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IMPACT OF INQUIRY-BASED INSTRUCTION ON SCIENCE PROCESS SKILLS ACQUISITION IN ECOLOGY AMONG SECONDARY SCHOOLS STUDENTS IN KATSINA STATE, NIGERIA

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Abstract

This study investigated the impact of inquiry-based instruction on science process skills acquisitionin ecology among secondary school students in KatsinaState, Nigeria. The study was guided by two research objectives, answered two research questions and tested two null hypotheses. A quasi-experimental research design was employed, involving pre-test and post-test non-equivalent groups. The population of the study consisted of a total number of 17527 senior secondary students two (SSII) offering Biology in 23 public secondary schools in Katsina Zonal Education Quality Assurance. Purposive sampling technique was used to select a sample of 124 (59 male and 65 female) Biology students from two co-educational schools. The validated instrument used for data collection was Science Process Skills Acquisition Test (SPSAT). The reliability coefficients of the instrument was 0.89 determined using Pearson Product Moment Correlation (PPMC). The study involves two groups. The experimental group were taught using inquiry-based instruction while the control group were taught using lecture method. Research questions were answered using Mean and Standard Deviation statistics while null hypotheses were tested using Independent Sample t-test at 0.05 level of significance. The findings of

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the study showed that the use of inquiry-based instruction is more effective in enhancing students science process skills in ecology than the conventional method. The findings also revealed that male and female students in the experimental group do not significantly differ in their science process skills. Based on the findings of this study, it was recommended among others that, Biology teachers should frequently employ the use of inquiry-based in teaching concepts in Biology like ecology to enhance students science process skills acquisition. States and Federal Ministries of Education including professional bodies like Science Teachers Association of Nigeria (STAN) should organize workshops, seminars and conferences to train and encourage teachers on the use of inquiry-based instruction.

Introduction

Science process skills is the foundation for the effective learning of Science. The acquisition of science process skills empowers students to actively and effectively engage in scientific investigations. According to Olayinka (2019), science is the study of knowledge that can be transformed into a system based on evaluative facts. Science is made up of two important parts product (Knowledge) and process (method). Salami, Isah and Ogedengbe (2022) opined that science is the study of nature or natural things around us, science is an organized body of knowledge In form of concepts, laws, theories and generalization. Usman (2020) posited that science is nothing but knowledge obtained by observation, reading, experimentation and realization. These skills are not only useful in science but also in the students daily lives and future. Science learning can be more meaningful if the acquisition of skills or knowledge is framed in the constructivism paradigm. Students Science Process Skills improved when they are exposed to inquiry-based instruction (Mulyeni, Jamaris & Supriyati 2019, Rumalolas, Rosely, Nunaki, Damopolii & Kandowangko 2021)

Science process skills consist of several skills that students must have namely: observing, interpreting observations, grouping, predicting, communicating, asking questions, proposing hypotheses, planning experiments, using tools and materials, applying concepts and carrying out experiments (Astalini, Darmaji, Kurniawan, & Ramadhanti, 2022, Beichumila, Bahati & Kafanabo, 2022). According to Gizaw and Sota (2023), science process skills are students' ability to apply scientific methods in understanding, developing science and discovering new knowledge. Science process skills are very important for students as a provision to use scientific methods in developing science to acquire new knowledge (Gizaw & Sota, 2023, Kurniahtunnisa, Harahap, Tumewu & Warouw, 2024). Science process skills are scientific methods that train steps to find knowledge through experience and experimentation (Koomson, Kwaah & Adu-Yeboah,

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2024). In general, science process skills are also an approach to teaching science subjects including Biology based on observation of what a scientist does.

Biology is a practical based subject, which equips students with concepts and skills that are useful in solving the day-to-day problems of life. Biology a key branch of science that holds a significant position in the Nigerian senior secondary school curriculum is defined as the study of life and the structure of plants and animals, and their relative environment (Usman, 2020). Biology serve as a central subject to many science related courses such as Medicine, Pharmacy, Agriculture, Nursing, Biochemistry and so on. Hence no student can study these disciplines without the knowledge of Biology. Yilshik, Ezekiel and Umar (2020) asserted that the subject biology excites intellectual curiosity, increases awareness of fragile ecosystem and stimulates critical thinking.

