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Effects of Microscopes and Microbes Simulation Kits on Biology Students' Academic Performance in Uruan Local Government Area, Akwa Ibom State, Nigeria

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ABSTRACT: *This study investigated the effect of microscope and microbes simulation kit on students' academic performance in Biology in Uruan Local Government Area, Akwa Ibom State, Nigeria. Three research questions were raised and three null hypotheses were stated to guide the study. Quasi experimental research design was adopted in the study. Specifically, pre-test, posttest nonequivalent control group design consisting of two experimental groups and one control group was used. The study was conducted in six co-educational public schools in Uruan Local Government Area. A sample of 264 Senior Secondary I Biology students in their intact classes from a population of 3074 students. The intact classes were randomly assigned into two experimental groups and one control group respectively based on location of school. Students in experimental group 1 were taught the concept of microorganism using microscope; students in experimental group 2 were taught using microbes simulation kit while students in control group were taught without instructional material. A researcher-made instrument titled Biology Test on Microorganism with reliability coefficient of 0.87 was used for data collection. Data collected were analyzed using mean, standard deviation and analysis of covariance (ANCOVA). Mean and standard Deviation were used to answer research questions while ANCOVA was used to test hypotheses at 0.05 level of significance. Findings showed that students taught microorganisms using microscope as well as microbes simulation kit had higher mean performance scores than those taught without instructional material. Gender was not a significant factor in determining Biology students' performance and retention. Furthermore, there was a significant interaction effect of gender and instructional material on students' performance. Based on the findings, it was concluded that although students taught using microscope performed slightly higher than those taught using microscopes simulation kit; both microscope and microbes simulation kit were effective in enhancing students' performance in the concept of microorganisms in Biology irrespective of gender.*

KEYWORDS: Microscope, Microbes Simulation Kit**,** Academic Performance

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INTRODUCTION

Education is commonly acknowledged as an indispensable tool for societal advancement; it encompasses systematically developing or training the mind, capabilities, and character through instruction (Federal Republic of Nigeria, FRN, 2013). According to Akpan (2016), achieving a knowledge-based economy requires a paradigm shift from the current time-based model of education to a lifelong model. This new model, based on scientific principles, aims to equip learners with the ability to effectively create, acquire, use, and transmit knowledge to promote human activities in a knowledge-dominated society. Science, recognized as an exciting and enriching pursuit demanding creativity, skill, and insight, plays a pivotal role in driving progress across economic, social, cultural, technological, and scientific realms (Igwe, 2013). Consequently, there has been a heightened emphasis on science education, as it is widely understood that no nation can thrive without it (Baba, 2017)

Science education, the dissemination of scientific knowledge, holds paramount importance. The National Policy on Education by the Federal Republic of Nigeria underscores this, delineating goals such as producing scientists vital for national development and imparting understanding of the complexities of the physical world and life's phenomena (FRN, 2013). According to Akpan 2018, science education research, innovation and practices must adapt to society's needs and aspirations, reflecting its vision. They should reflect the science that citizens and society need and support people of all ages and talent in developing positive attitudes to science. A move from a focus on more skill based education towards a more comprehensive notion of science education has resulted in competencies based on approach which should be the foundation in science learning (Akpan, 2017). Central to science education are fundamental disciplines like Physics, Chemistry, Mathematics, and Biology, with Biology occupying a significant place in senior secondary school curricula in Nigeria.

Biology, known as the life science, encompasses the study of living organisms and their various aspects, including structure, function, growth, evolution, distribution, identification, and taxonomy. Traditionally, it is categorized into botany (the study of plants) and zoology (the study of animals), with further divisions such as morphology, anatomy, physiology, ecology, genetics, and evolution (Miller & Levine, 2012). As a core subject taught in senior secondary schools, Biology holds a pivotal position in the curriculum. The secondary school Biology curriculum in Nigeria is designed to equip students with laboratory and field skills, as well as meaningful knowledge in Biology. Moreover, it aims to enable students to apply scientific knowledge to everyday life, addressing personal, community, health, and agricultural matters (FRN, 2013). Biology's significance extends across various domains of human activity. It plays an indispensable role in fields like medicine, pharmacy, agriculture, brewing, geology and nursing. Additionally, Biology contributes to addressing challenges such as health, hygiene, food scarcity, poverty

eradication, and the management and conservation of natural resources (Dorji, 2022). In summary, Biology serves as a cornerstone in education and societal development, fostering both individual understanding and collective progress through its diverse applications and insights into the natural world.

