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EFFECTS OF LABORATORY PEDAGOGIES ON INTEREST IN BIOLOGY AMONG VARIED-ABILITY SECONDARY-SCHOOLS STUDENTS IN TARABA STATE, NIGERIA

[1]Stanley Maikano, [2]Bulus Onesimus Shiaki and [3]Joshua Hoku Bako
Department of Science Education, Taraba State University, Jalingo, Nigeria

stanmaikano@gmail.com; obshiaki@gmail.com; joshuahbako@gmail.com

This study investigated the effects of laboratory pedagogies on interest in Biology among varied-ability secondary school students in Taraba State, Nigeria. The study adopted a quasi-experimental research design, and data was collected using the Students' Interest in Biology Scale (SIBS) instrument. The study formulated 18 research questions and 18 research hypotheses. The population of the study is 816 out of which a sample of 187 was drawn using multi-stage random sampling technique. A pilot study was used to test for the reliability of the research instrument. The results show that students' interest in Biology varied depending on the teaching method used. Indoor laboratory pedagogy showed a significant effect on students' interest in Biology ($P=0.013<0.05$). Also, it showed a significant effect on female students' interest in Biology ($P=0.047<0.05$). This suggests that hands-on, experiential learning in an indoor setting can be an effective way to engage students and foster their interest in Biology. Based on the findings, it is recommended that biology teachers adopt indoor laboratory pedagogies in their teaching practices. Also, workshops and seminars should be organized for biology teachers to promote equal engagements and interests among both male and female students through indoor laboratory pedagogy.

Key Words: Laboratory pedagogies, students' interest, ability grouping, gender and Biology

Introduction

Science education is very important in any educational system. This is because every country needs scientific knowledge and its application as the foundation of technological development. Several subjects are taught in science education. These include chemistry, physics, and biology amongst others. Biology, a branch of science, has been defined as the scientific study of life, involving the systematic study of living things and their interactions with each other and their environment (Hills, Seib, Pleva, Smythe, Gosling & Cole, 2020). In Nigeria, Biology is offered in many secondary schools, with one of its objectives being to equip students with adequate laboratory and field skills (NPE, 2019). Biology plays a vital role in society, promoting individuals' understanding of their relationship with the environment and the interrelationship between living and non-living things (Akinbola, 2020). The skills acquired through Biology education include observation, communication, problem identification, hypothesis formulation, data analysis, and prediction (Okebukola, 2022).

Biology, as a science of life, deals with the characteristics of living things, their forms, functions, and relationships with each another and with their environments. Effective biology teaching requires the use of methods or strategies that utilize the environment to convey the actual meaning of concepts. Biology is a crucial subject, serving as a prerequisite for studying various disciplines, including medicine, agriculture, pharmacy, microbiology, biochemistry, and psychology (Okebukola, 2022). The subject plays a vital role in a nation's economic development, addressing issues like

food scarcity, pollution, population explosion, and disease (Akinbola, 2020). Biology involves the study of living things, encompassing botany and zoology (Santos, 2020). The subject has numerous applications in fields like medicine, agriculture, and biotechnology, and is essential for addressing ecological problems (Uyulgan, 2022).

In pursuing the objective of understanding Biology the content and context of the curriculum emphasize innovative pedagogies like field studies, guided discovery, and laboratory techniques. However, most Nigerian biology teachers have deviated from these pedagogical approaches and adopting a talk-and-chalk approach that renders students passive in the learning process (Okebukola, 2022). In contrast, outdoor laboratory instructions offer rich educational possibilities, enabling students to learn through hands-on experiences rather than mere reading or listening (Santos, 2020). The key to success in science lies in enabling students to conceptualize science as a creative process, rather than a defined body of knowledge (Uyulgan, 2022). According to recent research, personal experiences play a crucial role in learning, as students who are actively involved in their work tend to be more motivated and enjoy the learning process (Akinbola, 2020).

In science education, students are exposed to various teaching and learning methods, including lectures, demonstrations, discovery, discussions, laboratory activities, and cooperative learning (Kirschner et al., 2017). For effective Biology teaching, strategies that utilize the environment can help students grasp concepts more effectively (Akinbola, 2020). Biology is a popular science subject, and its teaching requires innovative approaches to promote student interest and understanding (Okebukola, 2022). This study aims to investigate the effects of laboratory pedagogies on interest, academic performance, and retention in Biology among varied-ability secondary school students in Taraba State, Nigeria. Outdoor laboratory instruction is a recommended strategy for teaching Biology, as it enables students to learn through hands-on experiences in natural settings (Santos, 2020). However, many Biology teachers still rely on traditional lecture methods, neglecting the benefits of outdoor laboratory instruction (Uyulgan, 2022).

An outdoor laboratory instruction involves taking students outside the classroom to make relevant observations and obtain specific information based on the natural settings of the ecosystem (Santos, 2020). This approach provides students with hands-on experiences, enabling them to acquire knowledge and develop scientific process skills such as observation, identification, classification, and manipulation of substances in their natural surroundings (Uyulgan, 2022). Field trips, a form of outdoor laboratory instruction, offer students the opportunity to see concrete illustrations of classroom theories, promoting deeper understanding and retention of the material (Akinbola, 2020). Outdoor laboratories provide a real-life context for learning, enabling students to see the practical applications of scientific concepts and remember them better (Okebukola, 2022).

On the other hand, the indoor laboratory is a forum for science teachers and their students within a building that allows the interaction with apparatus under controlled conditions when seeking answers to problems in nature. Science is concerned with finding answers to problems in a bid to understand and interpret natural phenomena. It is often necessary to try out hypotheses through experimentation. The students or the teachers of science find the indoor laboratory a unique place for this. Interest is a crucial factor in students' learning. Merriam-Webster's Dictionary (2021) defines interest as a feeling of wanting to learn more about something or to be involved in something. Hidi and Renninger's (2017) view of interest emphasizes the predisposition to re-engage with particular objects, events, or ideas. In agreement with this perspective, Akinbola, 2020 sees students' interest in biology as a recurrent positive disposition to activities associated with the teaching and learning of biology. Also, students' interest in biology has a direct impact on their academic performance in this subject.

Moreover, using activity-based instructional strategies can arouse and sustain students' interest in learning (Uyulgan, 2022). Interest is a motivational construct that ensures sustained attention is given to the stimuli of interest. Therefore, any attempt to improve students' performance in biology must take into account their interest in the subject.

Students' interest plays a significant role in their performance in a school subject. According to recent research, students' curiosity and interest manifest in their performance (Akinbola, 2020). Poor teaching methods employed by teachers have been blamed for the lack of students' interest in Science, including Biology (Okebukola, 2022). Ability grouping is a practice where students are grouped based on educators' judgments of their abilities (Kilpatrick et al., 2017). This approach has been a topic of controversy, with proponents arguing that it allows teachers to target instruction more effectively (Subotnik et al., 2017). However, critics argue that ability grouping can lead to stigmatization and perpetuate existing inequalities (Dathe, 2017). Research has shown that ability grouping can have negative consequences, particularly for students from low-income backgrounds (Ladson-Billings, 2020). In contrast, heterogeneous grouping has been advocated for by middle grades educators, as it promotes diversity and inclusivity (Kidd et al., 2020). Ultimately, the decision to use ability grouping or heterogeneous grouping depends on the specific needs and goals of the students and the educational institution. The study also investigates how gender affects interest in Biology as a teaching subject.

