, 16, 21, 22, 23 and 26 where at analyzing level. A table of specification (test blue print), on Basic Science Achievement Test (BSAT) is presented in

The researchers administered fifty (50) copies of the Basic Science Achievement Test to primary five pupils in Calabar Education Zone who were not part of the sample for the study as a pilot test. The test was pilot tested on respondents with similar characteristics to the target group but who were not part of the study, Kuder Richardson formula-20 was employed to test the reliability of the test and yielded K-R20 value of 0.86 for the overall scholastic achievement test. Kuder Richardson formular -20 test was used for this study because it is a suitable test for checking the internal consistency of measurement with dichotomous choices.

The researcher used four (4) intact classes of primary five pupils from four public primary schools in Calabar Education Zone. One intact class was assigned control group; pupils in this group were taught in the traditional way of "talk and chalk" instructional strategy. The other three intact classes were assigned the experimental groups; pupils in these groups were taught using hands on activities, guided inquiry and concept map instructional strategies.

The topics for instruction were: Environmental change (pollution): pollutants, sources, effect and control. Waste: Types of waste, waste disposal and recycling. These topics were from the 9-year Basic

Education Curriculum for Basic Science and Technology (primary 4-6). Both groups of pupils were given a pre-test to measure their background knowledge. After the treatment, both the experimental and the control groups were given that same achievement-test (post-test). The test was administered by the researchers and assisted by the class teachers in those selected intact classes. This study was carried out during the first term of 2025/2026 session. It lasted for a period of eight (8) weeks. The serving class teachers in the participating schools were used as research assistants. A training session was done to acquaint the research assistants with the task ahead. The active classroom instruction commenced after pretest administration. The teaching exercise which lasted for six weeks was carried out by the researchers and the research assistants using three lesson periods per week. After the active classroom instruction exercise, the BSAT questions were reshuffled and administered as post-test. The test scripts were collected for marking and analysis. After collecting the Basic Science Achievement Test (BSAT) scripts marking and scoring was done based on the marking scheme. Each correct answer was awarded one mark and zero for wrong answer.

11. Results

The major independent variable of the study were instructional strategies (hands-on-activities, guided inquiry and concept mapping). The dependent variable was pupils' academic performance in Basic Science. This study was undertaken to determine the effect of instructional strategies; hands-on-activities, guided inquiry and concept mapping on Middle Basic Education pupils' academic performance in Basic Science in Calabar Education Zone of Cross River State. Adopting the quasi-experimental design, four intact classes were used. To establish the equivalent of the four (4) classes, a pre-test was administered and the one-way analysis of variance was performed to find out whether there were any significant differences in the academic performance of these groups as represented in Table 1. The information in Table 1 reveals that the four groups used for the study had the same ability before treatment (F=1.415; p=.241). Hence all the groups could be subjected to treatment in the experiment. However, the statistical package for social sciences (SPSS version 16.0) computer software enhanced the analysis

Table 1. Summary data and one-way analysis of variance of the academic performance of Pupils in Basic Science

S/N	Experimental group	N	X	SD
1	Hands-on-activities	37	13.08	4.06
2	Guided inquiry	39	14.38	2.76
3	Concept mapping	37	14.19	2.97
4	Control	36	13.81	1.43
	Total	149	13.87	2.98

Source of variance	SS	Df	MS	F	p-value
Between group	37.275	3	12.425	1.415	0.241
Within group	1273.302	145	.8.781		
Total	1310.577	148			

Sources: Field Data ,2025

Not significant at the 0.05 level of significance.

In this section, each hypothesis was re-stated and the result of data analysis done to test each hypothesis is presented and interpreted. All the hypotheses were tested at 0.05 level of significance.

11.1 Hypothesis one: There is no significant effect of hands-on-activities on Middle Basic Education pupils' academic performance in Basic Science. To test this hypothesis, the dependent t-test analysis was employed to find the difference in pre-test and post-test scores of pupils subjected to hands-on-activities instruction in Basic Science. The result is presented in Table 2.

Table 2. Dependent t-test analysis of the effect of hands-on-activities on Middle Basic Education pupils' academic performance in Basic Science (*n*=37)

Testing occasion	X	SD	T	p-value
Pretest	13.08	4.06	-3.456*	.001
Post-test	16.97	4.74		

*Significant at the 0.05 level of significance.
Sources: Field Data ,2025

The information in Table 2 shows that there is a significant difference in pretest and post-test scores of pupils under hands-on-activities (t=-3.456; p=0.001). Hence the null hypothesis that there is no significant effect of hands-on-activities on Middle Basic Education pupils' academic performance in Basic Science is rejected at the 0.05 level of significance. Clearly, the pupils taught Basic Science using hands-on-activities significantly improved their performance. Thus, it could be said that there is a significant effect of hands-on-activities on Middle Basic Education pupils' performance in Basic Science.

