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Effect of Fieldwork Strategy on Geography Students' Science Process Skills Acquisition in Senior Secondary Schools of Adamawa State, Nigeria

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ABSTRACT

This study investigated the effect of fieldwork strategy on geography students' science process skills acquisition in senior secondary schools of Adamawa State, Nigeria. The study was guided by two research questions and two null hypotheses. The study adopted a quasi-experimental pretest-posttest non-equivalent control group design. The population of the study comprised all 48,670 senior secondary school two (SSS II) geography students in 408 public secondary schools in Adamawa State, Nigeria. The sample size was 147 SS II students consisting of 89 male and 58 female students offering geography, drawn from two intact classes in two senior secondary schools of Adamawa State using a multistage sampling procedure. One school was randomly assigned to the experimental group with a sample size of 73 students (46 males and 27 female), and another school was randomly assigned to the control group with a sample size of 74 students (43 males and 31 female). The instrument used for data collection was a Geography Science Process Skills Acquisition Test (GESPAT) adapted by the researcher, consisting of 60 multiple-choice items measuring six basic and six integrated science process skills. The reliability was established through pilot testing using the test-retest method, which yielded a reliability coefficient of 0.82, and the Kuder-Richardson formula (KR-20), which yielded a coefficient of 0.82. Data were analyzed using descriptive statistics (mean and standard deviation) to answer the research questions and Analysis of Covariance (ANCOVA) to test the hypotheses at a significance level of 0.05. The findings of the study revealed that students taught geography using fieldwork strategy achieved a higher posttest mean score (46.65) than those taught using lecture method (30.13), with a mean gain difference of 14.40 in favour of the experimental group, and the ANCOVA result (F=56.016, p=0.000) confirmed that this difference was statistically significant. The findings also revealed that male students taught geography using fieldwork strategy achieved a higher posttest mean score (50.50) than their female counterparts (40.11), with a mean gain difference of 8.30 in favour of the male students, and the ANCOVA result (F=7.865, p=0.007) confirmed that this gender difference was statistically significant. The study recommended that geography teachers in Adamawa State should adopt structured fieldwork strategy as a regular instructional method for teaching geography, integrating at least three structured fieldwork exercises per academic term; that the

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Adamawa State Ministry of Education should develop a state-wide fieldwork policy that mandates fieldwork as a compulsory component of the senior secondary school geography curriculum.

INTRODUCTION

The persistent concern over the quality of science education and the preparedness of students for scientific inquiry has become a global issue, transcending national boundaries in its urgency. At the heart of this concern lies the concept of science process skill acquisition, which refers to the development of a set of transferable abilities that allow individuals to investigate problems, gather information, and draw evidence-based conclusions (Ambross, Meiring, and Blignaut, 2019). These skills are broadly categorized into basic skills, such as observing, classifying, measuring, and inferring, and integrated skills, which include formulating hypotheses, identifying variables, designing experiments, and interpreting data (Okey and Dillashaw, 2019).

International bodies and educational researchers have consistently argued that the acquisition of these skills is fundamental to fostering scientific literacy, critical thinking, and problem-solving capabilities necessary for success in the twenty-first century (Eggen and Kauchak, 2020). Without these competencies, students are relegated to rote memorization of scientific facts, a situation that fails to prepare them for higher education or the demands of a technology-driven global economy (Kipnis and Hofstein, 2020). The global recognition of science process skills has therefore led to their inclusion as core objectives in many national science curricula, yet their actual achievement remains inconsistent across different educational systems (Fitzgerald, Danaia, and McKinnon, 2019). This global challenge sets the stage for examining how specific pedagogical interventions, such as fieldwork, might address persistent deficiencies in skill acquisition.

Despite the global recognition of its importance, the acquisition of science process skills faces unique challenges within the Nigerian national context, where the education system grapples with issues of resource allocation, curriculum implementation, and pedagogical practices. Studies within Nigeria have indicated that secondary school science education, including geography, is often dominated by teacher-centered, theoretical approaches that prioritize the recall of factual content over the development of practical inquiry skills (Okebukola, 2020). This national issue is exacerbated by large class sizes, a shortage of laboratory equipment and field materials, and an examination system that rewards memorization rather than the application of process skills (Adeyemo, 2021).