Purpose of the Study

The main purpose of this study was to investigate the effects of laboratory pedagogies on interest ratings in biology among varied-ability male and female students of secondary schools in Taraba State, Nigeria. This study specifically:

i. Determined the interest ratings of varied ability students in Biology when taught using outdoor laboratory pedagogy.

ii. Found out the interest ratings of varied ability students in Biology when taught using indoor laboratory pedagogy.

iii. Determined the interest ratings of male students of varied ability in Biology when taught using indoor laboratory pedagogy.

iv. Determine the interest ratings of female students of varied ability in Biology when taught using indoor laboratory pedagogy.

v. Determine the interest ratings of male students of varied ability in Biology when taught using outdoor laboratory pedagogy.

vi. Determine the interest ratings of female students of varied ability in Biology when taught using outdoor laboratory pedagogy.

Research Questions

i. What is the difference in mean interest ratings of varied ability students in Biology when taught using outdoor laboratory pedagogy?

ii. What is the difference in mean interest ratings of varied ability students in Biology when taught using indoor laboratory pedagogy?

iii. What is the difference in mean interest ratings of male students of varied ability in Biology when taught using indoor laboratory pedagogy?

iv. What is the difference in mean interest ratings of female students of varied ability in Biology when taught using indoor laboratory pedagogy?

v. What is the difference in mean interest ratings of male students of varied ability in Biology when taught using outdoor laboratory pedagogy?

vi. What is the difference in mean interest ratings of female students of varied ability in

Biology when taught using outdoor laboratory pedagogy?

Hypotheses

i. There is no significant difference in the mean interest ratings of varied ability students in Biology when taught using outdoor laboratory pedagogy.

ii. There is no significant difference in the mean interest ratings of varied ability students in Biology when taught using indoor laboratory pedagogy.

iii. There is no significant difference in the mean interest ratings of male students of varied ability in Biology when taught using indoor laboratory pedagogy.

iv. There is no significant difference in the mean interest ratings of female students of varied ability in Biology when taught using indoor laboratory pedagogy.

v. There is no significant difference in the mean interest ratings of male students of varied ability in Biology when taught using outdoor laboratory pedagogy.

vi. There is no significant difference in the mean interest ratings of female students of varied ability in Biology when taught using outdoor laboratory pedagogy.

Materials and Methods

The research design adopted for the study was quasi-experimental design. The quasi-experimental design was chosen for this study because it allows for the examination of the effect of a specific intervention (in this case, the use of outdoor and indoor laboratory pedagogies) on the interest of varied ability male and female students in Biology. The study was conducted in Wukari Education Zone of Taraba State, Nigeria. Wukari education zone is made up of two local governments namely; Wukari local Government, and Ibbi local Government. The area was chosen due to its accessibility, relevance to the research problem, representation of the population, and limited studies on the topic. The choice of location was practical and feasible, making it an ideal setting for the study. The populations of the study consist of all the senior secondary school (SSII) biology students from the 30 public schools in Wukari Education zone. The populations of SSII biology students in 2023/2024 academic session was 816 students consisting of 398 male and 416 female students (Taraba State Post Primary School Management Board, 2024).

The sample of the study consist of 187 students in SSII offering biology in Wukari Education Zone, Taraba state of which the male students were 102 and female students were 85 respectively. The multi – stage random sampling technique was used. It involved taking the samples in different stages. The instrument for this research was Students' Interest in Biology Scale (SIBS). It was developed by the researcher. The SIBS consists of 17 items with four point likert scale; that is, Strongly agree (SA), Agree (A), Disagree (D) and Strongly disagree (SD). The weightings for the SIBS are as follows: for positive items, Strongly Agree (SA) is assigned 4 points, Agree (A) is assigned 3 points, Disagree (D) is assigned 2 points, and Strongly Disagree (SD) is assigned 1 point, while for negative items, the scoring is reversed.Trial test of the instrument was conducted to estimate the reliability index of the instrument using a school outside Wukari Education Zone. The aim was to ascertain the reliability index of the research instruments. Cronbach Alpha was used to test the reliability of the instruments because of its suitability for this purpose. The reliability index of the SIBS was found to be 0.839 which is above the threshold of 0.7 thus indicating that the instrument is reliable.

The data collected were subjected to analysis at two different levels, descriptive and inferential levels. At the descriptive level, the descriptive statistics of bar graph, mean and standard deviation were used to answer the research questions while the inferential statistics of Analysis of Covariance (ANCOVA) was used to test the hypotheses. The choice of ANCOVA for the test of the hypotheses is because of its power to take care of the initial lack of equivalence in the groups since intact classes were used and to ensure that initial group differences are taken care of statistically.

Results

Research Question One

What is the difference in mean interest ratings of varied ability students in biology in secondary schools when taught using outdoor laboratory pedagogy?

Table 1:

Mean Interest Ratings of Varied Ability Students in Biology Taught Using Outdoor Laboratory Pedagogy

Varied abilities		PreSIBS	PostSIBS	Mean gain
High Ability Student	Mean	2.33	3.10	0.77
	N	30	30	
	Std. Deviation	0.52	0.47	
Moderate Ability Student	Mean	2.45	3.11	0.66
	N	39	39	
	Std. Deviation	0.52	0.50	
Low Ability Student	Mean	2.26	3.12	0.86
	N	32	32	
	Std. Deviation	0.44	0.45	