11. 2 Hypothesis two: Guided inquiry does not significantly affect Middle Basic Education pupils' academic performance in Basic Science. The correlated t-test analysis was used to compare the pre-test and post-test academic performance of Middle Basic Education pupils under guided inquiry. The result is in Table 3.

The information in Table 3 shows that pupils' performance in Basic Science after exposure to guided inquiry strategy is significantly higher than their performance before the experiment (t=-5.66; p=0.000). Thus, the null hypothesis that guided inquiry does not significantly affect Middle Basic Education pupils' academic performance in Basic Science is rejected at the 0.05 level of significance. This implies that there is a significant positive effect of guided inquiry instructional strategy on Middle Basic Education pupils' academic performance in Basic Science.

Table 3. Dependent t-test analysis of the effect of guided inquiry on Middle Basic Education pupils' academic performance in Basic Science (n=39)

Testing session	X	SD	T	p-value
Pre-test	13.08	4.06	-5.66*	.000
Post-test	20.38	6.09		

*Significant at the 0.05 level of significance.
Sources: Field Data ,2025

11.3 Hypothesis three: Concept mapping does not significantly affect Middle Basic Education pupils' academic performance in Basic Science.

To test this hypothesis, the dependent t-test analysis was employed to compare Middle Basic Education pupils' academic performance before application of concept mapping instructional strategy and their performance after the experiment with concept mapping instructional strategy. The result is presented in Table 4.

Table 4. Dependent t-test analysis of the effect of concept mapping instructional strategy on Middle Basic Education pupil's academic performance in Basic Science (*n*=37).

Testing session	X	SD	T	p-value
Pre-test	14.38	2.76	-5.781*	0.000
Post-test	19.90	4.89		

*Significant at 0.05 level of significance.

The information in Table 4 shows that Middle Basic Education pupils under the concept mapping instructional strategy performed significantly better in Basic Science after the use of concept mapping than when they were not exposed to concept mapping (t=-5.781; p=0.000). Hence, the null hypothesis that concept mapping does not significantly affect Middle Basic Education pupils' academic performance in Basic Science is rejected at the 0.05 level of significance. This means that concept mapping brings about a significant improvement in pupils' academic performance in Basic Science.

Table 5. Fisher's LSD test of the effect of instructional strategies on Middle Basic Education pupils' academic performance in Basic Science

Instructional(I)	Strategies (J)	Mean-difference (I-J)	Standard Error	P-value
Hands-on-activities	Guided inquiry	-2.92*	1.15	.012
	Concept mapping	-2.92*	1.17	.014
	Conventional approach	-4.86*	1.18	.000
Guided inquiry	Concept mapping	.01	1.15	.996
	Conventional	-1.94	1.16	.101
Concept mapping	Conventional method	-1.94	1.18	.101

*Significant at the 0.05 level of significance.
Sources: Field Data ,2025

12 Discussion of Findings

This section focused on the discussion of findings of the hypotheses formulated to direct the study. This discussion is done hypothesis by hypothesis.

Hands-on-activities and Middle Basic Education pupils' academic performance in Basic Science

The result of the first analysis revealed that there is significant effect of hands-on-activities on pupils' academic performance in Basic Science. Thus, the null hypothesis was rejected. This finding is not surprising as a subject like Basic Science and Technology need to be taught through practical approach, a method that engages the learners mind and hands during the process of learning. This instructional strategy is learner-centered and allows learners to interact better while carrying out activities under the guidance of the teacher. It promotes learners' creativity, critical thinking and motivation to learn. Beside better academic performance and cognitive development, hands-on-activities instructional strategy aids learners' development of scientific skills and thinking. This result is in consonance with the work of Ekwu, *et al.* (2025) discuss that interactive, practical, and technology-supported approaches to science/STEM learning in Nigeria, reinforcing the value of engaging, activity-oriented pedagogy that fosters interest and deeper learning among pupils. Atiku, *et al.* (2025) argued that Nigerian education must move away from rote learning toward fostering critical thinking, analytical reasoning, and problem-solving to meet the demands of an innovation-driven society.Ojo*, et al. (*2025) explained that Nigerian study showed that exposure to laboratory equipment significantly affected physics performance, but the comparison with conventional teaching highlights how lack of equipment (a common challenge in practical work) can undermine the effectiveness of experimental tasks in learning PhysicMoreso, students who participated in the activities revealed that hands-on-activities helps them to understand what they had only memorized and agreed that the hands-on-activities has a bearing on real life and the knowledge acquired would help in their own life situations.