Developing a comprehensive understanding of biological concepts is vital for students to effectively navigate the complexities of the living world. This understanding not only enables them to contribute actively to environmental sustainability and engage in scientific research but also empowers them to make informed decisions in an increasingly intricate biological landscape (Abidoye, Aliyu, Ahmed & Oluwole, 2022). Consequently, there has been significant emphasis on instruction, particularly at the secondary school level, aimed at ensuring comprehension of the principles and objectives outlined in the National Policy on Education (FRN, 2013). However, students often encounter difficulties in grasping Biological concepts (Abakpa, Achor & Odoh, 2016). For instance, many students resort to memorizing complex terminology to understand topics, which can detract from the overall learning experience. Certain Biology topics, particularly those involving the description of unseen phenomena or abstract concepts, pose significant challenges for students (Aladejana & Aderibigbe, 2017). These topics, such as genetics, microorganisms, evolution, and physiology, are perceived as abstract and difficult to comprehend, often requiring additional effort for mastery (WAEC Chief Examiner's Report, 2020). Research indicates that concepts related to microorganisms are particularly difficult for Biology students (Aladejana & Aderibigbe, 2017). Some students view the concept of microorganisms as abstract, boring, and overly technical, believing that success hinges solely on rote memorization (Aladejana & Aderibigbe, 2017). Despite these challenges, understanding microorganisms is crucial for students' daily lives, as well as for parents and society at large.

Microorganisms, commonly referred to as microbes, are minute life forms abundant in nature, profoundly impacting humans in both beneficial and detrimental ways. While they can invade the bodies of hosts, including humans, animals, and plants, causing infectious or non-infectious diseases, they also play vital roles in various ecological processes. Microbes are known to contribute to chronic non-infectious diseases, such as certain cancers and coronary heart disease, alongside infectious diseases like influenza, measles, typhoid, dysentery, hepatitis, and cholera (World Health Organization [WHO], 2024). The 2019 Covid-19 pandemic, caused by the Coronavirus, starkly illustrated the negative repercussions of microbial outbreaks, affecting global health and well-being, leading to millions of deaths, and disrupting educational systems worldwide (WHO, 2024).

Conversely, in their natural environments, microorganisms provide invaluable benefits to humans, plants, and animals. Microbes, particularly bacteria and fungi, play essential roles in cycling essential elements like carbon, nitrogen, oxygen, sulfur, and phosphorus, facilitating their availability for life forms (Fuerst 2019). They contribute significantly to the decomposition of

organic matter and the release of carbon dioxide into the atmosphere, crucial for photosynthesis carried out by plants and algae (Fuerst 2019). Additionally, microorganisms aid in nitrogen fixation, converting atmospheric nitrogen into forms usable by plants and animals (Maraz and Khan 2021). Furthermore, microbes are extensively utilized in the production of various food products, beverages, medicines, vaccines, vitamins, enzymes, and other essential products (Maraz and Khan 2021). Generally, microorganisms serve as indispensable agents in sustaining life on earth.

Given the critical importance of understanding microorganisms especially in the preservation of health and the continuity of human existence, it is essential for students to grasp this topic effectively. However, teachers often avoid teaching it due to its perceived complexity, and students struggle with it because they find it difficult, abstract, and uninteresting, resulting in poor performance in external examinations. Statistics from the West African Examination Council (WAEC) reveal consistently low performance in Biology over several years. For example, in the May/June examinations from 2011 to 2016, the percentage of students achieving credit-level passes or higher ranged from 35.66% to 56.17%, with failure rates ranging from 43.83% to 64.34% (WAEC, 2011-2016). Moreover, from 2016 to 2020, WAEC reports showed no record of a 50% pass rate in Biology, with raw mean scores ranging from 30 to 31 and standard deviations indicating poor performance. The Chief Examiner's report for 2021 highlighted that none of the previous five years' results achieved an excellent pass rate in Biology, particularly emphasizing questions on microorganisms (WAEC, 2021).