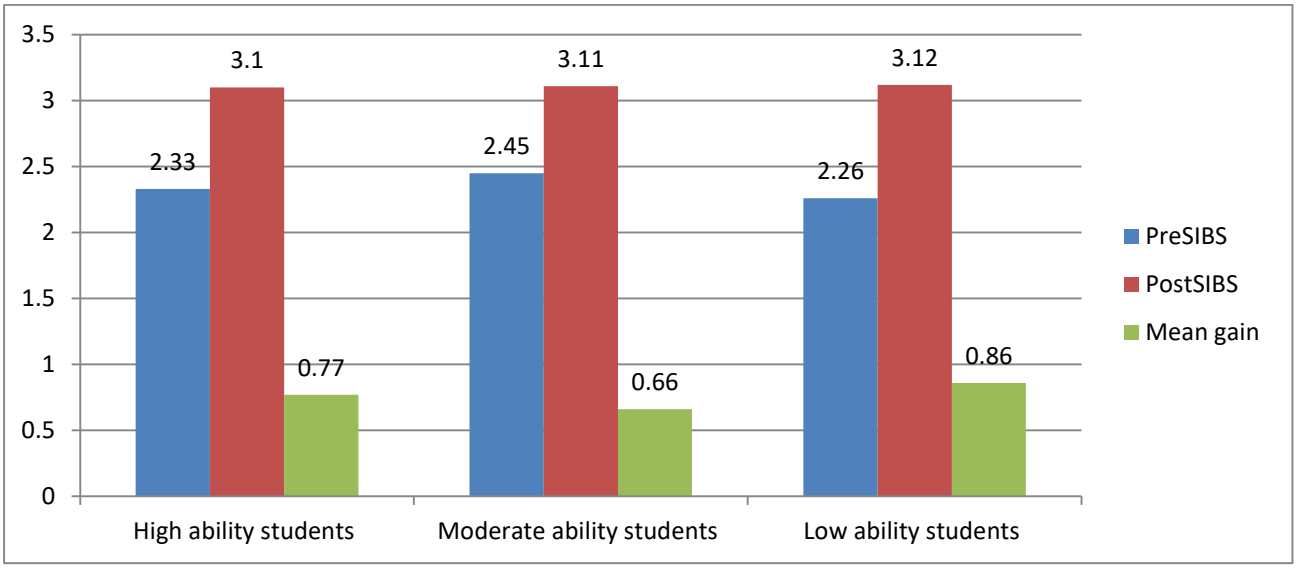

Figure 1: Pretest, Posttest and Mean Gain in Interest Ratings of Varied Ability Students in Biology Taught Using Outdoor Laboratory Pedagogy

Table 1 shows the mean interest ratings of varied ability students in biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy. The table shows that 30 high ability students, 39 moderate ability students and 32 low ability students were taught using outdoor laboratory pedagogy. The table shows that the mean interest ratings of high ability students is 2.33 (preSIBS) with a standard deviation of

0.52 in pre-test and 3.10 with a standard deviation of 0.47 in post test. The mean interest ratings of moderate ability students is 2.45 (preSIBS) with a standard deviation of 0.52 in pre-test and 3.11 with a standard deviation of 0.50 in post test. The mean interest ratings of low ability students is 2.26 (preSIBS) with a standard deviation of 0.44 in pre-test and 3.12 with a standard deviation of 0.45 in post test. Table 3 further shows that the mean gain in interest ratings for high ability students is 0.77 while that of moderate ability students is 0.66 and 0.86 for low ability students. The summary of the pretest, posttest and mean gain in interest of varied ability students in biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy is as shown in Figure 1

Research Question Two

What the difference in mean interest of varied ability students in biology in secondary schools when taught using indoor laboratory pedagogy?

Table 2:

Mean Interest Ratings of Varied Ability Students in Biology Taught Using Indoor Laboratory Pedagogy

Varied abilities		**PreSIBS**	**PostSIBS**	**Mean gain**
High Ability Student	Mean	2.12	3.20	1.08
	N	9	9	
	Std. Deviation	0.54	0.81	
Moderate Ability Student	Mean	2.19	3.00	0.81
	N	30	30	
	Std. Deviation	0.79	0.75	
Low Ability Student	Mean	2.09	3.41	1.32
	N	47	47	
	Std. Deviation	0.52	0.69	

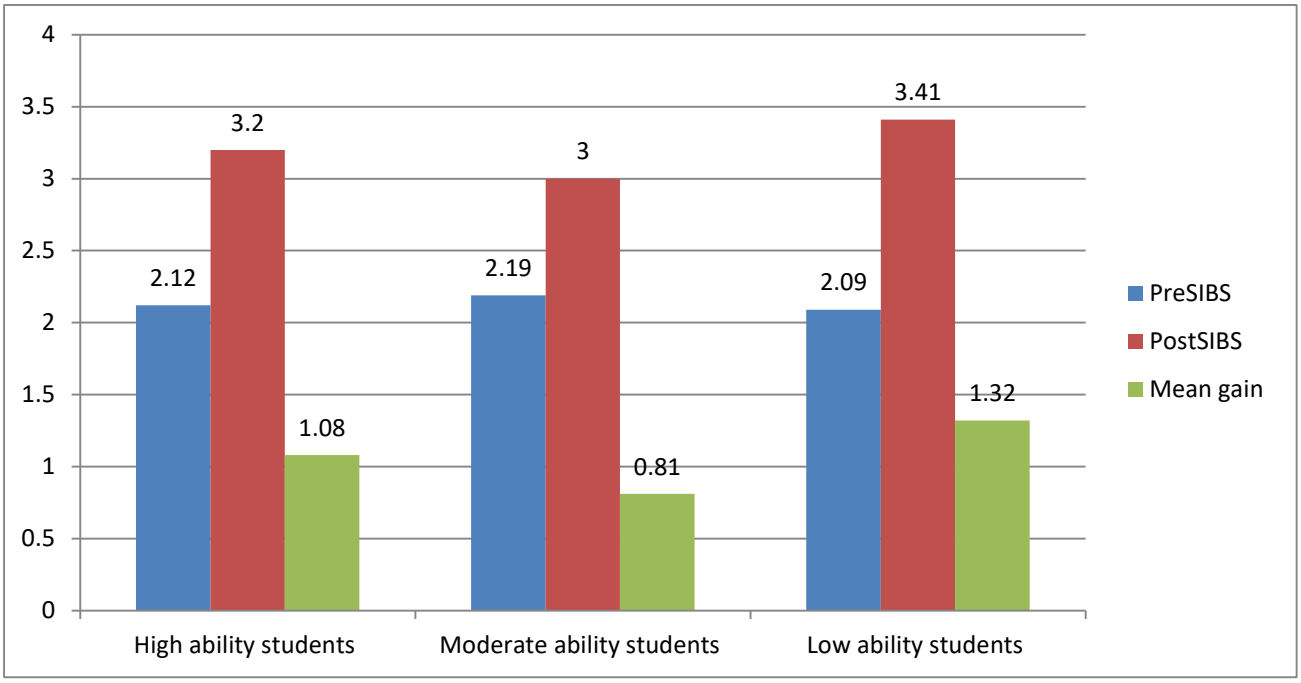

Figure 2: Pretest, Posttest and Mean Gain in Interest Ratings of Varied Ability Students in Biology Taught Using Indoor Laboratory Pedagogy

Table 2 shows the mean interest of varied ability students in biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy. The table shows that 9 high ability students, 30 moderate ability students and 47 low ability students were taught biology using indoor laboratory pedagogy. The table shows that the mean interest ratings of high ability students is 2.12 (preSIBS) with a standard deviation of 0.54 in pre-test and 3.20 with a standard deviation of 0.81 in posttest. The mean interest ratings of moderate ability students is 2.19 (preSIBS) with a standard deviation of 0.79 in pre-test and 3.00 with a standard deviation of 0.75 in posttest. The mean interest ratings of low ability students is 2.09(preSIBS) with a standard deviation of 0.52 in pre-test and 3.41 with a standard deviation of 0.69 in posttest. Table 4 further shows that the mean gain in interest ratings for high ability students is 1.08 while that of moderate ability students is 0.81 and 1.32 for low ability students. The summary of the pretest, posttest and mean gain in interest of varied ability students in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy is as shown in Figure 2.

