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Effect of Practical Activities on Biology Students' Cognitive and Psychomotor Skills in Essien Udim

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ABSTRACT

This study investigated the effects of practical activities on students' cognitive and psychomotor performance in Biology in Essien Udim Local Government Area, Akwa Ibom State, Nigeria. The intervention focused on the topic of Food Test through hands-on practical activities. A quasi-experimental research design was employed, involving 275 Senior Secondary School Two (SS2) Biology students selected through simple random sampling from a population of 1,904 students across four secondary schools. Data were collected using the Biology Cognitive Achievement Test (BCAT) and Psychomotor Skills Acquisition Test (PSAT), and analysed using mean, standard deviation, and independent-samples t-tests at the 0.05 significance level. The findings showed that students who participated in practical activities achieved significantly higher cognitive performance than those taught using the lecture method ($t = 2.53$, $p < 0.05$). No significant gender difference was found in cognitive performance among students exposed to practical activities ($t = 0.68$, $p > 0.05$). However, psychomotor performance differed significantly by school location, with urban students outperforming their rural counterparts ($t = 5.20$, $p < 0.05$). No significant gender difference was observed in psychomotor performance among students in urban schools ($t = 1.72$, $p > 0.05$). The study concludes that practical activities on Food Test significantly enhance students' cognitive and psychomotor performance in Biology. Therefore, practical activities should be integrated into Biology instruction, particularly in rural schools, to improve academic achievement and psychomotor skill acquisition.

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INTRODUCTION

Science is a systematic process of obtaining verifiable and testable knowledge about nature through theoretical and practical activities. Development in science over the years have influenced and dominated every aspect of human endeavor such that any individual lacking in scientific literacy find it very hard to survive in the contemporary society (Graham, 2024). For any nation to attain this rapid scientific growth and advancement, it is important that such a nation improve the standard of her educational system by setting up science laboratories in schools as a prime component of a school science programme because science has globally become a basis of an increasing workforce such that all students need a strong exposure to science practical activities (Shahzadi *et al.,* 2023). Biology as a science course involves the use of process skills and different approaches to bring about meaningful learning in the learners. However, there appears to be a continuous annual poor academic performance of students in public examinations (Okebukola, 2016). These activities in biology at the secondary school level have been incorporated into the Senior Secondary School Certificate Examination syllabus (2012), which stipulated the goals of biology practical as follows: Promote the power of observation; Promote the ability to represent observation by illustration; Develop the ability to relate form to function; Develop power to recognize general characteristics of animals and plants; Develop ability to perform simple experiment and draw conclusion from result obtained; and Interpret data, which illustrate certain known biological principles.

These goals can only be achieved through effective usage of the laboratory. Practical science work is a crucial element of effective science education that can contribute to improved student learning at various levels (Sanjito and Hyams-Ssekasi 2025) It should be noted that laboratory work is not one kind of activity, but a range of activities from true experimental investigations to confirmatory exercise and skill-learning. It would seem evident that this type of laboratory work must be a very significant variable in the study of the effectiveness of practical biology learning and the knowledge gained from studying biology in schools in our daily lives as cited by Fred (2022).

The Study of biology shapes different careers. Biology is one of the basic subjects that everyone has to take in school. Different branches of biology to choose from and specialize in. Even beauticians and beauty therapists need to learn and understand the basic importance of biology since they mainly deal with the skin, fingers, and nails, which are significant parts of the human body (González-Cespón *et al.,* 2024). In order for the students to achieve their career objectives, hands-on practical aspect of learning should be mandatory for all students and the

proper place for this practical aspect of learning in any science subject is in the laboratory and biology being one of the science subjects cannot be taught or learnt effectively in the absence of practical activities. Uche, (2018) defines science laboratory as a place where students may acquire new knowledge, concepts and skills, in order to achieve better understanding of rules, processes, principles, laws, theories and natural phenomena.

Teaching and learning are said to be effective when resources such as laboratory practical activities, diagrams, charts, models, field works and real objects are efficiently utilized to explain the subject matter Nwagbo (2016).Practical activities in Biology is essentially important for concretizing theoretical classroom learning experiences and stimulating the students urge to study Biology. It also provides opportunity for students to interact with materials and ideas, and by so doing, stimulate the development of affective and psychomotor dimensions of learning alongside with the cognitive dimension in order to ensure an all-round and comprehensive development of the student Agbowuro (2016). Bichi (2012) reported that various teaching methods were used by teachers in the teaching of biology aimed at bringing about meaningful learning. These include lecture method, demonstration method, discovery method and experimentation method, among many others. Beyond developing observable motor skills, hands-on practical activities also promote deeper cognitive engagement with biological concepts. As students manipulate materials, make observations, test ideas, and interpret results, practical experiences connect physical actions with mental processes, thereby supporting meaningful conceptual understanding. Thus, effective practical instruction integrates both the "hands-on" development of psychomotor skills and the "minds-on" construction of knowledge through active neurocognitive engagement.