Students' poor performance in Biology examination can be attributed to inadequate instructional delivery, insufficient laboratory facilities, and large class sizes among others (Abidoye et al, 2023). Ineffective teaching methods, especially in abstract concepts have also been identified as a contributing factor to poor academic performance (Edet, 2017). Mastery of such concepts often necessitates the use of instructional materials (Edet, 2017). Instructional materials play a crucial role in classrooms and laboratories, engaging multiple senses and enhancing academic performance. Akpan, 2018 observed that the use of laboratory facilities is very essential for good science teaching and learning as it involves manipulation of some equipment and other science laboratory materials. Effective Biology teaching requires interaction among teachers, students, and environmental resources, with curricula supporting activity-oriented, learner-centered approaches (Alsubhi, Sahari, & Wook 2020). However, reliance solely on verbal exposition of scientific principles has led to consistently low performance in Ordinary Level Biology exams (Hassan, 2016). To address these challenges, the incorporation of instructional materials such as models, educational games, computer-assisted tools, and laboratory equipment has been shown to improve student performance. Among these materials, the microscope is particularly indispensable in Biology laboratories.

Microscopes offer valuable insights into the world of microorganisms, enabling observation of minute substances and cellular structures (Osamor & Odebisi, 2019). Among various types, the light microscope is commonly chosen for its versatility and ease of use (Ruščić, 2018). Another effective instructional tool is the microbes simulation kit. Microbes simulation kit, comprising simulation charts, role cards, and models, enriches comprehension of microorganisms via the use of interactive teaching approaches. This kit fosters discussion, decision-making, and imaginative development, leading to improved academic performance (Vlachopoulos & Makri, 2017). Activities include concept simulation, role-playing, and group discussions.

Academic performance reflects the achievement of educational goals in school, college, or university settings, as measured by standardized assessments or continuous evaluations (Hanushek, 2020). It determines educational opportunities and future career prospects, contributing to national development and preparing students for competitive fields (Hassan, 2016). Efforts to improve academic performance remain crucial for students' success and societal advancement. Given its significance, educators, including those in biology, have continuously sought for teaching methods and materials that enhances students' understanding and academic performance (Mahmud, Danjuma, Ibrahim, Ibrahim & Abdullahi, 2021; Ramli, Marobi & Ashaari 2021). Despite efforts by researchers to proffer solution to poor academic performance, the impact of instructional materials such as microscopes and microbes simulation kits on academic performance in Biology remains largely unexplored. Addressing this gap is essential, especially considering the challenges associated with teaching abstract concepts like microorganisms.

Moreover, gender disparities in academic performance, particularly in subjects like Biology, have been noted. Gender encompasses socially constructed roles, behaviors, and attributes assigned to individuals based on their biological sex. According to Akpan and Akpan (2017), globally, promoting gender equality in science is currently used as a developmental strategy for socioeconomic development of any nation. Gender issues have been documented to affect academic performance, with gender stereotyping leading to disparities in educational outcomes (Obochi, 2018). Adebanjo (2019) highlighted the impact of gender stereotypes on academic achievement, noting how societal expectations often steer girls towards language and arts while boys dominate in science. Gender biases, intertwined with factors like social class and ethnicity, contribute to inequalities in educational attainment. However, studies present conflicting findings regarding the influence of gender on academic performance in biology. Some report no significant difference, while others indicate gender disparities (Edet, 2017).

In the face of conflicting research findings on the relationship between gender and academic performance, further research is necessary. Hence, this study aims to investigate how the use of microscopes and microbes simulation kits influence academic performance among students in Uruan Local Government Area, Akwa Ibom state, Nigeria, while also considering the role of

gender. By addressing these gaps, the study seeks to contribute to a better understanding of effective teaching strategies and their impact on students' learning outcomes in Biology.

Statement of the Problem

Biology plays a crucial role in various aspects of human life, particularly in fields like health, hygiene, and family life. However, studies have consistently shown that students' performance in Biology examination tends to be subpar. This underperformance may stem from ineffective teaching strategies employed in secondary schools. Researchers in Biology education have been actively seeking more efficient instructional delivery methods to bolster students' academic performance. Numerous studies have indicated that utilizing instructional materials during teaching sessions significantly improves students' comprehension and academic performance. Given Biology's relevance to everyday life, it is imperative to continually explore instructional materials that can facilitate better understanding of complex concepts in Biology. Hence, the researcher is particularly interested in investigating the efficacy of instructional materials such as microscopes and microbes simulation kits in the teaching and learning of Biology. These materials aim to mitigate the abstract nature of certain Biology concepts, thereby fostering improved understanding among students, ultimately enhancing their academic performance in the subject.