Research Question Three

What is the difference in mean interest of male students of varied ability in Biology in secondary schools when taught using indoor laboratory pedagogy?

Table 3:
Mean Interest Ratings of Male Students of Varied Ability in Biology Taught Using Indoor Laboratory Pedagogy

Varied abilities		PreSIBS	PostSIBS	Mean gain
High Ability Student	Mean	1.83	3.64	1.81
	N	5	5	
	Std. Deviation	0.31	0.36	
Moderate Ability Student	Mean	2.39	2.82	0.43
	N	14	14	
	Std. Deviation	0.86	0.84	
Low Ability Student	Mean	2.05	3.42	1.37
	N	25	25	
	Std. Deviation	0.48	0.67	

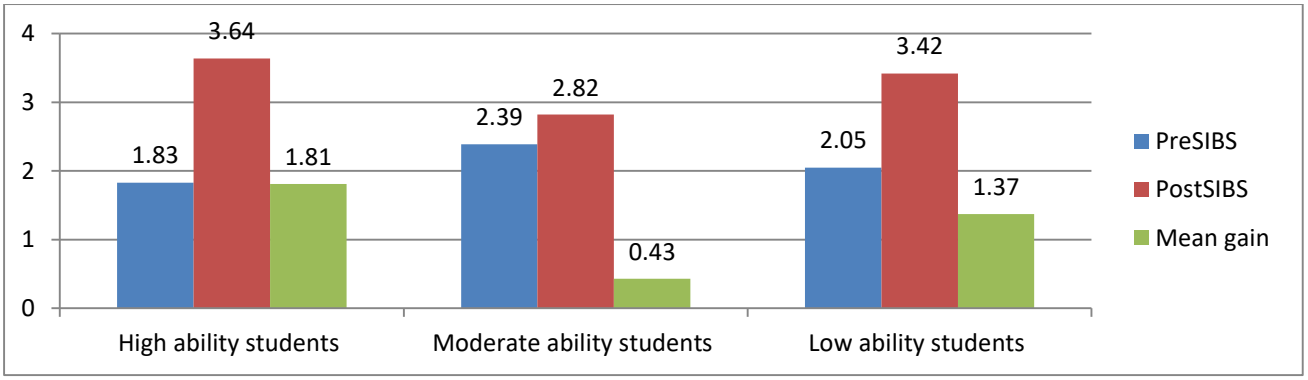

Figure 3: Pretest, Posttest and Mean Gain in Interest Ratings of Male Students of Varied Ability in Biology Taught Using Indoor Laboratory Pedagogy

Table 3 shows the mean interest of male students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy. The table shows that 5 male students of high ability, 14 male students of moderate ability and 25 male students of low ability were taught Biology using indoor laboratory pedagogy. The table shows that the mean interest ratings of male students of high ability is 1.83(preSIBS) with a standard deviation of 0.31 in pre-test and 3.64 with a standard deviation of 0.36 in post test. The mean interest ratings of male students of moderate ability is 2.39(preSIBS) with a standard deviation of 0.86 in pre-test and 2.82 with a standard deviation of 0.84 in post test. The mean interest ratings of male students of low ability students is 2.05(preSIBS) with a standard deviation of 0.48 in pre-test and 3.42 with a standard deviation of 0.67 in post test. Table 5 further shows that the mean gain in interest ratings for male students of high ability students is 1.81 while that of male students of moderate ability students is 0.43 and 1.37 for male students of low ability students. The summary of the pretest, posttest and mean gain in interest of male students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy is as shown in Figure 3.

Research Question Four
What is the difference in mean interest of female students of varied ability in Biology in

secondary schools when taught using indoor laboratory pedagogy?

Table 4:
Mean Interest Rating of Female Students of Varied Ability in Biology Taught Using Indoor Laboratory Pedagogy

Varied abilities		PreSIBS	PostSIBS	Mean gain
High Ability Student	Mean	2.48	2.66	0.18
	N	4	4	
	Std. Deviation	0.59	0.92	
Moderate Ability Student	Mean	2.03	3.13	1.10
	N	15	15	
	Std. Deviation	0.73	0.67	
Low Ability Student	Mean	2.12	3.39	1.27
	N	23	23	
	Std. Deviation	0.57	0.71	

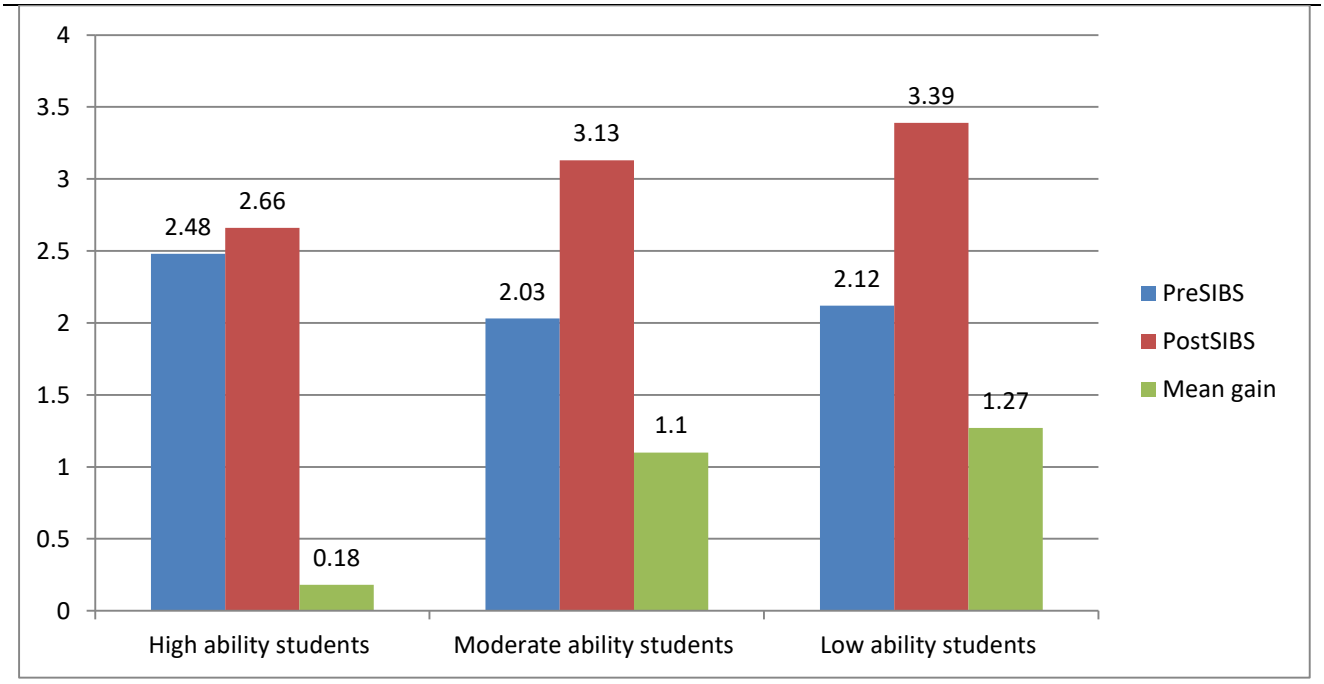

Figure 4: Pretest, Posttest and Mean Gain in Interest of Female Students of Varied Ability in Biology Taught Using Indoor Laboratory Pedagogy