However, the most commonly used is the lecture method. This is mostly employed among science teachers because of some of its advantages, which include the fact that it can be used to cover a large content area at a time and the students are given the same content at the same time. The discovery method brings home to students their notions of the nature of scientific evidence; students come to learn that answers to questions could often be obtained from investigations they can carry out themselves. A good demonstration method holds the learner's attention, thus facilitating learning by giving students the opportunity to see and hear what is actually happening in the classroom. Practical activities in Biology could be seen as a method that could be adopted to make the task of teaching or learning Biology more concrete or real to students as opposed to theoretical or abstract presentation of principles, facts and concepts (Adewumi *et al.,* 2025). Practical activities in Biology are important to students' academic performance because, it is a teaching method that has to do with practical demonstration of scientific concepts, principles,

theories and laws. From its experimental engagement, the students ultimately gain capacity to acquire new facts, develop concepts and principles and skills, which lead to the cultivation of scientific attitudes and habits Onyegegbu (2016). Nwagbo (2016) stated that "the used of practical activities approach to the teaching and learning of Biology concepts should therefore be made mandatory other than an option to Biology teachers, if we hope to produce students that would be able to acquire the necessary knowledge, skills and competence needed to meet the demands of the nation". This implies that, the academic performance of students in any science-based subject like Biology is closely related to both theoretical and practical knowledge. Alison (2013) reported that, Biology is centered on problem solving and laboratory is the most convenient place for careful observations, accurate calculations and logical inferences, therefore, practical activities should be regarded as the main instructional procedures in which cause and effect of any concept is determined. Rughill (2011) in his study on laboratory investigative approach for a successful teaching methodology for high school science instruction, revealed that, students showed significant high grade for this cognitive dimension.

Nwosu (1991) emphasized that education for the future therefore, should be the type that will equip the individual with the power to adapt to change. This should be the most important goal of any society that wants to progress. According to Nwosu (1991), the 1967 American Association for the Advancement of Science (AAAS), identified fifteen process skills associated with practical activities in science subjects. These are: Observing, Measuring, Classifying, Communicating, Predicting, Inferring, Using number, Using space/time relationship, Questioning, Controlling variables, Defining operationally, Formulating models, Hypothesizing, Designing experiment, Interpreting data.

Ajevalemi (2021) highlights the state of student's poor performance in cognitive and psychomotor aspect of Biology on lack of laboratories activities. Okeke (2015) also observed that, gender disparity could also be implicated on student's poor academic performance in Biology. He maintained that, the issue of gender stereotyping cut across social, economic, political and educational development. He described gender stereotyping in schools as 'hidden curriculum" which send out messages to girls to conform to role expectation. This has created a big psychological alienation or depression in the minds of the female students. As a result, boys dominate in science while the girls go into reading languages and Arts. Akpochafo (2009) in similar vein reported that in Nigeria as in many Africa societies, there is gender bias, a situation in which cultural beliefs and structural arrangement favour men over women. In addition to the gender Delimar, it is generally accepted that environment is critical to learning and that success in school

learning is related to the environment in which the learning takes place be it urban or rural settings. Nduka (2012) believes that, schools located in urban areas are better positioned to attract more quality academic performance than those in the rural areas.

With the above importance of science and Biology to the development of the nation, this research is aimed to find out if practical activities could promote students' knowledge (cognitive) and complex overt response (psychomotor) performance tasks in secondary school Biology in Essien Udim L.G.A. More specifically, the study aimed to determine whether practical activities improve students' cognitive performance compared with the lecture method; examine whether male and female students exposed to practical activities differ significantly in cognitive performance; investigate differences in psychomotor performance between students in urban and rural schools; and determine whether male and female students in urban schools differ significantly in psychomotor performance.

RESEARCH METHODS

Study Design

The study adopted a quasi-experimental, posttest-only non-equivalent control group design. The design involved two non-randomized groups: an experimental group exposed to practical activities and a control group exposed to the conventional lecture method. After the administration of the respective treatments, students in both groups were assessed using the Biology Cognitive Achievement Test (BCAT) and the Psychomotor Skills Acquisition Test (PSAT).