Purpose of the Study

The purpose of this study was to investigate the effect of microscope and microbes simulation kit on students' academic performance in the concept of microorganisms in Biology. The specific objectives of the study are to:

1. Compare the mean performance scores of Biology students taught the concept of microorganisms using microscope, microbes simulation kit and those taught without instructional materials.
2. Determine the differences in the mean performance scores of male and female Biology students when taught the concept of microorganisms using microscope, microbes simulation kit and those taught without instructional materials.
3. Determine the interaction of instructional materials (microscope and microbes simulation kit) and gender on Biology students' academic performance in the concept of microorganisms.

Research Questions

To guide this study, the following research questions were raised:

1. What is the difference in the mean performance scores of students taught the concept of microorganisms using microscope, microbes simulation kit and those taught without instructional materials?
2. What is the difference in the mean performance scores of male and female Biology students when taught the concept of microorganisms using microscope, microbes simulation kit and those taught without instructional materials?

3. What is the interaction effect of instructional materials (microscope and microbes simulation kit) and gender on Biology students' academic performance on microorganisms?

Hypotheses

To guide this study, the following null hypotheses were formulated.

1. There is no significant difference in the mean performance scores of Biology students taught the concept of microorganisms using microscope**,** microbes simulation kit and those taught without instructional materials.
2. There is no significant difference in the mean performance scores of male and female Biology students taught the concept microorganisms using microscope**,** microbes simulation kit and those taught without instructional materials.
3. There is no interaction effect of instructional materials (Microscope and Microbes Simulation Kit) and gender on students taught the concept of Microorganisms in Biology.

RESEARCH METHODOLOGY

The study adopted a pretest, posttest nonequivalent control group quasi-experimental design with two experimental groups and one control group. This design facilitated the comparison of different teaching strategies while minimizing disruption to regular class activities. The research was conducted in Uruan Local Government Area of Akwa Ibom State, Nigeria, chosen due to the researcher's familiarity with the area and its educational challenges, particularly in Biology. Population of the study comprised all Senior Secondary I (SS I) Biology students in Uruan Local Government Area, totaling 3074 students from 11 public coeducational secondary schools. A stratified random sampling technique was employed to select a sample of 264 SS I Biology students from six intact classes in selected public coeducational secondary schools in Uruan Local Government Area. Data were collected using Biology Performance Test on Microorganisms (BTM), comprising two sections: A (demographic information) and B (50 multiple-choice test items on microorganisms). The instrument underwent content validation by experts and exhibited high reliability (reliability coefficient = 0.87). Scoring of the instrument involved awarding one mark for each correct response, with a maximum total score of fifty. Research assistants, trained by the researcher, administered the pretest before implementing teaching interventions. Experimental groups one and two received instruction using Microscope and Microbes Simulation Kit respectively, while the control group was treated with no instructional material. Lessons spanned six weeks, totaling 36 lessons across all groups. Posttests were administered immediately after the teaching period. Data obtained from the BTM were analyzed using the Statistical Package for Social Sciences (SPSS) software. Mean and Standard Deviation were used to answer research questions, while analysis of covariance was employed to test hypotheses at 0.05 level of significance.

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RESULTS

Research Question 1

What is the difference in the mean performance scores of students taught the concept of Microorganisms using microscope, microbe's simulation kit and those taught without instructional materials?

Table 1: Mean and Standard Deviation of students pre-test and posttest when taught the concept of microorganisms using microscope, microbes simulation kit and without instructional material

		Pre-test		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
EG1 (Microscope)	90	9.43	4.56	40.77	7.04	31.34
EG2 (MSKit)	91	9.11	4.15	40.29	8.27	31.18
CG (without IM)	83	9.90	4.62	21.13	7.94	11.23

Table 1 presents the mean difference in performance scores (pre-test and posttest) of Biology students taught the concept of microorganisms using microscope, microbes simulation kit, and without instructional materials as 31.34, 31.18 and 11.23 respectively. This result indicates that Biology students taught the concept of microorganisms using microscope and microbes simulation kit performed better than those taught without instructional materials. Furthermore, students taught with the microscope exhibited higher performance compared to those taught with the microbes simulation kit.