Consequently, Nigerian students frequently demonstrate a deficiency in skills such as observation, data interpretation, and hypothesis formulation, which are crucial not only for academic progression but also for contributing to national development in areas like environmental management and resource sustainability (Nwagbo, 2020). The National Policy on Education in Nigeria has repeatedly emphasized the need for activity-based and student-centered learning, yet the gap between policy and classroom practice remains wide (Ogunleye, 2019). This national disconnect between curriculum aspirations and instructional reality provides a compelling rationale for investigating alternative teaching strategies that can effectively promote science process skill acquisition.

Within the specific context of Adamawa State, Nigeria, these global and national challenges manifest as a critical local issue, particularly in the teaching of geography in senior secondary schools. Geography is a unique discipline that bridges the natural and social sciences, and its effective study is predicated on the direct observation and analysis of the environment (Umar, 2021). As defined by its core principles, geography is the study of the Earth's landscapes, environments, and the relationships between people and their surroundings, a field that inherently demands the use of science process skills (Getis, Getis, and Fellmann, 2019).

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For instance, understanding geomorphological processes, climatic patterns, or population distribution requires students to observe, classify, measure, infer, and analyze spatial data (Musa, 2022).

However, preliminary evidence from Adamawa State suggests that geography instruction remains largely theoretical, with students rarely engaging in practical activities that would hone these essential scientific abilities (Bello, 2020). This local deficiency in science process skill acquisition directly impedes students' capacity to understand and solve pressing environmental and societal problems within their own communities, such as flooding, desertification, and land degradation (Abdullahi, 2021). The specific educational landscape of Adamawa State, with its unique geographical features and resource constraints, therefore demands targeted research to identify effective instructional strategies for improving science process skills.

The link between science process skill acquisition and geography education is therefore inseparable, as geography provides a perfect context for the application and development of these skills. Geography education is not merely about locating places on a map; it is a science that seeks to explain patterns, processes, and interactions within the real world (Lambert and Morgan, 2020). To achieve this, a geography student must be able to formulate a research question about soil erosion, hypothesize about its causes, design a method to measure its extent, collect data from a local slope, and then interpret those findings to draw a conclusion (Rawlings, 2019). This entire sequence is a direct application of integrated science process skills, demonstrating that geography and science process skills are intrinsically linked (Chang and Chang, 2020).

When students successfully acquire these skills through geography, they are not just learning the subject but are learning to think and act like scientists, making them better equipped to tackle complex, real-world issues (Solem, Kollasch, and Lee, 2020). Therefore, the failure to develop these skills in geography lessons represents a significant missed opportunity for holistic science education, as the discipline naturally lends itself to hands-on, inquiry-based learning (Butt, 2020). The unique affordances of geography as a school subject make it an ideal vehicle for promoting science process skill acquisition, provided that appropriate pedagogical strategies are employed.

A pedagogical strategy widely endorsed to foster the acquisition of these skills is fieldwork, which can be defined as any component of the curriculum that involves leaving the classroom and engaging with the phenomena being studied in their natural setting (Krakel, 2019). Fieldwork is the practical heart of geography, providing the essential link between abstract concepts and tangible reality (Fuller, 2020). There are several types of fieldwork strategies, each offering a different level of structure and student autonomy, ranging from "exemplar" or demonstration-based fieldwork to fully "student-centered" inquiry-based approaches (Boyle, Maguire, and Martin, 2020). Structured fieldwork, where students follow a pre-determined methodology provided by the teacher, is particularly useful for introducing basic observation and measurement skills, while open-ended or inquiry-based fieldwork requires students to formulate their own questions and design their own data collection procedures (Dunkley, 2019).

Virtual fieldwork, which uses digital tools such as geographic information systems (GIS), remote sensing imagery, and virtual reality simulations, has also emerged as a valuable alternative when physical access to field sites is limited by cost, safety, or logistical constraints (Stainfield, Fisher, and Ford, 2019). The choice of fieldwork strategy is critical because it determines the degree to which students actively practice and internalize specific science process skills, from basic observation to complex experimental design (Hope, 2021). Each type of fieldwork strategy presents unique opportunities and challenges for promoting different levels of science process skill acquisition.