Table 4 shows the mean interest of female students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy. The table shows that 4 female students of high ability, 15 female students of moderate ability and 23 female students of low ability were taught Biology using indoor laboratory pedagogy. The table shows that the mean interest ratings of female students of high ability is 2.48 (preSIBS)with a standard deviation of 0.59 in pre-test and 2.66 with a standard deviation of 0.92 in post test. The mean interest ratings of female students of moderate ability is 2.03(preSIBS) with a standard deviation of 0.73 in pre-test

and 3.13 with a standard deviation of 0.67 in post test. The mean interest ratings of female students of low ability students is 2.12 (preSIBS)with a standard deviation of 0.57 in pre-test and 3.39 with a standard deviation of 0.71 in post test. Table 6 further shows that the mean gain in interest ratings for female students of high ability students is 0.18 while that of female students of moderate ability students is 1.10 and 1.27 for female students of low ability students. The summary of the pretest, posttest and mean gain in interest of female students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy is as shown in Figure 4.

Research Question Five

What is the difference in mean interest of male students of varied ability in Biology in secondary schools when taught using outdoor laboratory pedagogy?

Table 5

Mean Interest Rating of Male Students of Varied Ability in Biology Taught Using Outdoor Laboratory Pedagogy

Varied abilities		PreSIBS	PostSIBS	Mean gain
High Ability Student	Mean	2.23	3.47	1.24
	N	20	20	
	Std. Deviation	0.12	0.72	
Moderate Ability Student	Mean	2.17	3.13	0.96
	N	20	20	
	Std. Deviation	0.21	0.44	
Low Ability Student	Mean	2.39	3.15	0.76
	N	18	18	
	Std. Deviation	0.57	0.42	

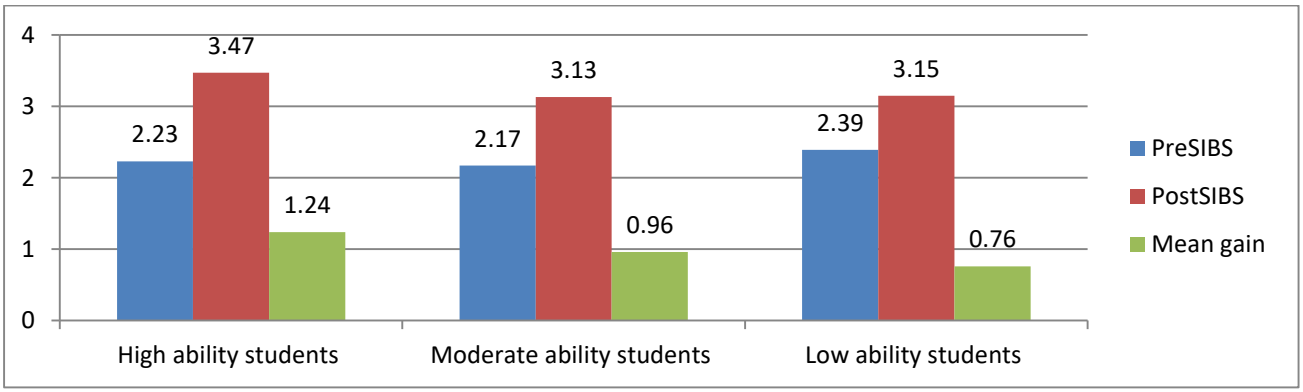

Figure 5: Pretest, Posttest and Mean Gain in Interest of Male Students of Varied Ability in Biology Taught Using Outdoor Laboratory Pedagogy

Table 5 shows the mean interest of male students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy. The table shows that 20 male students of high ability, 20 male students of moderate ability and 18 male students of low ability were taught Biology using outdoor laboratory pedagogy. The table shows that the mean interest ratings of male students of high

ability is 2.23(preSIBS) with a standard deviation of 0.12 in pre-test and 3.47 with a standard deviation of 0.72 in post test. The mean interest ratings of male students of moderate ability is 2.17(preSIBS) with a standard deviation of 0.21 in pre-test and 3.13 with a standard deviation of 0.44 in post test. The mean interest ratings of male students of low ability students is 2.39(preSIBS) with a standard deviation of 0.57 in pre-test and 3.15 with a standard deviation of 0.42 in post test.

Table 7 further shows that the mean gain in interest ratings for male students of high ability students is 1.24 while that of male students of moderate ability students is 0.96 and 0.76 for male students of low ability students. The summary of the pretest, posttest and mean gain in interest of male students of varied ability in biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy is as shown in Figure 5.

Research Question Six

What is the difference in mean interest of female students of varied ability in Biology in secondary schools when taught using outdoor laboratory pedagogy?

Table 6

Mean Interest Rating of Female Students of Varied Ability in Biology Taught Using Outdoor Laboratory Pedagogy

Varied abilities		PreSIBS	PostSIBS	Mean gain
High Ability Student	Mean	2.57	3.09	0.52
	N	10	10	
	Std. Deviation	0.62	0.51	
Moderate Ability Student	Mean	2.48	3.10	0.62
	N	18	18	
	Std. Deviation	0.60	0.49	
Low Ability Student	Mean	2.40	2.98	0.58
	N	15	15	
	Std. Deviation	0.57	0.43	