Ecology as one of the concepts in Biology deals with the study of interactions between organisms and their environment. Ibe and Abamuche (2019) viewed ecology as the scientific study of the relationships between organisms including humans, and their physical environment. Ecology helps students understand the relationships between organisms, populations, communities and the influence of environmental factors on their distribution, abundance and behaviors. It provides invaluable insights into the mechanisms driving life processes, ecological dynamics and the intricate web of interactions between organisms and their environments (Huntley, 2023)

One of the most common methods of teaching science at the Senior Secondary level is lecture method. Most of the secondary school teachers rely much on the lecture method of teaching rather than the use of inquiry-based instruction. According to Garba (2020), the lecture method is characterized by the teacher speaking to a large group of students, where the main aim is to transmit knowledge efficiently. It is a teacher centered type of instruction in which the teacher is activive while the students are passive. In its true nature, lecture method is not effective for science teaching. Edarho (2020) argues against it because it does not promote meaningful learning. He further explained that the use of lecture method of teaching in science leads to rote learning. Lecture method is a process of delivering verbally a body of knowledge according to preplanned scheme. Lecture method of teaching should not be totally discouraged, but there is need to improve on it for effective teaching and learning of ecology.

This can be done by the use of inquiry-based instruction. Inquiry-based instructions are a student-centered teaching approach that encourages active learning, critical thinking, problem-solving skills and application of knowledge in real-life contexts. The inquiry me tothod occupies a significant position among the various methodologies (Vorholzer & Von Aufschnaiter 2019, Martell 2020 & Cetin 2021). Students are encouraged to ask questions, make observations, gather evidence, analyze data, and construct their understanding of the content. Inquiry-based instructions are a powerful method for teaching biology, it is

then important that new and innovative strategies are used by teachers for effective teaching and learning. Instructional process is critical, meanwhile the students perception gives way to operational challenges. It was opined that the way the students perceived knowledge and their achievement assists the teacher to change teaching strategies which will improve students learning outcomes (Malik, Salman, Ameen & Abdullahi, 2020).

Gender in science is the classification of the roles males and females play in science. This is the consequence of gender stereotypes which have classified different roles for male and female in the society. In the view of Orji, Phoebe, Ogbonnaya, Nkpoyen and Edet (2021) gender is part of a broader sociocultural context. Previous studies in elementary, secondary and university settings have examined the effects of gender on science process skills some researchers have found no differences while others have suggested that gender plays a significant role which calls for more research. Some studies suggest no significant effect of gender on science process skills acquisition (Ihejiamazu, Neji & Isaac 2020) others report notable differences (Usman, 2021, Maikano, Ezeaghasi & Aliyu, 2022).

Statement of the Problem

The persistent challenge of improving students' mastery of science process skills (SPS) highlights the necessity for more effective pedagogical approaches. Student's inability to acquire skills has been attributed to several factors which includes lack of students exposure to practical lesson, influence of gender and non-effective methods of teaching concepts, because some of the ways of teaching ecology in some secondary schools are teacher-centered approach. Students find it difficult to apply the knowledge acquired through conventional teaching methods to solve scientific problems in a new situation. In view of these researchers in science education have continually sought for better teaching methods that will enhance students science process skills and bridge gender gap in male and female students. Against this backdrop, the current study examines how inquiry-based instruction impacts secondary school students' development of science process skills in ecology within Katsina Zonal Education Quality Assurance.

Objectives of the study

1. Examine the impact of inquiry-based instruction on science process skills acquisition in ecology among secondary schools students in Katsina Zonal Education Quality Assurance.
2. Investigate the impact of inquiry-based instruction on acquisition of science process skills in ecology among male and female secondary schools students in Katsina Zonal Education Quality Assurance.

Research Questions

1. What is the difference between the mean science process skills acquisition scores of secondary schools students taught ecology using inquiry-based instruction and those taught the same concept using conventional method?

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2. What is the difference between the mean science process skills acquisition scores of male and female secondary schools students taught ecology using inquiry-based instruction?

Null Hypotheses

Ho_1: There is no significant difference between the mean science process skills acquisition scores of secondary schools students taught ecology using inquiry-based instruction and those taught the same concept using conventional method.

H_{o2}: There is no significant difference between the mean science process skills acquisition scores of male and female secondary schools students taught ecology using inquiry-based instruction.

Methodology

The research design for this study is quasi-Experimental design involving the pre-test and post-tests. It consist of two groups: the experimental group and control group. The Experimental group received instruction using the inquiry-based instruction , while the control group was taught using the conventional method for the period of six weeks. The population of the study consisted of seventeen thousand two hundred and fifty seven (17257) senior secondary two (SSII) Biology students in Katsina Zonal Education Quality Assurance. The sample of the study comprised 124 senior secondary II Biology students made up of 59 males and 65 females from two public co-educational schools in Katsina Zonal Education Quality Assurance. Purposive sampling technique was employed in this study. Intact classes were used for the research. Science Process Skills Acquisition Test (SPSAT) which comprised of twenty (20) questions was the instrument used to collect data which was validated by experts and the reliability of the instrument was obtained using Pearson Product-Moment Correlation (PPMC) which yielded coefficient of reliability of 0.89. The data collected was analyzed using mean and standard deviation to answered research questions while independent t-test was used to test the null hypotheses at 0.05 level of significance.