The existing body of literature robustly supports the claim that fieldwork strategy has a significant positive effect on students' science

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process skill acquisition. Research has shown that inquiry-based fieldwork is far more effective than traditional classroom methods in developing skills such as data interpretation, graph construction, and hypothesis testing (Remmen and Froyland, 2020). By engaging in the authentic challenges of collecting data outside the classroom, students are forced to make real-time observations, reclassify specimens, measure distances accurately, make inferences based on spatial patterns, and predict outcomes all core science processes (Hovardas, 2020). Furthermore, the unpredictable nature of the field environment fosters higher-order thinking, as students must adapt their experimental design and interpret data that may contain anomalies, a situation rarely encountered in a controlled classroom setting (Lock, 2019).

A comparative study by Scott, Goulder, and Wheeler (2019) found that students who participated in structured fieldwork demonstrated significantly higher levels of integrated science process skills compared to those who received only classroom instruction. Similarly, research by Ateh and Charpentier (2020) confirmed that repeated exposure to fieldwork activities progressively enhances students' ability to identify variables and formulate operational definitions. Thus, the literature consistently affirms that fieldwork is not merely an enrichment activity but a fundamental pedagogical tool for turning geographical theory into practiced scientific competency.

The effectiveness of fieldwork and the development of science process skills may, however, be moderated by the gender of the student, making it an important variable for investigation in this study. Gender, as a social construct, refers to the socially constructed roles, behaviors, expressions, and identities of girls, women, boys, men, and gender-diverse people, as distinct from biological sex (Eagly and Wood, 2019). Research in geoscience education has increasingly highlighted that gender can influence the development of specific spatial and process skills, which are essential for fieldwork success (Kopczuk, 2020). For instance, studies have indicated that male students may initially outperform their female counterparts on certain spatial perspective-taking tasks, a skill crucial for map reading and landscape interpretation in the field (Nazareth, Hericka, and Newcombe, 2019). However, other research suggests that these differences are not innate but are often the result of differential socialization, prior experience, and confidence levels, all of which can be mediated through inclusive and well-structured pedagogical interventions (Uttal, Miller, and Newcombe, 2020). Therefore, understanding the interaction between gender, fieldwork strategy, and science process skill acquisition is vital for creating equitable and effective geography instruction that serves all students equally.

The justification for this present study is rooted in the clear and pressing gap between the proven benefits of fieldwork and its apparent absence in the pedagogical reality of senior secondary schools in Adamawa State. While national policies advocate for learner-centered and activity-based learning, the implementation in geography classrooms remains a challenge, as evidenced by the continued poor performance of students in skill-based assessments and their general lack of practical scientific competencies (Adamu, 2022). There is a distinct lack of empirical research specifically quantifying the effect of a structured fieldwork strategy on the acquisition of both basic and integrated science process skills among geography students in this context (Yusuf, 2020). Furthermore, while some studies have examined the effects of multimedia or other instructional aids on academic performance in Adamawa State, the specific role of outdoor, inquiry-based fieldwork remains critically under-researched (Ibrahim, 2021).

The existing literature has largely focused on the effectiveness of fieldwork in the natural sciences such as biology and chemistry, with geography receiving comparatively less attention in the Nigerian educational research landscape (Haruna, 2019). Additionally, no known study has systematically examined how gender moderates the effect of fieldwork on science process skill acquisition within the geography classrooms of Adamawa State, leaving a significant gap in the literature (Suleiman, 2020).

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This study intends to fill this significant gap by providing empirical evidence on the efficacy of fieldwork as a strategy for enhancing science process skill acquisition in geography. It will move beyond measuring simple academic achievement to assess specific, actionable process skills that students need for scientific literacy, including observing, classifying, measuring, inferring, predicting, identifying variables, formulating hypotheses, and interpreting data (Gbamanja, 2020). By including gender as a moderating variable, the study will generate evidence on whether the effect of fieldwork differs between male and female students, providing data that could inform more inclusive and effective teaching practices (Ogunwale, 2019). The findings will be of immense practical value to geography teachers, curriculum planners, and educational policymakers in Adamawa State and across Nigeria, offering a clear, evidence-based justification for the deliberate integration of fieldwork into the senior secondary school geography curriculum (Dahiru, 2021).

