JLSTAN, VOLUME 1, ISSUE 1, 2024

Harnessing the Indigenous Vocational-Based Practices for Enhanced Academic Performance of Basic Science Students in Community Junior Secondary Schools: The Nexus Effect

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KEYWORDS:

Basic science, Community schools, Indigenous-based approach, Students' performance, Separation techniques.

WORD COUNT:
298

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ABSTRACT

Recognizing the disconnection between traditional pedagogical approaches and the lived experiences of students, this study explores how indigenous practices can enrich the learning environment and enhance students' understanding of scientific principles. This empirical study examines specifically the intricate dynamics of improving basic science students' academic performance through the integration of Indigenous Vocational-Based Practice (IVBP) in community junior secondary schools. A 2x2 non-equivalent pre-test and post-test quasi experimental design was adopted. A simple random sampling technique was used to select two junior secondary schools from Ibeju/Lekki Zone of Education District III, Lagos State, Nigeria. Basic science students in two intact classes of an arm of junior secondary school one was involved in the study. The sample comprised of 67 students with 31 students in experimental group and was taught separation techniques using indigenous processes of coconut oil extraction. The control group comprised of 36 which were exposed to the conventional lecture method. The main research instrument for data collection, Separation Techniques Achievement Test (STAT) had a reliability coefficient of 0.87 using Kuder Richardson formular-21. The research questions raised were answered using bar chat, mean and standard deviation while the null hypotheses were tested with Analysis of Covariance at 0.05 level of significance. Results revealed that students exposed to separation techniques using indigenous vocational-based practice significantly performed better than those taught using lecture method [$F(1,65)=8.68$; $p<.05$] and in respect of their gender, a significant difference was found [$F(1,30)=11.57$; $p>.05$]. The study concluded that relating scientific ideas to students' cultural contexts would not only improve learning outcome but also promote a comprehensive understanding of scientific concepts. Based on this, it was recommended that culturally responsive teaching approaches should always be adopted by basic science teachers in their teaching in order to enhance students' comprehension and effective learning of basic science concepts.

HOW TO CITE

Saibu S.O, Braimoh D.S, Ogunmade T.O & Olude A.S. (2024). Harnessing the Indigenous Vocational-Based Practices for Enhanced Academic Performance of Basic Science Students in Community Junior Secondary Schools: The Nexus Effect. JSTAN, 1(1), pg 1-12.

Introduction

Education is a dynamic field that continually seeks innovative approaches to enhance students' learning experiences and academic achievements. In the field of basic science education, particularly within the dynamic context of community junior secondary schools, the quest for new and creative teaching approaches that connect with students' real-world experiences is ever-evolving (Saibu et al., 2017). Basic science has generally been referred to as a meta-discipline and the creation of discipline based on the integration of other disciplinary knowledge into a new whole (Oginni et al. 2023; Cherkesova, 2016). This inter-disciplinary bridging among discrete disciplines is now treated as an entity.

Basic science as a fundamental subject introduced into the junior secondary school basic science and technology curriculum serves as a bedrock of all senior secondary science subjects and gives students a unified and interconnected perspective on basic ideas, concepts, and principles in biology, chemistry, physics, and other related subjects (Ajewole et al., 2017; Erinosho, 2008). Thus, it provides learners with one of the best chances to understand the world holistically as opposed to piecemeal (Effiong & Nkwo, 2012). It is important to note that in selecting the contents of basic science, three major issues (globalization, information and communication technology (ICT) that are critical to influencing the world of knowledge in the modern era and to shaping the development of nations worldwide were identified (Nigeria Education Research and Development Council, NERDC, 2012).

According to Saibu et al. (2017), basic science curriculum places a strong emphasis on encouraging guided inquiry and activity-based ways of teaching and learning using locally available materials. Consequently, the fundamental premise of basic science education transcends the mere dissemination of facts and theories; includes developing a natural curiosity, nurturing critical thinking abilities, and instilling a passion for inquiry. However, conventional approaches often fall short in engaging students on a meaningful level, which results in apathy and disengagement from the material. This disconnect is particularly pronounced in community junior secondary schools, where socioeconomic issues and resource limitations might further reduce the efficacy of traditional teaching methods (Oginni et al., 2020).