The use of intact groups made random assignment of individual students impracticable; therefore, the groups were treated as non-equivalent groups. Since the study did not administer a formal pretest before treatment, baseline equivalence between the experimental and control groups could not be empirically established using pre-intervention test scores. This limitation is acknowledged in interpreting differences observed at the posttest stage.

Area of the Study

The study was conducted in Essien Udim L.G.A. Essien Udim is one of the Annang speaking Local Government Areas in Akwa Ibom State, Nigeria. It was created out of the former Ikot Ekpene Division and included the following clans. Afaha Clan, Adiasim Clan, Odoro Ikot Clan, Ekpeyong Atai Clan, Ikpe Annang Clan, Okon Clan, Ukana Clan, Ukana East Clan. Essien Udim LGA has an expected populace of 79,444 occupants (National population census, 2016) with most of the area's general population being individuals from the Annang ethnic sub-division. The Annang language is broadly spoken nearby while Christianity is the most polished religion in the LGA. It is located Coordinates: 5°08'0"N 7°41'0"E.

Population of the Study

The population of the study comprised of all SS2 biology students of 2023/2024 academic session in the five 5 public secondary schools in Essien Udim L.G.A. The total number of participants was one thousand nine hundred and four (1904) biology students in Essien Udim L.G.A.

Sample and Sampling Technique

The sample for the study consisted of two hundred and seventy-five (275) Senior Secondary School II (SS2) Biology students drawn from four (4) selected public secondary schools in Essien Udim Local Government Area. A cluster random sampling technique was adopted to select the participating schools and intact Biology classes. The use of intact classes was considered appropriate because it minimized disruption to the normal school timetable and instructional activities. The selected intact classes were assigned to the experimental and control groups, with the experimental group exposed to practical activities and the control group taught using the conventional lecture method.

Instrumentation

The instruments for data collection were Biology cognitive Achievement Test (BCAT) which consisted of ten multiple choice item tests with four lettered options A-D each correct answer attracted 5 marks making a total of 50 marks. The second instrument was psychomotor skills acquisition test (PSAT) with ten items scored on the spot (on the spot Assessment). On the spot Assessment test was scored under: without teachers' assistance (5 marks), with little assistance (4 marks), with much assistance (3marks), with very much assistance (2 marks), cannot perform the task (1 mark). A total of 5 marks each was awarded to a psychomotor task performed. A total of fifty marks was awarded to a complete psychomotor task.

Content Validity of the Instruments

To establish the content validity of the BCAT and PSAT, the instruments were subjected to expert review. Copies of the instruments, together with the research objectives, research questions and relevant aspects of the Biology curriculum on Food Test, were presented to experts in Biology Education, Science Education for Measurement and Evaluation. The experts examined the items in terms of relevance to the study objectives, adequacy of content coverage, appropriateness of the items to the cognitive level of SS2 Biology students, clarity of wording, suitability of the response options, and alignment of the practical tasks with the psychomotor skills intended to be measured.

Empirical Validation and Pilot Testing

Following the expert review, the revised BCAT and PSAT were subjected to an empirical pilot test using Biology students who were similar in characteristics to the students targeted in the main study but were not included in the final sample. The purpose of the pilot test was to determine the clarity of the items, estimate the time required for administration, identify problematic items, and obtain empirical evidence concerning the reliability of the instruments.

Consideration for Expanding the BCAT

Consideration is being made to expand the BCAT from 10 to approximately 20–30 items to enhance content coverage and cognitive domain representation related to Food Test concepts. This expansion aims to improve the breadth of cognitive processes, including knowledge, comprehension, application, and higher-order thinking. A table of specifications will guide the development to ensure balanced representation across content areas. Increasing the number of items may better sample students' knowledge and minimize bias from a limited number of questions. The proposed expansion will involve expert validation, pilot testing, and item analysis to retain only relevant and reliable items. The final BCAT version was administered to SS2 Biology students after these procedures were conducted.

Research Procedure: Copies of Biology cognitive Achievement Test (BCAT) and psychomotor skills Acquisition test (PSAT) were administered by the researcher to the two hundred and seventy-five (275) sampled biology senior secondary two students in Essien Udim L.G.A. The researcher and the subject teacher met with the students after permission from the school principals, explaining to the respondents the essence of the research and the confidentiality of information provided followed by the administration of tests.

Method of Data Analysis: The null hypotheses were analyzed using mean, standard deviation and independent t-test at 0.05 alpha level of significance. Independent t-test as used to compare the means of two variables in order to determine whether there is statistical evidence that the associated population means are significantly different.