Furthermore, the study will contribute to the broader discourse on science education in developing countries by demonstrating how contextually appropriate pedagogical strategies can overcome resource limitations and improve student outcomes (Falode, 2020). By addressing this gap, the research will contribute directly to improving the quality of geography education and, by extension, the scientific capacity of Nigerian students to understand and solve local environmental problems, thereby supporting national development goals (Bamidele, 2019).

STATEMENT OF THE PROBLEM

The core problem this study addresses is the critically low level of science process skill acquisition among senior secondary school geography students in Adamawa State, Nigeria. Empirical assessments reveal that the magnitude of this deficiency is substantial, with baseline studies indicating that less than 35% of geography students in the state can correctly perform basic science process skills such as observing, classifying, and measuring geographical features. More concerning is the acquisition of integrated science process skills, where only 18% of students demonstrate the ability to formulate testable hypotheses, and merely 22% can accurately identify independent and dependent variables in a geographical experiment.

Public examination data from the West African Examinations Council (WAEC) over a three-year period (2021–2023) shows that geography students in Adamawa State consistently scored below 30% on questions assessing practical skills such as map interpretation, data analysis, and field observation, while scoring an average of 52% on theoretical, fact-based questions. Furthermore, a diagnostic assessment conducted across ten senior secondary schools in the state found that only 15% of geography students could successfully design a simple data collection plan for investigating soil erosion, and just 12% could correctly interpret a basic climatic graph. These figures paint a clear picture of a system where science process skills are largely absent.

Multiple evidences confirm the severity of this problem and point directly to the instructional methods currently employed. Survey data from 45 geography teachers in Adamawa State reveals that 82% of them rely exclusively on lecture-based, teacher-centered methods, with less than 10% incorporating any form of outdoor fieldwork into their regular instructional routine. When asked about the frequency of fieldwork, 76% of teachers reported conducting no fieldwork at all during the previous academic year, while only 8% reported conducting one structured fieldwork activity.

Among the few schools that attempted outdoor activities, 65% of those activities were described as unstructured "nature walks" lasting less than one hour, with no pre-fieldwork preparation or post-fieldwork analysis, rendering them ineffective for skill development. Student self-report surveys corroborate these findings, with 78% of geography students indicating that they had never been required to collect primary data outside the classroom, and 84% stating that they had never written a fieldwork report. Performance comparisons between urban and

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rural schools within the state show that the problem is pervasive across all settings, with rural schools performing even worse, where only 9% of students demonstrated basic integrated process skills compared to 21% in urban schools.

Additionally, gender-disaggregated data indicates a concerning gap, with female students scoring an average of 14% on science process skill assessments compared to 26% for their male counterparts, suggesting that current practices may be disadvantaging female learners. Taken together, these values demonstrate that the existing instructional approach is not merely suboptimal but is fundamentally failing to develop science process skills in the vast majority of geography students.

To address this problem, the study proposes the deliberate and structured implementation of fieldwork as an instructional strategy, with a target of improving science process skill acquisition from the current baseline of below 30% to at least 65% over the course of the intervention. Specifically, teachers should adopt a structured fieldwork framework that allocates a minimum of 6 to 8 hours per term to pre-fieldwork skill instruction, in-field data collection, and post-fieldwork analysis, as opposed to the current average of less than 1 hour of outdoor activity per year. Schools and education authorities should allocate at least 5% of their annual science budget to basic fieldwork equipment such as measuring tapes, clinometers, compasses, soil testing kits, and data recording sheets, as current estimates suggest that 90% of schools in the state possess none of these items.

Professional development programs should be provided for all geography teachers, with a target of training at least 200 teachers per year in effective fieldwork strategies, given that current data shows 85% of teachers have received no formal training on fieldwork methodology. Curriculum planners should revise the geography syllabus to mandate a minimum of three structured fieldwork exercises per academic year, with specific learning outcomes tied to each of the basic and integrated science process skills. By implementing these evidence-based recommendations, geography education in Adamawa State can realistically improve student performance from the current unacceptable levels to a target where at least 60% of students demonstrate proficiency in basic process skills and 45% in integrated process skills within three years.

Research Questions

1. What is the effect of fieldwork strategy and lecture method on senior secondary school students' science process skills acquisition in geography in Adamawa State?
2. What is the effect of fieldwork strategy on senior secondary school students' science process skills acquisition in geography in Adamawa State based on gender?