Therefore, recognizing the need for a paradigm shift, science educators and scholars have advocated for and focused more on indigenous knowledge practices as a means of revolutionising science teaching and learning (Ademola et al., 2022a; Dansu, 2021; Abah et al., 2015). These practices, deeply rooted in the cultural fabric of local communities, provide a plethora of firsthand knowledge that can be easily incorporated into the classroom environment. Olusegun et al. (2024) emphasised that educators seek to create a more culturally relevant and engaging learning environment by aligning educational practices with indigenous perspectives and this is done by recognising the rich cultural heritage and traditional wisdom embedded within the local community. The cultural background of learners is therefore imperative to planning and teaching science in order to promote the acquisition of hands-on and minds-on practical activities. This in essence will make science learning a child-centred since most of what they learn through socialization takes place within their immediate environment (Fabinu et al., 2022).

There is no gain saying that the inability of the learners to apply their knowledge of indigenous cultural practice constitutes one of the major barriers to science teaching (Olusegun et al., 2024; Ogunmade & Saibu, 2021). In addition, Oladejo et al. (2021) noted in a prior study that the content-context gap is a major problem that impacts the teaching of STEM subjects in our classrooms, particularly at the senior school level. Thus, it is imperative to integrate pertinent indigenous customs with contemporary scientific methods to improve students' understanding of fundamental science curriculum and to encourage the growth of entrepreneurial abilities for personal growth. Numerous indigenous practices can be incorporated into basic science education in schools to help students meet the needs for cognitive, psychomotor, and emotional requirements. For instance, the local extraction process of coconut oil is one of the indigenous vocational practices among coastal communities in Nigeria (Antoniraj, 2017; Nayar, 2016). The processes of extraction of coconut oil from coconut seeds involve some scientific practices of separation techniques which can be utilised to teach students about the notion of separation of mixtures in basic science classrooms.

Moreover, McClallum (2012) asserted that indigenous practices can be meaningfully integrated into western science curriculum to create rich learning experience for our learners. Proper integration of indigenous practices system into science teaching activities will greatly assist science teachers and learners to make extensive use of hands-on learning activities, investigative laboratory activities, open-ended questions, inquiry-oriented discussion, co-operative learning and in fact performance assessments as pedagogical tools (Khupe, 2014). Therefore, by equipping students with both scientific literacy and practical skills derived from indigenous traditions, community junior secondary schools serve as incubators for future generations of innovators, entrepreneurs, and stewards of sustainable development (Onyewuchi, 2022). This holistic model of education not only empowers students to navigate a rapidly changing world but also fosters a sense of agency and resilience in the face of global challenges.

Statement of Problem

Despite the recognized importance of basic science education in fostering critical thinking skills, scientific literacy, and preparing students for future academic and vocational pursuits, ccommunity junior secondary schools frequently face significant challenges to provide quality instruction. These challenges include a lack of resources, restricted access to contemporary instructional materials, and a mismatch between classroom instruction and practical application (Oginni et al., 2020). As a result, students may exhibit low levels of engagement, retention, and performance in science subjects (Ogunmade & Saibu, 2021).

Additionally, there is a gap between the rich reservoirs of indigenous vocational-based practices ingrained within local communities and the conventional teaching methods used in community junior secondary schools (Fabinu, 2022). While these indigenous practices hold immense potential for enriching students' understanding of scientific concepts and fostering a deeper connection to their cultural heritage, they are often overlooked or marginalized in mainstream educational discourse.

Thus, the central problem addressed in this study is the lack of integration between indigenous vocational-based practices and basic science education in community junior secondary schools, and its impact on students' academic performance.

Research Questions

The following research questions were posed and answered in this study.

1. What difference exists between the academic performances of students taught separation techniques using indigenous vocational-based

practice and those taught with lecture method in basic science?

2. Does gender have any impact on students taught separation techniques using indigenous vocational-based practice?

Null Hypotheses

To answer the research questions, the following null hypotheses were formulated.

$H0_1$: There is no statistically significant difference between academic performances of students taught separation techniques using indigenous vocational-based practice and those taught using the lecture method.

$H0_2$: There is no statistically significant difference between the academic performance of male and female students taught separation techniques using indigenous vocational-based practice.

Methodology

Study Design and Sample Selection

This study employed a 2x2 non-equivalent pre-test and post-test quasi experimental design. The quasi experimental design was adopted because the subjects were not randomised, hence intact classes were used. All of the students enrolled in the public community junior secondary schools located in the Ibeju/Lekki zone of Education District III, Lagos State, made up the study population. Ibeju/Lekki Zone of the district was purposively chosen for housing schools in rural areas which still have reasonable level of indigenous knowledge system and cultural practices. Furthermore, the community junior secondary schools, often situated in socio-economically diverse and culturally vibrant settings, offer a unique context for the application of native vocational-based practices. These schools serve as crucial hubs for education in underserved areas, where students may face unique challenges in accessing quality learning resources.