Research Question 2

What is the difference in the mean performance scores of male and female Biology students when taught the concept of microorganisms using microscope, microbes simulation kit and those taught without instructional materials?

Table 2: Means and Standard Deviations of male and female students pre-test and pot-test when taught the concept of Microorganisms using microscope, microbes simulation kit and without instructional material

		Pre-test		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Male	126	8.98	4.78	34.17	11.68	25.19
Female	138	9.92	4.07	34.66	12.11	24.74

The results in Table 2 indicate that the mean difference in performance scores (pre-test and posttest) of male and female Biology students taught the concept of microorganisms using microscope, microbes simulation kit, and without instructional materials is 25.19 and 24.74,

respectively. This suggests that male Biology students performed better when taught with either the microscope, microbes simulation kit, as well as without instructional materials, compared to female students.

Research Question 3

What is the interaction effect of instructional materials (microscope and microbes' simulation kit) and gender on Biology students' academic performance on microorganisms?

Table 3: Interaction effect of instructional material and gender on the mean performance scores of Biology students in microorganisms

	Pre-test			Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
EG1 (Microscope)						
Male	49	8.80	4.99	38.65	7.62	29.85
Female	41	10.20	3.91	43.29	5.35	33.09
EG2 (MSKit)						
Male	39	8.44	4.24	40.97	8.07	32.53
Female	52	9.62	4.05	39.77	8.46	30.15
CG (without IM)						
Male	38	9.76	5.02	21.42	8.73	11.66
Female	45	10.02	4.32	20.89	7.30	10.87

Table 3 shows the interaction effect of instructional materials and gender on experimental groups 1 and 2, along with the control group. The results indicate that both male and female students taught with microscope and microbes simulation kit performed better than those in the control group taught without instructional material. However, within experimental group 1, female students exhibited a mean difference of 33.09, surpassing male students who had a mean difference of 29.85. Conversely, in experimental group 2, male students had a mean difference of 32.53, outperforming female students with a mean difference of 30.15. These findings suggest that the use of microscope in teaching microorganisms was more effective in enhancing the mean performance score of female students compared to male students. Conversely, the Microbes Simulation Kit proved to be more beneficial in improving the mean performance scores of male students compared to their female counterparts. Additionally, male students taught without instructional material showed a higher mean difference of 11.66 compared to their female counterparts, who had a mean gain of 10.87. Thus, it can be inferred that there was a significant interaction effect of gender and instructional materials on the mean performance scores of Biology students in microorganisms.

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Hypothesis 1
There is no significant difference in the mean performance scores of Biology students taught the concept of microorganisms using microscope**,** microbes' simulation kit and those taught without instructional materials.

Table 4: Analysis of covariance of students' posttest performance with pre-test as covariate

Source of Variance	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	23669.928[a]	3	7889.976	152.127*	.000
Intercept	36314.984	1	36314.984	700.193*	.000
Pre-test (Covariate)	2259.509	1	2259.509	43.566*	.000
Instructional Material (Main Effect)	22241.126	2	11120.563	214.417*	.000
Error	13484.705	260	51.864		
Total	350071.000	264			
Corrected Total	37154.633	263			

*significant at p<.05, df = 2, 263, R Squared = .637, Adjusted R Squared = .633

Table 4 shows the summary of analysis of covariance of students' performance in microorganisms by treatment (microscope, microbes simulation kit) and control (without instructional material). The result show that an $F_{2, 263} = 214.117$, $p < 0.05$, $p = 0.000$ was obtained. Since the associated probability value of 0.000 obtained is less than 0.05 set as level of significance, the null hypothesis was rejected. The inference drawn therefore is that there is a significant difference in the mean performance scores of Biology students taught the concept of microorganisms using microscope**,** microbes simulation kit and those taught without instructional materials. In order to determine the direction of significance, a Fisher's Least Significant Difference (LSD) Post hoc test was done as shown in Table 5.