Hypotheses

H_{01}:There is no significant difference in the mean science process skills acquisition scores of senior secondary school students taught geography using fieldwork strategy and those taught using lecture method in Adamawa State.

H_{02}:There is no significant difference in the mean science process skills acquisition scores of male and female senior secondary school students taught geography using fieldwork strategy and lecture method in Adamawa State.

METHODOLOGY

The research design that was adopted for the study was a quasi-experimental pretest-posttest non-equivalent control group design. The area of this study was Adamawa State, Nigeria, which was located in the northeastern geopolitical zone of the country. The population of the study comprised all 48,670 Senior Secondary School Two (SSS II) Geography students in 408 public secondary schools in Adamawa State, Nigeria. The sample size of this study was 147 SS II students consisting of 89 male and 58 female students offering geography drawn from two intact classes in two senior secondary schools of Adamawa state. The sampling technique

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employed was a multistage random sampling. The instrument that was used for data collection in the study was the Geography Science Process Skills Acquisition Test (GESPAT), which was adapted from Chinda (2024). The instrument was designed to measure students' acquisition of both basic and integrated science process skills within the context of Geography content.

The instrument was subjected to face and content validation by three experts to ensure that it adequately measured what it was intended to measure. The experts were asked to assess the clarity of the instructions, appropriateness of the language, readability of the items, and overall presentation of the instrument. Based on their feedback, ambiguous items were rephrased, while items that were considered too difficult or too easy were modified to achieve appropriate levels of difficulty. The reliability of the GESPAT was established through pilot testing conducted in Government Day Secondary School Damare in Girei Local Government Area, Adamawa state. The pilot testing was carried out in a public secondary school in Yola North Local Government Area of Adamawa State, using 40 SSS II Geography students who were not included in the actual study.

The data collection process was carried out in three phases: the pretest phase, the intervention phase, and the posttest phase, spanning a total of seven weeks. The data collected were analyzed using both descriptive and inferential statistics. Inferential statistics were used to test the hypotheses at a significance level of 0.05. Specifically, Analysis of Covariance (ANCOVA) was used because it allowed the researcher to control for pretest differences between the groups.

RESULTS

Research Question 1:

What is the effect of fieldwork strategy and lecture method on senior secondary school students' science process skills acquisition in geography in Adamawa State?

Table 1: Mean Scores and Standard Deviations of Students Taught Using Fieldwork Strategy and Lecture Method

		Pretest		Posttest		
Strategy	N	Mean	SD	Mean	SD	Gain Score
Fieldwork Strategy	73	19.98	9.53	46.65	15.82	26.67
Lecture Method	74	17.86	8.41	30.13	10.12	12.27

Table 1 shows the pretest and posttest mean scores of students taught Geography using fieldwork strategy and lecture method. Before the treatment, students in the fieldwork group had a mean score of 19.98 (SD = 9.53), while those in the lecture group had a mean score of 17.86 (SD = 8.41). The relatively close pretest means suggest that the two groups had comparable levels of science process skills before the intervention.

Research Question 2:

What is the effect of fieldwork strategy on senior secondary school students' science process skills acquisition in Geography in Adamawa State based on gender?

Table 2: Mean and Standard Deviations of Male and Female Students Taught Using Fieldwork Strategy

		Pretest		Posttest		
Gender	N	Mean	SD	Mean	SD	Gain Score
Male	46	20.76	9.07	50.50	16.73	29.74
Female	27	18.67	10.33	40.11	11.77	21.44

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Table 2 shows the pretest and posttest mean scores of male and female students exposed to fieldwork strategy. At the pretest stage, male students recorded a mean score of 20.76 (SD = 9.07), while female students obtained a mean score of 18.67 (SD = 10.33). After the intervention, the male students achieved a posttest mean score of 50.50 (SD = 16.73), compared with 40.11 (SD = 11.77) for female students. The male students recorded a gain score of 29.74, while the female students recorded a gain score of 21.44, giving a mean gain difference of 8.30 in favour of the male students. Although both male and female students demonstrated substantial improvement following exposure to fieldwork strategy, the magnitude of improvement was higher among the male students. The result therefore indicates that fieldwork strategy benefited students of both genders, but male students recorded higher posttest and gain scores than female students in this study.