The experimental and control groups were made up of two schools that were chosen using a simple random sample technique. Two intact classes of JSS 1 basic science students were used. With 31 students in the experimental group (14 males and 17 females) and 36 students (15 males and 21 females) in the control group, the sample size was 67 students.

Research Instrument

The main instrument used in this study for data collection was the Separation Techniques Achievement Test (STAT). The STAT had two sections; Section A sought for the demographic details of the participants while section B contained 30 discrete items (multiple choice questions) with four options lettered A-D with each item having three distractors and one key. The Items were constructed using the revised Bloom's taxonomy (Wilson, 2016) of educational objectives for its table of specifications with the items distributed across four cognitive levels of knowledge, comprehension, application and analysis. This instrument was developed using the Basic Education Certificate Examination (BECE) past questions (2018–2023) and two commonly used junior secondary school Basic Science textbooks. In line with the performance objectives highlighted in the instructional guides (lesson plans) for the study, it was ensured that all the stated objectives were tested within the 30 items. Experts in test and measurement, and science education validated the instrument, and based on their observations, some adjustments were made to it to improve clarity and participants' comprehension. The reliability of the STAT was established using the test-retest method, and using K-21 produced a reliability coefficient of 0.87, which was deemed high for its usage.

Treatment Procedures

The approval from the Principals of the sampled schools was sought to have access for the study and the Subject Teachers for their cooperation. In order for the students to participate in the study, their consent was also requested. Thereafter, a pre-test using the same achievement measures (STAT) was administered to the experimental and control groups.

In the intervention stage, the students in experimental group were taught the concept of separation of mixtures using the indigenous vocational-based practice while the students in the control group were taught using the conventional lecture method. The treatments were conducted with the aid of Instructional Guide on Indigenous Vocational-Based Practice (IGIVBP) and Instructional Guide on Lecture Method (IGLM) which contained three lesson plans respectively on the concepts of filtration, decantation, sedimentation and evaporation techniques of separation of mixtures.

The Researchers applied the processes involved in indigenous local extraction of coconut oil to teach the experimental group on mixture separation procedures such as filtration, decantation, sedimentation, and evaporation. This involved classroom activities and hands-on laboratory practical activities. The sampled students were divided into six-person, small, mixed experimental groups, each with five members. The six groups were further split into two sets in order to guarantee efficacy. The first group was instructed, given the freedom to complete their extraction procedures, and followed concurrently by the second group. These lessons were taught for a period of three weeks of double periods of 80 minutes per week as illustrated below.

Step 1: The students crack opened the 2 to 3 coconuts using a blunt object like hammer or small axe, remove and collect coconut meat from the shell using chopping board for cutting the coconut flesh/meat and grounded the coconut meat using a local iron grinder.

Step 2: In a clean muslin cloth, the students gathered the grated coconut meat seed; well-meshed it, poured water, mixed it, kneaded it, and squeezed it to extract the coconut milk. Squeezing the grated coconut releases the milk that had gathered in the basin below as it is combined. This process *is filtration.* In this case, the filtrate is required and used for additional processing is *milk.*

Step 3: The next stage is that the milk (filtrate) that drained in the basin is a mixture of milk and water used to wash the grounded coconut is for some hours where this mixture is kept

undisturbed. As a result, the milk is able to separate from the water by floating on the surface and being decanted off. With care, this oil layer is poured off, revealing water. The *decantation method* is the separation technique used in the example above.

Step 4: The partially decanted oil is moved into a flat or heating pan, where it begins to heat up and evaporate, removing any remaining water. Continuous stirring is used during the one to two hour heating process to evaporation. This guarantees that all water is removed, and the aroma of the oil fills the air. This procedure, known as *evaporation*, involves sacrificing the solvent in order to recover a solid solute from solution using the separation of mixtures method.

Step 5: The coconut oil is poured into muslin to filter soft sediment from the pure oil. This process is called *sedimentation.* Sedimentation is a separation technique use to remove solid suspension from a liquid.

Step 6: The filtered oil is pure virgin coconut oil. Before bottling, it is let to cool for a few hours. In the meantime, more water was released from the soft sediment by squeezing and kneading it. In order to release additional oil, the oil is filtered off the surface and heated until it evaporates. A portion of the sediments were utilised to make candies, such as toffee and other sweets.

However, the students in the control class had the same learning experience as the experimental class but without any elements of indigenous vocational-based practice. However, at the final stage of the intervention, all the students in both the experimental and control groups were post-tested using the reshuffled version of the pre-test and this took two days to achieve.

Data Analysis and Results

The statistical tools applied for the answering the research questions and testing of the null hypotheses were bar chats and Analysis of Covariance (ANCOVA) at 0.05 alpha level of precision using IBM Statistical Package for Social Sciences (SPSS) version 23.0.

