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Assessing Students' Involvement in Improvisation Practices in Learning Basic Science: Implications for Sustainable Development Goals (SDGs)

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A B S T R A C T

This study examined students' involvement in the design, development, and usability of improvised instructional resources as predictors of academic achievement in Basic Science, with particular reference to the Sustainable Development Goals (SDGs). A mixed-method research design was adopted, involving 120 students selected through a multistage sampling technique. Data were collected using the Basic Science Achievement Test (BSAT) and an observation checklist measuring students' engagement in the design and development of improvised resources, as well as their usability. The research instruments were validated, and reliability was established using test–retest and Cronbach's alpha techniques. Correlation analysis was conducted at the 0.05 level of significance. The findings revealed a strong positive relationship between students' engagement in improvisation practices and academic achievement, indicating significant improvement in learning outcomes. Similarly, a very strong positive correlation was found between the usability of improvised resources and students' academic achievement. These results demonstrate that student-centered improvisation practices support inclusive, sustainable, and resource-efficient science education, thereby contributing to the attainment of relevant SDGs. Improvisation should be systematically integrated into science curricula, with teachers actively involving learners in the design and development of instructional resources.

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1. INTRODUCTION

Science is the bedrock of technological innovation and societal advancement, offering a basis for addressing real-world challenges and driving sustainable development. Across the globe, Stakeholders in Education have acknowledged its pivotal role in enhancing economic growth and national progress. In Nigeria, scientific literacy is a vital requirement for equipping learners with the knowledge, skills, and attitudes that can stimulate innovations and contribute to national development. Basic Science is a subject that enables students to have background knowledge of their natural environment and how to solve life problems in their daily routines. The effective teaching of Basic Science relies heavily on the use of instructional resources, designed to facilitate the transfer of knowledge and improvement in learning outcomes. Instructional materials enhance comprehension, engagement, and retention by making abstract concepts more concrete and relatable (Ajayi & Olagunju, 2021). Unfortunately, many schools in developing countries are facing a severe shortage of essential resources such as laboratory equipment, models, and charts, largely due to inadequate funding and poor resource allocation. This scarcity often compels teachers to rely on purely theoretical explanations, which limits students' understanding of practical scientific concepts.

Improvisation has emerged as a practical and cost-effective alternative to address these challenges. Some researchers define improvisation as the creative process of designing and developing instructional materials from readily available local resources when standard teaching aids are unavailable. This approach mitigates the negative impacts of resource scarcity and also cultivates creativity, adaptability, and problem-solving abilities among learners. Improvisation is the deliberate and creative adaptation or construction of instructional materials and teaching strategies in situations where conventional resources are unavailable, insufficient, or inaccessible. This approach is useful in educational environments that face resource constraints, where teachers must rely on locally available materials and inventive methods to deliver effective instruction. Rather than perceiving the lack of standard

laboratory equipment or commercial teaching aids as a barrier, educators who embrace improvisation transform these limitations into opportunities for innovation, engagement, and

deeper learning. Improvisation serves as a strategic response to resource scarcity, enabling educators to bridge instructional gaps while simultaneously cultivating essential skills such as creativity, problem-solving, and adaptability. Improvisation enhances the quality of teaching by encouraging flexible thinking and innovative practices. When engaging with improvised materials such as homemade models, repurposed tools, or locally sourced items, there is a high tendency for students to internalize scientific concepts and develop a lasting understanding (Dragan & Tertychna, 2021).

This experiential learning approach allows students to connect abstract scientific principles to tangible, real-world phenomena. The use of familiar, everyday materials in scientific demonstrations helps students relate complex ideas to their lived experiences, thereby making learning more relevant, practical, and memorable. Moreover, improvisation fosters critical thinking and creativity among students. Learners who participate in the creation of improvised instructional tools exhibit enhanced analytical skills, greater adaptability, and increased creative capacity (Nyakato *et al*., 2024). These attributes are not only vital for academic success but also for lifelong learning and effective problem-solving in diverse contexts. Students exposed to improvisation-based teaching methods show higher levels of motivation, engagement, and academic performance compared to those taught using traditional, standardized resources alone (Mehrez *et al*., 2023). Improvisation enables teachers to contextualize scientific principles, thereby enhancing students' comprehension and retention (Motswiri *et al*., 2023). For instance, simple items such as string, stones, recycled containers, or kitchen utensils can be used to illustrate concepts like motion, density, chemical reactions, or anatomical structures. Some researchers underscore the educational benefits of improvisation, noting that it cultivates resilience, resourcefulness, and creativity, which are essential for navigating academic challenges and real-world problems. Some researchers (Darling-Hammond *et al*., 2019) affirmed that tangible, interactive learning aids significantly improve student engagement and understanding in STEM subjects. Furthermore, improvisation contributes to the achievement of global educational objectives, as stipulated by the United Nations Sustainable Development Goal 4, which promotes inclusive and equitable quality education for all. It also supports environmental sustainability by encouraging the reuse and repurposing of materials, thereby fostering ecological awareness and responsibility among learners.