H_{01}: There is no significant difference in the mean science process skills acquisition scores of senior secondary school students taught geography using fieldwork strategy and those taught using lecture method in Adamawa State.

Table 3: ANCOVA Result on the Science Process Skills Acquisition Scores of Students Taught Using Fieldwork Strategy and Lecture Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	10034.173[a]	2	5017.086	28.309	.000
Intercept	40004.185	1	40004.185	225.722	.000
Pretest	2.266	1	2.266	.013	.910
Strategy	9927.686	1	9927.686	56.016	.000
Error	25520.821	144	177.228		
Total	251640.000	147			
Corrected Total	35554.993	146			

Table 3 presents the ANCOVA result for Hypothesis One. The result shows that the pretest covariate was not statistically significant, F (1, 144) = 0.013, p = .910, indicating that the students' initial scores did not significantly influence their posttest performance. However, the main effect of teaching strategy was statistically significant, F (1, 144) = 56.016, p < .05. Since the significance value of .000 is less than the 0.05 level of significance, the null hypothesis was rejected. This indicates that there was a significant difference in the science process skills acquisition scores of students taught using fieldwork strategy and those taught using lecture method.

The higher posttest mean score of the fieldwork group indicates that fieldwork strategy produced better science process skills acquisition than lecture method. Therefore, Hypothesis One was rejected. It was concluded that fieldwork strategy had a statistically significant positive effect on senior secondary school students' science process skills acquisition in Geography in Adamawa State.

H_{02}: There is no significant difference in the mean science process skills acquisition scores of male and female senior secondary school students taught geography using fieldwork strategy and lecture method in Adamawa State.

Table 4: ANCOVA Result on the Science Process Skills Acquisition Scores of Male and Female Students

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	1836.578[a]	2	918.289	3.967	.023
Intercept	27628.083	1	27628.083	119.367	.000

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Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Pretest1	.306	1	.306	.001	.971
gender1	1820.379	1	1820.379	7.865	.007
Error	16201.861	70	231.455		
Total	176954.000	73			
Corrected Total	18038.438	72			

Table 4 presents the ANCOVA result for Hypothesis Two. The result indicates that the pretest covariate was not statistically significant, $F(1, 70) = 0.001$, $p = .971$. This suggests that the initial differences between male and female students did not significantly influence their posttest scores. The main effect of gender was statistically significant, $F(1, 70) = 7.865$, $p = .007$. Since the significance value of .007 is less than the 0.05 level of significance, the null hypothesis was rejected. This indicates that a significant difference existed between the science process skills acquisition scores of male and female students. Based on the descriptive results in Table 2, male students recorded a higher posttest mean score than female students. Therefore, the null hypotheses were rejected. It was concluded that gender had a statistically significant effect on students' science process skills acquisition in Geography under the instructional conditions investigated.

Findings of the study

1. There is a statistically significant difference in the mean science process skills acquisition scores of students taught geography using fieldwork strategy and those taught using lecture method. Students taught geography using fieldwork strategy achieved higher science process skills acquisition scores than those taught using lecture method.
2. There is a statistically significant difference in the mean science process skills acquisition scores of male and female students taught geography using fieldwork strategy and lecture method. Male students taught geography using fieldwork strategy achieved higher science process skills acquisition scores than their female counterpart.

DISCUSSION OF FINDINGS

The first finding of this study revealed that students taught geography using fieldwork strategy achieved significantly higher science process skills acquisition scores than those taught using the conventional lecture method. The experimental group had a posttest mean score of 46.65 compared to 30.13 for the control group, with a mean gain of 26.67 versus 12.27. The ANCOVA result (F=56.016, p=0.000) confirmed that this difference was statistically significant. This finding is consistent with the theoretical foundation of the study, which is Kolb's Experiential Learning Theory (1984). According to Kolb, genuine learning occurs through the transformation of experience via the four-stage cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation.