Research Question One: What difference exists between the academic performances of students taught separation techniques using indigenous vocational-based practice approach and those taught with lecture method in basic science?

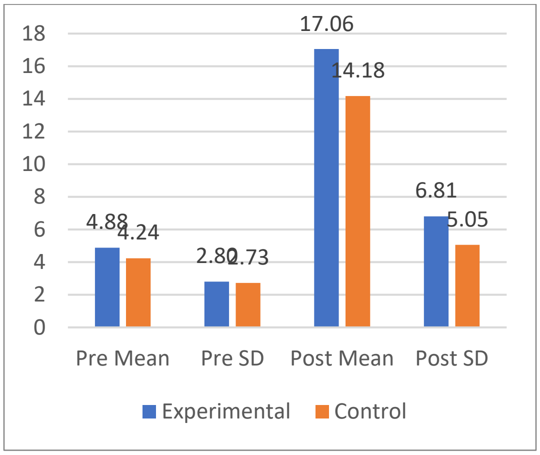

Figure 1: Mean and SD of performances of students taught separation techniques using indigenous vocational-based approach and lecture method

According to the descriptive statistics of the data in Figure 1, students who learnt separation techniques through indigenous vocational-based practice outperformed (M=17.06, SD=6.81) students who learnt them through lecture method (M=14.18, SD= 5.05) in terms of academic performance. The outcome shows that students' achievement in learning separation technique is impacted by indigenous vocational-based practice. However, the students in both groups had comparable achievement levels before the treatment.

$H0_1$: There is no statistically significant main difference between the academic performances of students taught separation techniques using indigenous vocational-based practice and those taught using the lecture method.

Table 1: ANCOVA of academic performances of students taught separation techniques using indigenous vocational-based practice and those taught using the lecture method.

Source	Type III SS	Df	MS	F	Sig.	$p\eta^2$
Corrected Model	1556.321	14	62.306	12.641	0.000	0.640
Group	73.792	1	36.896	8.683	0.001	0.077
Error	684.813	65	4.034			

The result in Table 1 demonstrates a statistically significant difference in academic performance between students who were taught separation techniques using lecture-based instruction and those who were taught utilising indigenous vocational-based practice [$F(1,65)=8.68$; $p<.05$]. The R Squared shows that the independent variables accounted for 64.0% of the variation in performances. According to the partial eta squared estimate, the treatment was responsible for 7.7% of the variation in the students' performance that was seen in the post-test. This suggests that the students in the treatment group improved on their performances. Therefore, the null hypothesis which stated that there is no statistically significant main difference between the performances of students taught separation techniques using indigenous vocational-based practice and those taught using the lecture method is rejected.

Research Question Two: Does gender have any impact on students taught separation techniques using indigenous vocational-based practice?

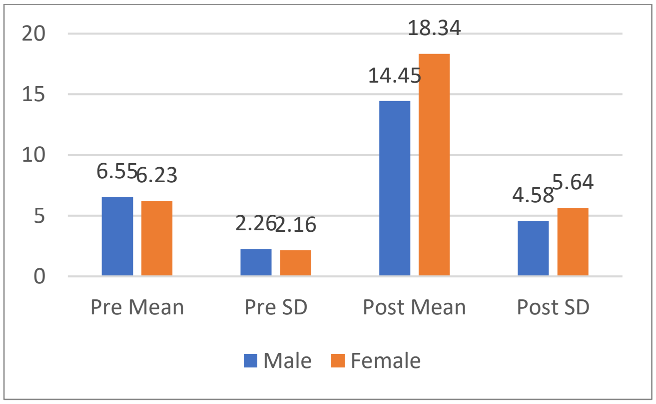

Figure 2: Mean and SD of students' performance based on gender

The descriptive statistics shown in Figure 2 on comparable mean and SD differences between the performances of male and the female students in the indigenous vocational-based practice group reveals female students (M=18.34, SD=5.64) outperformed male students (M=14.45, SD=4.58). The result provides that there is gender effect on students' performance in basic science when taught through indigenous vocational-based practice. Meanwhile, the initial performances of the students reflected no gender difference in performance.

H0$_2$: There is no statistically significant main difference between the academic performance of male and female students taught separation techniques using indigenous vocational-based practice.