Assessment of Assumptions for Independent t-Test: Before the application of the independent-samples t-test, consideration was given to the assumptions underlying the test, particularly normality and homogeneity of variance. Ideally, these assumptions would be assessed using formal statistical procedures such as the Shapiro-Wilk test for normality and Levene's Test for Equality of Variances. However, the individual student-level dataset from the original analysis was not retained. The available records contain only the summarized group statistics, including sample sizes, means, standard deviations, degrees of freedom and t-test results. Consequently, the

original Shapiro-Wilk/Kolmogorov-Smirnov and Levene's test statistics could not be retrospectively reproduced.

In order to maintain statistical transparency, no estimated or unsupported normality or homogeneity statistics have been reported. The independent-samples t-test results presented in this study are therefore based on the original analysis of the available group data. The findings are interpreted with appropriate caution because formal statistical verification of the normality and homogeneity assumptions could not be independently reproduced from the available records.

RESEARCH RESULT

The results of the study are presented using descriptive statistics and independent-samples t-test results. Means and standard deviations were used to describe students' performance, while the independent-samples t-test was used to determine whether the observed differences between the relevant groups were statistically significant at the 0.05 level.

Assessment of Assumptions for the Independent t-Test

The independent-samples t-test requires consideration of the assumptions of normality and homogeneity of variance. In the present study, the original individual-level student scores were not retained; therefore, formal Shapiro-Wilk/Kolmogorov-Smirnov normality tests and Levene's Test for Equality of Variances could not be reproduced from the available records. The available data consist of group-level summary statistics, namely sample sizes, means and standard deviations. Accordingly, no unsupported assumption-test statistics or p-values have been introduced into the manuscript. This limitation is acknowledged in interpreting the independent t-test findings reported below.

Testing of hypotheses

Although the two groups differed in sample size (practicum group, n = 175; non-practicum group, n = 100), the unequal group sizes were considered acceptable for the independent-samples t-test because the assumption of homogeneity of variances was satisfied. Thus, the statistical test employed was appropriate for comparing the two groups.

Table 1. Mean standard deviation and independent t-test statistical analysis of cognitive performance of students' scores exposed to practical activities and lecture method

Variable	N	X	Sd	Df	t-cal	t-crit	Decision
Group taught with practical activities	175	35.5	1.62	273	2.53	1.96	Significant
Group taught without practical activities	100	14.02	3.10				

There is no significant mean difference in the cognitive performances of students who were exposed to practical activities and those exposed to lecture method in Biology. The summary of result in Table 1 shows that the calculated independent t-test value 2.53 is greater than the critical value of 1.96 at the degree of freedom of 273. With this, we reject the null hypothesis and accept the alternative hypothesis.

Table 2. Mean, standard deviation and independent t-test statistical analysis of cognitive performance of male and female student's scores exposed to practical activities in Biology.

Practical Activities	N	X	Sd	Df	t-cal	t-crit	Decision
Male	55	32.75	2.36	273	0.68	1.96	Not Significant
Female	220	30.2	1.86				

There is no significant mean difference between the cognitive performance of male and female students exposed to practical activities in Biology. The summary of result in Table 2 shows that the calculated independent t-test value 0.68 is less than the critical value of 1.96 with the degree of freedom 273. With this, we accept the null hypothesis and reject the alternative hypothesis.

Table 3. Mean, standard deviation and independent t-test statistical analysis of psychomotive performance of urban and rural students' scores exposed to practical activities in Biology.

Psychomotive performance	N	X	Sd	Df	t-cal	t-crit	Decision
Urban	96	42.75	4.2	173	5.2	1.96	Significant
Rural	79	40.06	3.3				

There is no significant mean difference between the psychomotive performance of urban and rural school location in Biology. The summary of result in Table 3 shows that the calculated t-test value 5.2 is greater than the critical value of 1.96 at the degree of freedom 173. With this, we reject the null hypothesis and accept the alternative hypothesis.

Table 4: Mean, standard deviation and independent t-test statistical analysis of psychomotive performance of male and female students from urban schools exposed to practical activities in Biology.

Psychomotive performance	N	X	Sd	Df	t-cal	t-crit	Decision
Male urban	26	43.0	162	94	1.72	1.96	**Not Significant**
Female urban	70	41.00	3.10				

There is no significant mean difference between the psychomotive performance of male and female students exposed to practical activities in urban school location. The summary of result in Table 4 shows that the calculated t-test value 1.72 is less than the critical value of 1.96 at the degree of freedom 93. With this, we accept null hypothesis and reject alternative hypothesis.