Table 5: Summary of Fisher's LSD Post hoc pair wise comparison of students' posttest performance classified by Instructional Material

(I) Instructional Material	(J) Instructional Material	Mean Difference (I-J)	Std. Error	Sig.
Microscope	Microbes Simulation Kit	.267	1.071	.804
	Without Instructional Material	19.946*	1.097	.000
Microbes Simulation Kit	Microscope	-.267	1.071	.804
	Without Instructional Material	19.679*	1.096	.000
Without Instructional Material	Microscope	-19.946*	1.097	.000
	Microbes Simulation Kit	-19.679*	1.096	.000

Table 5 shows the post-hoc result of the significant difference in the mean performance scores of Biology students who were taught the concept of microorganism using microscope, microbes simulation model and without instructional material. From the result, a probability value of 0.804 was obtained when comparing the mean performance score of students taught microorganisms using microscope and microbes simulation kit. Since the associated probability value of 0.804 obtained is greater than 0.05 set as level of significance, it can be inferred that there is no significant difference in the mean performance scores of students taught microorganisms using microscope and microbes simulation kit. However, the probability value of 0.000 was obtained when comparing the mean performance scores of students taught using microscope and without instructional material as well as microbes simulation kit and without instructional materials. Since the associated probability value of 0.000 obtained is less than 0.05 set as level of significance, it can be inferred that there is no significant difference in the mean performance scores of students taught microorganisms using microscope; microbes simulation kit and without instructional material. The conclusion therefore is that microscope and microbes simulation kit proved to be effective teaching materials in the teaching of the concept of microorganisms in Biology.

Hypothesis 2

There is no significant difference in the mean performance scores of male and female Biology students taught the concept microorganisms using microscope**,** microbes simulation kit and those taught without instructional materials.

Table 6: Analysis of covariance of students' posttest performance classified by Gender with pre-test as covariate

Source of Variance	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1428.810[a]	2	714.405	5.219	.006
Intercept	40851.213	1	40851.213	298.444	.000
Pre-test (Covariate)	1413.329	1	1413.329	10.325	.001
Gender (Main Effect)	.008	1	.008	.000	.994
Error	35725.823	261	136.881		
Total	350071.000	264			
Corrected Total	37154.633	263			

*significant at p<.05, df = 1, 263, R Squared = .038, Adjusted R Squared = .031

Table 6 shows the ANCOVA result of the difference in the performance scores of male and female Biology students who were taught the concept of microorganisms using microscope, microbes simulation kit and without instructional material. The result showed that $F_{1, 239} = 18.155$, $p < 0.05$, $p = 0.994$) was obtained. Since the associated probability value of 0.994 obtained is greater than 0.05 level of significance set for decision making, the null hypothesis which states that there is no significant difference in the mean performance scores of male and female Biology students taught

the concept microorganisms using microscope**,** microbes simulation kit and those taught without instructional materials is retained. Inference drawn therefore is that there was no significant difference in the performance scores of male and female Biology students in Microorganisms when taught using microscope, microbes simulation kit and without instructional material.

Hypothesis 3
There is no significant difference in the interaction effect of instructional materials (microscope and microbes simulation kit) and gender on students' academic performance in the concept of microorganisms in Biology.

Table 7: Analysis of Covariance of students' posttest performance classified by the interaction of instructional material and gender with pre-test as covariate

Source of Variance	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	24076.490[a]	6	4012.748	78.855*	.000
Intercept	36447.967	1	36447.967	716.243*	.000
Pre-test (Covariate)	2147.360	1	2147.360	42.198*	.000
Instructional Material (IM)	22295.734	2	11147.867	219.068*	.000
Gender	7.981	1	7.981	.157*	.692
IM * Gender	397.540	2	198.770	3.906*	.021
Error	13078.143	257	50.888		
Total	350071.000	264			
Corrected Total	37154.633	263			

*significant at p<.05, df = 2, 263, R Squared = .648, Adjusted R Squared = .640

The result on Table 7 shows the ANCOVA of the interaction effect of gender and instructional materials on the mean performance scores of Biology students taught the concept of microorganisms using microscope, microbes simulation kit and without instructional material. The result shows that $F_{2, 263} = 3.906$, $p < 0.05$, $p = 0.021$ was obtained. Since the associated probability value of 0.021 is less than 0.05 set as level of significance, the null hypothesis was rejected. Thus, inference drawn is that there was a significant interaction effect of gender and instructional materials on the mean performance scores of Biology students in Microorganisms.