Table 2: ANCOVA of academic performance of male and female students taught separation techniques using indigenous vocational-based practice

Source	Type III SS	df	MS	F	Sig.	$p\eta^2$
Corrected Model	1556.321	14	62.306	12.641	0.000	0.640
Gender	5.031	1	4.041	11.570	0.039	0.037
Error	684.813	30	4.034			

The academic performance of male and female students taught separation techniques employing indigenous vocational-based practice differs statistically significantly in Table 2, [$F(1,30)=11.57$; $p<.05$]. According to the partial eta squared estimate, the treatment was responsible for 3.70% of the variation in the performance of male and female students who were taught separation techniques in the post-test. As a result, the null hypothesis that claimed there is no significant main difference in performance between male and female students who are taught separation techniques using indigenous vocational-based practice is rejected statistically.

Discussion of Findings

The opening hypothesis of the study found a statistically significant difference between the academic performances of students taught separation techniques using indigenous vocational-based practice and those taught using the lecture method. It implies that the experimental group outperformed the group taught using the lecture method. This finding is in agreement with Olusegun et al. (2024), and Ugwu and Diovu (2016), who discovered that incorporating traditional knowledge and methods into the teaching of science and chemistry improved students' academic performance. In keeping with this, Onyewuchi (2022) confirmed that in physics the positive link between the students' daily practice and the new classroom physics background accounts for the significance in students' performance.

This result further concurs with Saibu (2023) who found statistically significant difference in cognitive and practical achievements, and entrepreneurial skill acquisition of students in senior school chemistry when taught using entrepreneurial-motivated-approach and lecture method. In addition, Yulita and Prayitno (2023) study concluded that CEP-based chemistry learning has a positive influence in improving vocational skills and students' learning outcomes. Onyebu (2015) in his study also found that a strong significant relationship exists between entrepreneurial skills and academic achievement of students in science. Similarly, Kadala (2014) stressed that project-based learning activities greatly enhanced students' performance in physics. More so, Parsons and Carlone (2013) agreed that if both hands work together, then culture can become a vehicle to, not only advancing our understanding about an equitable, robust science education for the 21st century but in acting in systemic ways to create it.

However, in this study, the disparity between the performances of students taught by harnessing their indigenous vocational-based practice and those taught using the lecture method could be due to the fact that indigenous knowledge is an unforgettable previous knowledge which the child grew up with and currently are sometimes involved in.

The finding from hypothesis two in Table 4 shows statistically significant difference between the academic performances of male and female students taught separation techniques using indigenous-based approach. This depicts that female students do understand and perform as better than their male counterparts when they are taught when deploying their indigenous vocational-based practice. This discovery aligns with the research conducted by Jegede and Olu-Ajayi (2017), Godpower-Echie and Amadi (2013), and Isaak et al. (2022) who all demonstrated significant effects of gender on science students' performance. Along the same lines, Schmidt et al. (2017) discovered differences between the sexes when it comes to performance-related and entrepreneurial qualities. However, the performance gap in this study could not be unrelated to female propensity for career-based vocational processes and also the traditional roles of females in the local communities.

In contrast to the finding of this study, Olusegun et al. (2024) found no significant gender difference in performance of chemistry students taught using culturo-techno-contextual approach. This result is also inconsistent with Ogunmade et al. (2024) who found no statistically significant gender difference in manipulative skills and academic achievements of students in science when taught using laboratory practical approach. Similarly, Saibu et al. (2022) and Oludipe et al. (2022) findings revealed no significant difference in the academic achievement of male and female students when taught using entrepreneurial-motivated-approach in chemistry. In addition, Ugwu and Diovu (2016) found that the integration of indigenous knowledge and practices into chemistry teaching has no significant effect on male and female students' achievement. Also, Oludipe and Bankole (2017) in their studies found that the performance means scores of male and female chemistry students did not significantly differ.

Conclusion

The impact that the indigenous vocational-based practice had on the performance of basic science students, more especially, in the area of separation techniques, underscores the significance of incorporating indigenous knowledge into educational practices. According to the findings, by relating scientific ideas to students' cultural contexts, this approach would not only improve learning outcome but also promote a comprehensive comprehension of scientific concepts.

Recommendations

Based on the findings, the Researchers made the following recommendations:

1. Integration of indigenous vocational-based practice into the curriculum of community junior secondary schools in order to leverage the positive impact observed on basic science students' performance.
2. Continuous training and professional development opportunities for teachers to effectively incorporate indigenous vocational-based practice into their teaching practices should be encouraged, and ensuring they are well-equipped to deliver culturally relevant lessons.
3. Collaboration between schools, local communities, and indigenous knowledge holders to ensure a comprehensive and authentic integration of cultural elements in the teaching of basic science need to be encouraged, particularly in separation techniques.
4. Provision of more inclusive and culturally sensitive educational framework should be provided in order to empower students and enrich their learning experiences.

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