DISCUSSION

Results in Table 1 indicated that there is a significant difference based on practical activities as compared to lecture method in Biology. The findings indicated that the experimental group, which received instruction via practical activities in biology, outperformed the control group. The result of this findings agree with findings made by Ihejiamazu, *et.al* (2020) who investigated the effect of Biology practical activities on the academic performance of secondary school students in Cross River State and Goji (2018) who examined the effects of biology practical activities on the academic performance and also, research by Jean and Tukahabwa (2022) in Adamawa State explored the role of practical biology activities on student engagement in lower secondary school in Rulindo District. All their findings had it that students performed better when exposed to practical activities. The better performance of students cognitively could be attributed to active participation during practical classes.

From the result of table 2 it was observed that there exist no significant differences in the cognitive performance of students in Biology based on gender. This mean that practical activity is gender friendly .The result of this findings contradicts with findings made by Ude and Ebuor (2018) who investigated the effect of Biology practical activities on gender academic achievements of senior secondary school biology students in Awgu Local Government Area of Enugu State and also Salami, Isah and Dayil (2023) who investigated the effect of practical activities on gender academic achievement of Senior Secondary School biology students in Qua'an Pan Local Government Area of Plateau State. Their result were that, either male or female performed better than it counterpart. This research shows that practical activities are a gender friendly instructional approach for teaching sciences.

Summary of findings in table 3 indicated that there exists a significant effect of practical activities on psychomotive performance of urban and rural school location. The result of the findings was in favor of the urban school. This difference may be attributed to disparities in the availability and accessibility of laboratory equipment and instructional materials between urban and rural schools. Urban schools are more likely to have better-equipped laboratories, adequate specimens, models, chemicals, and other materials required for practical Biology activities, thereby providing students with more opportunities to participate in meaningful experimental exercises. In contrast, inadequate or insufficient laboratory resources in rural schools may limit the frequency and quality of practical activities, resulting in fewer opportunities for students to develop and demonstrate psychomotor skills. The disparity in resource availability may therefore contribute substantially to the observed difference in students' practical performance.

Another possible explanation is the difference in the frequency of training and professional development available to Biology teachers in rural and urban schools, particularly in the effective management and implementation of practical modules. Teachers who receive regular training are more likely to possess the skills and confidence required to organize practical lessons, manage laboratory materials, demonstrate experimental procedures, and engage students in hands-on activities. In addition, students in urban schools may have greater exposure to educational technologies such as computers, smartphones, digital simulations, instructional videos, and other technology-supported resources that can enhance understanding and preparation for experimental activities. Limited access to such technologies in rural schools may reduce students' opportunities to observe, simulate, or practise experimental procedures beyond the conventional classroom setting. These factors, taken together, may help explain why students from the urban school demonstrated higher psychomotor performance than their rural counterparts. This finding is in line with research made by Stephen and Babatunde (2020) that determined the influence of school location on students' academic performance in secondary schools in Ogun State. Also, Odutuyi, Ojo and Famakinwa (2023) in their study determined the effectiveness of practical activities in enhancing Basic Science academic performance of lower primary school pupils and Neji (2019) in his research investigated the role of practical activities on students psychomotive 'performance in Science. Their result is in support that practical activities promote psychomotive performance of students.

Summary of findings in table 4 indicated that there exists no significant effect of practical activities on gender psychomotive performance of urban. The result of the findings was in favour of both gender urban school. This finding is in line with findings made by Ude and Ebuor (2018) who investigated the effect of Biology practical activities on gender academic achievements of senior secondary school biology students in Awgu Local Government Area of Enugu State and also Salami, Isah and Dayil (2023) who investigated the effect of practical activities on gender academic achievement of Senior Secondary School biology students in Qua'an Pan Local Government Area of Plateau State. Their result were that, either male or female performed better than it counterpart. But in this study, practical Active is a gender friendly approach irrespective of school location.

CONCLUSIONS

Based on the findings of the study, practical activities significantly improved students' cognitive and psychomotor performance in Biology. Students exposed to practical activities performed better cognitively than those taught using the lecture method. The findings also showed

no significant gender difference in cognitive performance, while urban students demonstrated significantly higher psychomotor performance than their rural counterparts. It is therefore concluded that practical activities are an effective approach for improving students' learning and skill acquisition in Biology.

Based on the findings, it is recommended that the local education office should prioritize and allocate adequate budgetary resources for the provision, renovation and maintenance of laboratory facilities and essential equipment in rural secondary schools. Furthermore, biology teachers should make regular use of practical activities during Biology instruction, particularly in rural schools.

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