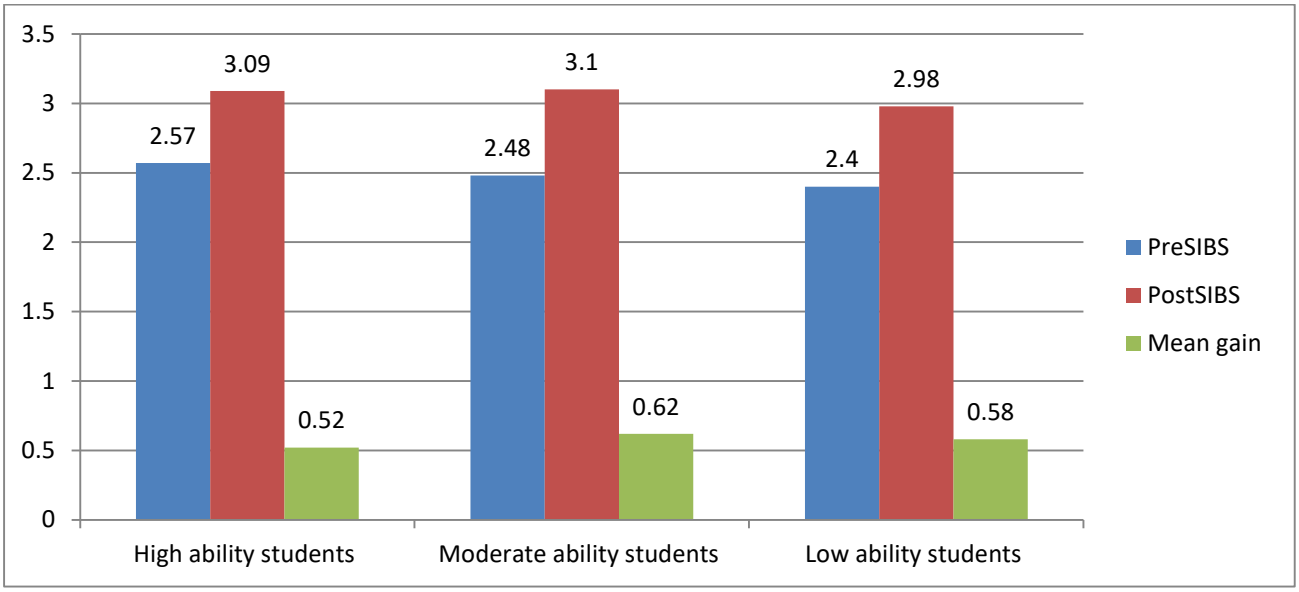

Figure 6: Pretest, Posttest and Mean Gain in Interest of Female Students of Varied Ability in Biology Taught Using Outdoor Laboratory Pedagogy

Table 6 shows the mean interest of female students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy. The table shows that 10 female students of high ability, 18 female students of moderate ability and 15 female students of low ability were taught Biology using outdoor laboratory pedagogy. The table shows that the mean interest ratings of female students of high ability is 2.57(preSIBS) with a standard deviation of 0.62 in pre-test and 3.09 with a standard deviation of 0.51 in posttest. The mean interest ratings of female students of moderate ability is 2.48 (preSIBS)with a standard deviation of 0.60 in pre-test and 3.10 with a standard deviation of 0.49 in post test. The mean interest ratings of female students of low ability students is 2.40(preSIBS) with a standard deviation of 0.57 in pre-test and 3.98 with a standard deviation of 0.43 in post test. Table 8 further shows that the mean gain in interest ratings for female students of high ability students is 0.52 while that of female students of moderate ability students is 0.62 and 0.58 for female students of low ability students. The summary of the pretest, posttest and mean gain in interest of female students of varied ability in biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy is as shown in Figure 6.

Hypothesis One

There is no significant difference in the mean interest Rating of varied ability students in Biology in secondary schools when taught using outdoor laboratory pedagogy.

Table 7

ANCOVA of Interest Rating of Varied Ability Students in Biology When Taught Using Outdoor Laboratory Pedagogy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.904[a]	3	.301	1.335	.268	.040
Intercept	53.590	1	53.590	237.300	.000	.710
PreSIBS	.900	1	.900	3.984	.049	.039
Ability	.024	2	.012	.052	.949	.001
Error	21.906	97	.226			
Total	1001.497	101				
Corrected Total	22.810	100				

a. R Squared = .040 (Adjusted R Squared = .010)

Table 7 shows that F(2,97) = 0.052; p = 0.949 > 0.05. Thus, the null hypothesis is not rejected. This implies that there is no significant difference in the mean interest of varied ability students in biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy. The partial eta square of 0.001 obtained for abilities means that only 0.1 percent of mean interest ratings of students in Biology is accounted for by their ability in outdoor laboratory pedagogy class.

Hypothesis Two

There is no significant difference in the mean interest of varied ability students in Biology in secondary schools when taught using indoor laboratory pedagogy.

Table 8

ANCOVA of Interest Rating of Varied Ability Students in Biology When Taught Using Indoor Laboratory Pedagogy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	30.005[a]	3	10.002	48.080	.000	.638
Intercept	169.758	1	169.758	816.047	.000	.909
PreSIBS	26.909	1	26.909	129.355	.000	.612
Ability	1.890	2	.945	4.543	.013	.100
Error	17.058	82	.208			
Total	954.139	86				
Corrected Total	47.063	85				

a. R Squared = .638 (Adjusted R Squared = .624)

Table 8 shows that F(2,82) = 4.543; p = 0.013 < 0.05. Thus, the null hypothesis is

rejected. This implies that there is significant difference in the mean interest of varied ability students in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy. The partial eta square of 0.100 obtain for abilities means that 10.0 percent of mean interest ratings of students in Biology is accounted for by their ability in indoor laboratory pedagogy class.

Table 9

Pairwise Comparisons of Interest of Varied Ability Students in Biology when taught using Indoor Laboratory Pedagogy

(I) Varied ability students in indoor laboratory pedagogy	(J) Varied ability students in indoor laboratory pedagogy	Mean Difference (I-J)	Std. Error	Sig.[b]
High Ability Student	Moderate Ability Student	.143	.173	1.000
	Low Ability Student	-.177	.166	.867
Moderate Ability Student	Low Ability Student	-.320*	.107	.011

Table 9 shows the pairwise comparisons of interest of varied ability students in biology when taught using indoor laboratory pedagogy at P = 1.000 > 0.05 for high ability students and moderate ability students. Again, pairwise comparisons of interest of varied ability students in biology when taught using indoor laboratory pedagogy at P = 0.867 > 0.05 for high ability students and low ability students. However, pairwise comparisons of interest of varied ability students in biology when taught using indoor laboratory pedagogy at P = 0.011 < 0.05 for moderate ability students and low ability students. The null hypothesis is therefore rejected. Therefore, the rejected null hypothesis is confirmed and upheld. This implies that there is significant difference in the mean interest of varied ability students in biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy.

Hypothesis Three

There is no significant difference in the mean interest of male students of varied ability in Biology when taught using indoor laboratory pedagogy.

Table 10:

ANCOVA of Interest Rating of Male Students of Varied Ability in Biology When Taught Using Indoor Laboratory Pedagogy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	15.915[a]	3	5.305	24.053	.000	.643
Intercept	83.754	1	83.754	379.732	.000	.905
PreSIBS	11.885	1	11.885	53.888	.000	.574
Ability	.845	2	.423	1.916	.160	.087
Error	8.822	40	.221			
Total	492.417	44				
Corrected Total	24.738	43				

a. R Squared = .643 (Adjusted R Squared = .617)

Table 10 shows that F(2,40) = 1.916; p = 0.160 > 0.05. Thus, the null hypothesis is not rejected. This implies that there is no significant difference in the mean interest of male students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy. The partial eta square of 0.087 obtained for abilities means that 8.7 percent of mean interest ratings of male students of varied ability in biology is accounted for by their ability in indoor laboratory pedagogy class.