Results and Discussions

Ho_1: There is no significant difference between the mean science process skills acquisition scores for secondary school students taught ecology using inquiry-based instruction and those taught the same concept using conventional method

Table1: Summary of Independent Sample t-test of SPSAT Scores for Students in the Experimental and Control Groups

Groups	N	Mean	Std.Dev	Df	t-cal	P-value	Remark	
Experimental	56	68.57	9.03					
				122	4.82	0.000	Significant	
Control	68	60.37	9.74					

*Significantatp≤0.05

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Table 1 presents the t-test result of testing null hypothesis one (Ho_1). The result indicates that the t-value calculated is 4.82 and the p-value of 0.000 is observed at the degree of freedom (df) 122. Since the p-value is less than the alpha value which is 0.05, it means that there is significant difference between the mean science process skills acquisition scores of secondary schools students taught ecology using inquiry-based instruction and those taught using conventional method. The observed difference was in favour of the experimental group. Therefore the null hypothesis which stated that there was no significant difference between the mean science process skills acquisition scores of secondary school students taught ecology using inquiry-based instruction and those taught using conventional method is rejected.

H_{o2}: There is no significant difference between the mean science process skills acquisition scores of male and female secondary schools students taught ecology using inquiry-based instruction.

Table 2: Summary of Independent Sample t-test of SPSAT Scores for Male and Female Students in the Experimental Group

Groups	N	Mean	Std.Dev	Df	t-cal	P-value	Remark
Male	27	70.37	9.79				
				54	1.300	0.199	NotSignificant
Female	29	67.07	9.21				

*Significantatp≤0.05

Table 2 presents the t-test result of testing null hypothesis two (H_{o2}). The result indicate that the t-value calculated is 1.300 and the p-value of 0.199 is observed at the degree of freedom (df) 122. Since the p-value is greater than the alpha value which is 0.05, it means that there is no significant difference between the mean science process skills acquisition scores of male and female secondary school students taught ecology using inquiry-based Instruction. The observed difference was in favour of the male students. Therefore the null hypothesis which stated that there was no significant difference between the mean science process skills acquisition scores of male and female secondary schools students taught ecology using inquiry-based instruction is retained.

Discussion of findings

From the result obtained, students in the experimental group demonstrated a higher mean score in science process skills acquisition (68.57) than their counterparts in the control group (60.37). This difference was significant as indicated by the t-test analysis in Table 1. This result suggest that students who learned ecological concepts through the

inquiry-based instruction achieved significantly greater science process skills acquisition than those who received conventional instruction. The finding agreed with that of Majeed, Yasmin and Ahmad (2023) who found that using inquiry-based instruction enhance students science process skills.

Furthermore, the results obtained indicate that male students in the experimental group had higher mean science process skills acquisition score (70.37) than their female peers (67.07) with this difference being not significant, as shown by the t-test analysis in Table 2. This implies that inquiry-based is gender-friendly as both male and female science process skills acquisition was improved without any significant difference. This finding aligns with the research conducted by Ihejiamazu, Neji and Isaac (2020) who found that gender does not significantly influence Biology students science process skill. The finding contradict with that of Adewumi and Adejoke (2023), who highlighted a gender difference in favour of girls regarding mastery of science process skills.

Summary

The following findings were revealed based on the results of this study:

1. There is statistically significant difference between the mean science process skills acquisition scores of secondary school students taught ecology using inquiry-based instruction and those taught using conventional method.
2. There is no statistically significant difference between the mean science process skills acquisition scores of male and female secondary schools students taught ecology using inquiry-based instruction.

Conclusion

The conclusions were drawn from the findings of the study based on the statistical analysis of the data collected. Therefore, it was concluded that; Inquiry-based instruction has positive effect on Biology students science process skills in ecology. Using inquiry-based instruction in teaching ecology in Katsina Zonal Quality Assurance is gender friendly as far as science process skills acquisition is concern.

Recommendations

1. Biology teachers should be encouraged to be using inquiry-based instruction in teaching biological concepts since the method is found to enhance students' acquisition of science process-skills in ecology.
2. The State Quality Assurance should from time to time go round the secondary schools in the state to supervise and ensure that the use of conventional teaching method in teaching ecological concepts is minimized.

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3. The Federal and State Government through the Ministries of Education should embark on retraining of Biology teachers to design and implement classroom instructions based on the inquiry-based instruction through regular seminars, workshops and conferences.

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