12.1 Guided inquiry and middle basic education pupils' academic performance in basic science

The result of the second hypothesis revealed that there is a significant positive effect of guided inquiry instructional strategy on Middle Basic Education pupils' academic performance in Basic Science. The observed difference in pupils' post-test score after treatment (guided inquiry instruction) shows the effectiveness of guided inquiry as an instructional strategy for teaching science. This learner-centered approach to learning allows learners to think outside the box, think critically and build their own concept about the nature of science knowledge and skills. The finding of this study corroborates the work of Olawuwo, *et al.* (2024) discuss that guided-inquiry, a learner-centered strategy, enabled pupils to ask questions, investigate concepts, manipulate data, and relate new ideas to prior knowledge demonstrating how student-led inquiry supports prioritizing key information for learning goals. Gideon Stella *et al.* (2025) found that integrated inquiry-based science teaching significantly enhanced Basic Science students' academic performance and promoted equitable outcomes, suggesting that students engage

more deeply with scientific concepts through inquiry processes compared to guided instruction. Similarly, Anari, (2025) suggested that inquiry-based learning significantly increases student engagement and conceptual understanding in Chemistry classrooms compared to traditional strategies, explaining that active, student-centered processes foster deeper involvement and better learning outcomes in science education.

12.2 Concept mapping and middle basic education pupils' academic performance in basic science

The result of the third hypothesis indicated that Middle Basic Education pupils under the concept mapping instructional strategy performed significantly better in Basic Science after being exposed to the instructional strategy than when they were not taught with concept mapping. The finding of this hypothesis is in agreement with the work of Usman (2023) reported that concept mapping significantly improved chemistry students' comprehension and retention, demonstrating its effectiveness as a learning strategy for difficult chemistry content. Concept mapping was shown to significantly improve students' performance outcomes compared to alternative strategies, indicating stronger cognitive engagement and organized knowledge (Attah & Udu, 2025).

Yahaya*, et al.* (2024) found that concept mapping instruction improved students' entrepreneurial skill acquisition and creativity in senior secondary science education, highlighting the value of structured graphic representations for linking concepts and developing higher-order thinking. Akpoghol, et al. (2025) buttress that the use of concept mapping significantly improved students' interest and understanding in Basic Science, demonstrating how visually organizing concepts fosters meaningful learning beyond rote memorization. Students knew exactly what to do at the different points in the writing exercise because the ideas to input were made available with the help of concept mapping. Students were engaged in the writing exercise from the beginning to the finishing because they were directed by the map associated with the story (Attah & Udu 2025).

13. Summary of the study

This study was undertaken out of curiosity to determine the effect of instructional strategies (hand-on-activities, guided inquiry and concept mapping) on Middle Basic Education pupils' academic performance in Basic Science. Relevant data were collected and analyzed to test the following four null hypotheses:

1. There is no significant effect of hands-on-activities on Middle Basic Education pupils' academic performance in Basic Science.
2. Guided inquiry does not significantly affect Middle Basic Education pupils' academic performance in Basic Science.
3. Concept mapping does not significantly affect Middle Basic Education pupils' academic performance in Basic Science.

14. Conclusion

Some instructional strategies are found to be more effective than others in improving learners' academic performance in school. Based on the result of data analysis and findings from this study, it was concluded that, instructional strategies have positive effect on pupils' academic performance in Basic Science. Hands-on-activities, guided inquiry and concept mapping significantly affect pupils' academic performance in Basic Science.

15. Recommendations

Based on the findings and conclusions reached from this study, the following recommendations were made:

1. There is the need for Middle Basic Education teachers to be innovative in the selection and utilization of instructional strategies in the teaching of Basic Science.
2. Middle Basic Education teachers should adopt hands-on-activities, guided inquiry and concept mapping in view of the fact that they enhance pupils' academic performance in Basic Science

3. Pupils in Middle Basic Education should be encouraged to perform tasks and discover things for themselves under the guidance of the teacher so as to facilitate brainstorming and critical thinking, the bedrocks for science learning.

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