Hypothesis Four

There is no significant difference in the mean interest of female students of varied ability in Biology in secondary schools when taught using indoor laboratory pedagogy.

Table 11

ANCOVA of Interest Rating of Female Students of Varied Ability in Biology When Taught Using Indoor Laboratory Pedagogy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	14.447[a]	3	4.816	23.270	.000	.648
Intercept	72.079	1	72.079	348.289	.000	.902
PreSIBS	12.367	1	12.367	59.757	.000	.611
Ability	1.373	2	.686	3.317	.047	.149
Error	7.864	38	.207			
Total	461.721	42				
Corrected Total	22.311	41				

a. R Squared = .648 (Adjusted R Squared = .620)

Table 11 shows that F(2,38) = 3.317; p = 0.047 < 0.05. Thus, the null hypothesis is rejected. This implies that there is significant difference in the mean interest of female students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy. The partial eta square of 0.149 obtain for abilities means that 14.9 percent of mean interest ratings of female students of varied ability in Biology is accounted for by their ability in indoor laboratory pedagogy class.

Table 12

*Pairwise Comparisons of **I**nterest of Female Students of Varied Ability in Biology when Taught Using Indoor Laboratory Pedagogy*

(I) Varied ability female students in indoor laboratory pedagogy	(J) Varied ability female students in indoor laboratory pedagogy	Mean Difference (I-J)	Std. Error	Sig.[a]
High Ability Student	Moderate Ability Student	-.074	.261	1.000
	Low Ability Student	-.420	.250	.304
Moderate Ability Student	Low Ability Student	-.345	.151	.084

Table 12 shows the pairwise comparisons of interest of female students of varied ability in biology when taught using indoor laboratory pedagogy at P = 1.000 > 0.05 for high ability students and moderate ability students. Again, pairwise comparisons of interest of female students of varied ability in biology when taught using indoor laboratory pedagogy at P = 0.304 > 0.05 for high ability students and low ability students. Similarly, pairwise comparisons of interest of female students of varied ability in biology when taught using indoor laboratory pedagogy at P = 0.084 > 0.05 for moderate ability students and low ability students. The null hypothesis is therefore rejected. Therefore, the rejected null hypothesis is confirmed and upheld. This implies that there is significant difference in the mean interest of female students of varied ability in biology in secondary schools in Wukari Education Zone of Taraba State when taught using indoor laboratory pedagogy.

Hypothesis Five

There is no significant difference in the mean interest of male students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy.

Table 13

ANCOVA of Interest Rating of Male Students of Varied Ability in Biology When Taught Using Outdoor Laboratory Pedagogy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.102[a]	3	.367	1.623	.195	.083
Intercept	23.072	1	23.072	101.977	.000	.654
PreSIBS	.672	1	.672	2.972	.090	.052
Ability	.321	2	.161	.710	.496	.026
Error	12.217	54	.226			
Total	589.643	58				
Corrected Total	13.319	57				

a. R Squared = .083 (Adjusted R Squared = .032)

Table 13 shows that F(2,54) = 0.710; p = 0.496 > 0.05. Thus, the null hypothesis is not rejected. This implies that there is no significant difference in the mean interest of male students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy. The partial eta square of 0.026 obtained for abilities means that 2.6 percent of mean interest ratings of male students of varied ability in Biology can be attributed to their ability in outdoor laboratory pedagogy class.

Hypothesis Six

There is no significant difference in the mean interest of female students of varied ability in Biology in secondary schools when taught using outdoor laboratory pedagogy.

Table 14

ANCOVA of Rating Interest of Female Students of Varied Ability in Biology When Taught Using Outdoor Laboratory Pedagogy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.320[a]	3	.107	.464	.709	.034
Intercept	24.833	1	24.833	108.084	.000	.735
PreSIBS	.187	1	.187	.813	.373	.020
Ability	.160	2	.080	.347	.709	.017
Error	8.960	39	.230			
Total	411.854	43				
Corrected Total	9.280	42				

a. R Squared = .034 (Adjusted R Squared = -.040)

Table 14 shows that F(2,39) = 0.347; p = 0.709 > 0.05. Thus, the null hypothesis is not rejected. This implies that there is no significant difference in the mean interest of female students of varied ability in Biology in secondary schools in Wukari Education Zone of Taraba State when taught using outdoor laboratory pedagogy. The partial eta square of 0.017 obtain for abilities means that 1.7 percent of mean interest ratings of female students of varied ability in biology can be attributed to their ability in outdoor laboratory pedagogy class.

Discussion

This study investigated the effects of laboratory pedagogies on interest in biology among varied-ability students of secondary schools in Taraba State, Nigeria. The sample comprised male and female students of varied abilities, and gender-based ability level was incorporated as a moderator variable. The mean gain in interest ratings for high-ability students was 0.77, while that of moderate-ability students was 0.66, and 0.86 for low-ability students. There was no significant difference in the mean interest of varied-ability students in biology when taught using outdoor laboratory pedagogy (P=0.949>0.05). This means that the effect of outdoor laboratory pedagogy on students' interest in Biology was not significant. The reason for the effect not being significant may be that the facilities supplied were inadequate or that the teachers employed needed more training to be more effective. Again, the reason for its not being significant may be that there are more distractions in outdoor pedagogies than that indoors. It could also be caused by the ability groupings of the students into high, moderate and low groups/categories. Such grouping may have adverse effect on some students psychologically and so may negatively affect their interest in the subject. This opinion is also supported by the critics of the ability grouping of students. The critics argue that ability grouping can lead to stigmatization and perpetuate existing inequalities (Dathe, 2017). Research has shown that ability grouping can have negative consequences, particularly for students from low-income backgrounds (Ladson-Billings, 2020). Also, although the effect was not significant, yet there were some measures of effects that improved the interest of the students in Biology to some extent. These are expressed in the mean gains in interest in Biology of the various categories (abilities) of students: high ability (outdoor laboratory pedagogy, 0.77); moderate ability (outdoor laboratory pedagogy, 0.66); low ability (outdoor laboratory pedagogy, 0.86). Thus the use of outdoor laboratory pedagogy if effectively managed is ability-friendly with reference to interest in biology of varied-ability students. It is thus expected that if handled with a greater degree of efficiency, the effect of outdoor

laboratory pedagogy may be significant in the near future.

The mean gain in interest ratings for high-ability students was 1.08, while that of moderate-ability students was 0.81 and 1.32 for low-ability students. There was a significant difference in the mean interest of varied-ability students in biology when taught using indoor laboratory pedagogy ($p=0.013<0.05$). The effect this time is significant. This is in line with the opinion of Uyulgan, 2022 who asserted that using activity-based instructional strategies can arouse and sustain students' interest in learning. The reason for this significant effect may be that there are less distractions indoors than outdoors and this may have enhanced the concentration of the students on what is being taught. This implies that the use of indoor laboratory pedagogy is ability-friendly with reference to interest in biology of varied-ability students.