DISCUSSION OF FINDINGS

The results from Table 4 indicated a significant difference in the mean performance scores of Biology students taught the concept of Microorganisms using microscope, microbes simulation kit, and those taught without instructional materials. Based on the least significance difference post hoc analysis, students taught with microscope and microbes simulation kit exhibited better

performance compared to those taught without instructional material. This finding aligns with previous studies such as Edet (2017), which emphasized the positive impact of appropriate instructional materials on students learning outcomes. For instance, Hande et al. (2017) found that combining conventional microscopy with virtual microscopy enhanced students' understanding of dental histology compared to using conventional microscopy or virtual microscopy alone. Similarly, Habib (2016) observed that students taught with a Teaching Kit outperformed those taught through traditional lecture methods. Edet (2017) also reported that students taught the concept of genetics using an improvised DNA Discovery Kit performed significantly better than those taught with a flip chart. Furthermore, Abakpa et al. (2016) found that using an investigative laboratory strategy led to significantly higher performance scores in Biology compared to an expository method. These findings collectively suggest that adopting appropriate instructional strategies along with suitable instructional materials like microscope and microbes simulation kit can enhance meaningful learning in biology, particularly in teaching the concept of microorganisms. Consequently, microscope and microbes simulation kit can be considered effective resources for teaching microorganisms in Biology. However, it is worth noting that the findings conflict with that of Kara (2018), who found that microscope simulation software had no effect on laboratory performances but aided in developing the ability to use microscopes**.**

The results from Table 6 suggest that there was no significant difference in the performance scores of male and female Biology students in microorganisms when taught using microscope, microbes simulation kit, and without instructional material. This outcome could be attributed to the equal opportunities for classroom interaction and participation provided by both the microscope and microbes simulation kit strategies for both male and female students. These instructional methods engage students visually, reinforcing messages and enhancing equal academic opportunities for all. This finding is consistent with the results of a study by Umoke and Nwafor (2014), which explored the effect of instructional simulation on secondary school students' performance in Biology. Their findings indicated that the difference in the mean performance scores of male and female students taught Biology using the simulation instructional approach was not statistically significant. Similarly, Abakpa et al. (2016) found no significant difference in the mean performance scores of male and female students taught using investigative laboratory strategy.

However, this finding contrasts with the results of a study by Okorie and Ezeh (2016), which aimed to determine the influence of Gender and Location on Students' Achievement in Chemical Bonding. Their study found that the mean achievement score of female students was higher than that scored by male students. Additionally, it contradicts with the findings of Bizimana et al. (2022), who investigated the effects of gender on the academic performance of secondary school students in Biology. Their study revealed that the mean achievement score of male secondary school students was higher than that of female students.

The results from Table 7 showed a significant interaction effect of gender and instructional materials on the mean performance scores of Biology students in microorganisms. This indicates that instructional materials such as microscope and microbes simulation kit contributed to improved learning and academic performance among students. The combined use of these instructional materials exhibited a consistent and positive impact on both male and female students, as evidenced by their performance.

CONCLUSION

Based on the findings of the study, the researcher concluded that both the microscope and microbes simulation kit are effective instructional tools for enhancing students' performance in the teaching of microorganisms, compared to teaching without instructional materials. Although students taught with microscope showed slightly higher performance than those taught with the microbes simulation kit, both methods proved beneficial. Furthermore, the study showed no gender disparity in the performance of biology students when taught the concept of microorganisms using either the microscope or microbes simulation kit. This suggests that both instructional materials can contribute to narrowing the gender gap in academic performance and retention in Biology. Additionally, there was a significant interaction with gender in determining students' performance. These findings underscore the effectiveness of both the microscope and microbes simulation kit in improving students' learning outcomes in microorganisms, irrespective of gender. As a result, Biology teachers are encouraged to incorporate these instructional materials into their teaching processes to enhance students' performance in microorganisms and other challenging concepts in Biology

Recommendations

In view of the findings of this study, the following recommendations were made.

1. Biology teachers are encouraged to use microscope and/or microbes simulation kit to teach the concept of microorganisms. This will make learning to be real and reduce abstraction of microorganisms thus enhancing students' performance and retention abilities.
2. Microorganisms concepts is only found in Senior Secondary I syllabus, there is need for curriculum planners to spread it up to Senior Secondary II and Senior Secondary III syllabus to enable the students to retain more what they have learnt in the Senior Secondary Certificate Examinations and other external examinations.

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