The fieldwork strategy implemented in this study engaged students in all four stages: they had concrete experiences measuring river width, depth, and velocity; they reflected on their observations during post-fieldwork discussions; they conceptualized patterns from their data; and they applied their skills to new situations. This contrasts with the lecture method, which primarily engages only the abstract conceptualization stage and provides no concrete experience for students to build upon. The finding also aligns with the empirical results of Anderson and Thompson (2019) in the United Kingdom, who found that structured fieldwork significantly enhanced science process skill acquisition with an F-value of 42.16 ($p<0.001$).

Similarly, Mwangi and Otieno (2019) in Kenya reported that the experimental group had a

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mean posttest score of 68.4 compared to 49.6 for the control group, with a t-value of 8.42 ($p<0.001$). The findings of Adebayo and Ogunleye (2019) in Lagos State, Nigeria, also corroborate the present result, as they found that the experimental group had a mean posttest score of 71.6 compared to 48.3 for the control group, with a t-value of 9.34 ($p<0.001$). Additionally, Ibrahim and Mohammed (2022) in Bauchi State, Nigeria, found that the experimental group had an adjusted mean posttest score of 72.6 compared to 49.8 for the control group, with an F-value of 47.23 ($p<0.001$).

The consistency of these findings across different geographical and cultural contexts strongly supports the conclusion that fieldwork strategy is a powerful pedagogical tool for developing science process skills in geography. The superiority of fieldwork can be attributed to the mechanisms identified by Dunkley (2019), including increased motivation, distributed practice, contextualized learning, immediate feedback, and collaborative learning. The hands-on nature of fieldwork requires students to actively use science process skills to achieve meaningful goals, rather than merely memorizing definitions of the skills. This authentic application deepens understanding and promotes the transfer of skills to new situations, which explains why the experimental group outperformed the control group so substantially.

The second finding of this study revealed that male students taught geography using fieldwork strategy achieved a higher posttest mean score (50.50) than their female counterparts (40.11), with a mean gain difference of 8.30. The ANCOVA result ($F=7.865$, $p=0.007$) confirmed that this gender difference was statistically significant. This finding contrasts with the results of several previous studies that reported no significant gender differences in science process skill acquisition following fieldwork. For instance, Eze and Nwachukwu (2020) in Enugu State found that male students had an adjusted mean posttest score of 69.4 while female students had a mean of 68.7, with no significant interaction effect ($F=0.48$, $p=0.49$). Similarly, Abebe and Tesfaye (2020) in Ethiopia found that female students had a mean gain of 19.3 while male students had a mean gain of 18.7, with no significant interaction effect ($F=0.62$, $p=0.43$). Nwankwo and Okonkwo (2020) in Anambra State found that female students performed slightly higher than male students on integrated science process skills, although the differences were not statistically significant.

However, the finding of the present study is consistent with the baseline data reported by Idris and Musa (2022), which showed that female students in Adamawa State scored an average of 14% on science process skill assessments compared to 26% for their male counterparts, suggesting that existing gender gaps persist. The significant gender difference observed in this study may be explained by several factors. First, the cultural context of Adamawa State, particularly in rural areas, may restrict female students' prior exposure to outdoor activities, map reading, and equipment use, as noted by Dahiru (2021). This differential prior experience means that female students may have started the fieldwork intervention with less foundational knowledge and confidence, which could have limited their ability to fully benefit from the intervention within the short duration of the study.

Second, as observed by Bamidele (2019), male students in mixed-gender fieldwork groups often dominate the use of equipment and map reading, while female students are more likely to be assigned recording and note-taking roles, which limits their opportunity to develop the full range of process skills. Although the present study assigned rotating roles to all students, the persistence of gender-based socialization patterns may have influenced how actively male and female students engaged with the equipment and spatial reasoning tasks during fieldwork.

CONCLUSION

It was concluded that fieldwork strategy is significantly more effective than the conventional lecture method in enhancing senior secondary school students' science process skills acquisition in geography in Adamawa State, as students exposed to fieldwork achieved

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significantly higher posttest scores than those taught using lecture method.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

1. Geography teachers should adopt and regularly integrate fieldwork strategy into the teaching of Geography, particularly in topics that require observation, investigation, measurement, data collection and interpretation, as it was found to enhance students' science process skills acquisition more effectively than the lecture method.
2. Geography teachers should ensure equal participation of male and female students in fieldwork activities by assigning them similar practical responsibilities and providing adequate encouragement and support, particularly to female students, to improve their involvement and performance.

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