The mean gain in interest ratings for male students of high-ability was 1.81, while that of male students of moderate-ability was 0.43, and 1.37 for male students of low-ability. There was no significant difference in the mean interest of male students of varied ability in biology when taught using indoor laboratory pedagogy ($p=0.160>0.05$). The effect is not significant. The reason may be that the indoor laboratory facilities were either inadequate or somewhat obsolete or that the teachers needed more training to be more effective. It may also be to the negative psychological effect that ability groupings may have on students for being forced to be in some groups based on their abilities and as such denied their desire to interact with some of their colleagues. This finding is supported by critics of the ability grouping such as Dathe (2017) and Ladson-Billings (2020) as mentioned earlier. Dathe (2017) argued that ability grouping can lead to stigmatization and perpetuate existing inequalities while Ladson-Billings (2020) argued from research findings that ability grouping can have negative consequences, particularly for students from low-income backgrounds.

On the other hand, the mean gain in interest ratings for female students of high-ability was 0.18, while that of female students of moderate-ability was 1.10 and 1.27 for female students of low-ability. There was a significant difference in the mean interest of female students of varied ability in biology when taught using indoor laboratory pedagogy ($p=0.047<0.05$). Again, because the effect on interest is significant the reason may be that there is less distraction indoors than outdoors and also, sometimes the teachers' experience may result in a better control of the classroom and make students listen more attentively than otherwise. This finding also agrees with the opinion of Akinbola (2020) who posits that for effective Biology teaching, strategies that utilize the environment can help students grasp concepts more effectively. In this case the indoor environment is utilized. The finding is also supported by Uyulgan (2022) who asserted that activity-based instructional strategies can arouse and sustain students' interest in learning.

Furthermore, the mean gain in interest ratings for male students of high-ability was 1.24, while that of male students of moderate-ability was 0.96, and 0.76 for male students of low-ability. There was no significant difference in the mean interest of male students of varied ability in biology when taught using outdoor laboratory pedagogy ($p=0.496>0.05$). The reasons adduced for outdoor pedagogies earlier assumed may be the same reasons in this case. However, though the effect of the outdoor pedagogy was not significant, yet there were gains made by enhancing the interest of the different categories (abilities) of male students in Biology (high ability, 1.84; moderate ability, 0.96; low ability, 0.76). It is expected that with a more efficient utilization of the outdoor pedagogy, its effect on the interest of male students may be significant. The mean gain in interest ratings for female students of high-ability was 0.52, while that of female students of moderate-ability was 0.62 and 0.58 for female students of low-ability. There was no significant difference in the mean interest of female students of varied ability in biology

when taught using outdoor laboratory pedagogy (0.709>0.05). Also, the earlier reasons already provided for outdoor pedagogies may be responsible for this result. There were however some gains made by using this pedagogical approach. The interest in Biology of the female students of varied abilities was increased to some extent (high ability, 0.52; moderate ability, 0.62; low ability, 0.58). With more efficient management, it is expected that the result may be significant in the near future.

The study's findings have significant educational implications. The use of indoor laboratory pedagogies can promote inclusive education and increase interest in biology among students of varied abilities if effectively and efficiently managed by providing more and better facilities and more experienced and better trained teachers. Teachers may use these pedagogies to address gender disparities in interest in biology. Professional development for teachers and a review of the biology curriculum are also recommended to ensure effective implementation of these pedagogies.

Conclusions and Recommendations

Based on the outcome of the study, it can be concluded that the use of indoor laboratory pedagogy is very effective for the teaching of Biology in secondary schools and it is also gender friendly. Furthermore, students with varied abilities can be taught effectively using this instructional strategy. As such, if teachers of Biology can adopt the use of indoor laboratory pedagogy to teach learners of the subject it will make them to have a real life experience of what science is all about, and particularly Biology, thereby enhancing students' interest in the subject.

Based on the findings the study recommends as follows:

1. School supervisors and Heads of schools should ensure that the use of indoor Laboratory pedagogy is encouraged and recommended in all schools for the effective implementation of the Biology curriculum with regular supervision and monitoring.
2. Ministry of Education and school proprietors should ensure that Biology teachers are trained to use modern effective teaching methods especially indoor Laboratory pedagogies through sponsorship to workshops, seminars and even further trainings.
3. Since indoor Laboratory pedagogy has been proven to enhance students' interest in Biology, teachers of Biology should give students enough opportunity to explore divers practical activities in the indoor laboratories as this will enable them develop scientific skills.
4. There should be provision of all the necessary teaching materials especially practical facilities in Biology indoor laboratories for effective teaching and learning.
6. Biology teachers should endeavor to give female and male students equal opportunities in the classroom especially during indoor laboratory lessons.

References

Akebukola (2022). Corporate Interest and Professional Journal in Extensive Experience in Financial Analysis, Interest Modelling. Internet Society Nigeria Chapter htpp/soc.ng

Akinbola, A. (2020). The role of Biology Education in Promoting Environmental Awareness. *Journal of Education and Human Development*, 9(2), 1-9.

Hills, PJ, Seib, E, Pleva, M, Smythe, J, Gosling, MR, & Cole, T. (2020). Consent, wantedness, and pleasure: Three dimensions affecting the perceived stress of and judgements of rape in sexual encounters. J Exp Psychol Appl. 26(1):171-197. doi: 10.1037/xap0000221.

Kidd, D., Sanchez, T., & Thorius, K. K. (2020). The case for heterogeneous grouping in middle grades. *Middle School Journal*, 51(4), 14-23.

Kilpatrick, J., Swafford, J., & Findell, B. (2017). Adding it up: Helping children understand math. National Academies Press.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2017). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, 52(2), 75-86.

Ladson-Billings, G. (2020). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice*, 59(2), 147-155.

NPE (2019) National Policy on Education Seeks To Fulfill The Role Of The Government on Educational Policy.http/ubgtdes,World Bank Org.pdf.4mg

Dathe S. J. (2017). Keeping track: How schools structure inequality. Teachers College Press.

Okebukola, P. A. (2022). The importance of biology education in the 21st century. *Journal of Science Education*, 23(1), 1-8.

Santos, R. G. (2020). Outdoor laboratory instructions: A key to effective science education. *Journal of Science and Mathematics Education*, 14(1), 1-10.

Santos, (2020). The study of Investigation of Interest in the context of digital Teacher Education Institute (TEI) during Covid-19 Pandemic. https/www.scnp.org

Subotnik, R. F., Olszewski-Kubilius, P., & Worrell, F. C. (2017). Rethinking giftedness and gifted education: A proposed direction forward. *Gifted Child Quarterly*, 61(1), 3-13.

Uyulgan, M. A. (2022). The role of science education in promoting critical thinking and creativity. *Journal of Science and Mathematics Education*, 16(1), 1-12.