Improvisation in Basic Science Education relates to the level of involvement of students in the design and development of instructional materials. This participatory approach transforms students from passive recipients of information into active contributors to the learning process. Students can develop critical thinking skills, apply theoretical knowledge, and gain hands-on experience through engaging in the creation of models, diagrams, and experimental setups. Such involvement promotes meaningful learning and improves retention of scientific concepts (Okeke & Nworgu, 2017). Students who construct their own learning aids demonstrate deeper comprehension and are better able to recall and apply scientific principles in new contexts (Ogunniyi & Olatoye, 2016). Some reports (Chukwuneke *et al*., 2018) emphasized the interactive and dynamic nature of these activities, which foster teamwork, peer learning, and communication skills, competencies that are essential for academic and professional success.

Similarly, appropriate usage of the improvised materials is necessary to achieve success in learning goals, through active learners' participation and engagement in their design and development. Usability of improvised instructional material is defined as the degree to which students can interact with and benefit from the improvised resources in a learning environment. Poorly designed or overly complex materials can limit learning, while user-friendly designs aligned with learners' cognitive levels could ensure motivation, exploration, and mastery of scientific concepts. Well-structured improvised resources have been shown to improve comprehension and retention in science subjects. The use of improvised instructional materials is a critical factor in determining their effectiveness. Usability encompasses qualities such as accessibility, adaptability, relevance, and ease of manipulation. When thoughtfully designed, improvised materials can offer instructional value comparable to that of standard laboratory equipment, particularly in settings where such resources are lacking. Well-crafted improvised tools make science learning more interactive and practical, allowing students to engage directly with scientific phenomena (Adenagbe *et al*., 2024). Common household items such as plastic bottles, paper clips, or kitchen utensils can be effectively repurposed for scientific experiments, provided they are adapted to meet specific instructional goals. Involving students in the evaluation and refinement of improvised materials enhances their engagement and deepens their understanding (Carvajal *et al*., 2022). This process also encourages learners to take ownership of their education and develop a critical perspective on the quality and effectiveness of teaching tools.

Empirical reports investigated the effect of improvisation on students' academic performance in Basic Science and Technology (Ojo & Dennis, 2024). They found out that students taught using the improvised instructional materials demonstrated significantly

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higher comprehension and retention rates than those taught with traditional resources. The hands-on nature of improvisation promoted creativity, critical thinking, and problem-solving skills. They recommended that schools should adopt improvisation strategies in science teaching, particularly in resource-limited environments. Also, there are significant differences in student performance in chemistry when improvised and standard laboratory equipment are compared (Ajayi *et al.*, 2019). Students taught with improvised apparatuses achieved higher academic performance and retention rates than their counterparts using standard laboratory equipment. Additionally, there was no significant gender difference in performance, leading to a recommendation for the inclusion of improvised materials in science teaching for both male and female students. Some reports assessed the effectiveness of using student-constructed improvised instructional resources on academic performance in Physics (Yusuf & Abubakar, 2020). Students in the experimental group, who constructed their own materials as directed by the instructor, scored significantly higher than those using teacher-prepared materials without their engagement in their construction. It was also observed that urban students outperformed their rural counterparts. They recommended encouraging the use of student-constructed materials while addressing resource disparities between urban and rural schools.

On the contrary, the success of improvisation depends on both creativity and the practical usability of the materials. Poorly designed or difficult-to-use tools can hinder learning and lead to frustration. Usability is greatly enhanced when materials are user-friendly and supported by clear teacher guidance (Eze & Okoro, 2021). In such cases, improvised instructional aids can significantly improve students' comprehension, boost their confidence, and lead to higher academic achievement. Ultimately, the effectiveness of improvisation in Science Education lies in its ability to transform limitations into opportunities for enriched learning, innovation, and personal growth.

The effort of instructors in Basic Science to achieve success in student performance in Basic Science is well appreciated, but the goal is still far from reality. Effective Basic Science education relies on adequate instructional materials, yet many schools in the Uyo Local Government Area face persistent shortages of standard resources like laboratory equipment and models. This limits students' understanding and contributes to poor academic performance. Improvisation using locally available materials has emerged as a practical solution. However, the impact of students' direct involvement in designing and using these improvised tools on their academic achievement remains underexplored. While existing research supports the general benefits of instructional materials, few studies focus on students' participation in improvisation and its effect on learning outcomes. This study aims to address this gap by examining how student engagement in improvisation and the usability of improvised materials influence academic achievement in Basic Science.

This research is guided by the following questions and hypotheses;

(i) What is the relationship between students' engagement in the design and development of improvised instructional resources and their academic achievement in Basic Science in Uyo metropolis?

(ii) What is the relationship between students' usage of improvised instructional resources and their academic achievement in Basic Science in Uyo metropolis?

(iii) There is no significant relationship between students' engagement in the design and development of improvised instructional materials and their academic achievement in Basic Science in Uyo Metropolis.

(iv) There is no significant relationship between students' usability of improvised instructional materials and their academic achievement in Basic Science in Uyo Metropolis.

2. METHODS

The mixed-method research design, which combines quantitative and qualitative approaches, was adopted for this study. The quantitative aspect employed a correlational analysis to examine the strength of the relationship between students' engagement in improvisation practices, the usability of improvised instructional materials, and their academic achievement in Basic Science. The qualitative component involves assessing the students' engagement in the design and development of improvised resources through active participation in their construction. The research was conducted in Uyo Metropolis, an urban-based centre of the Uyo Local Government Area of Akwa Ibom State, Nigeria. Uyo, the state capital, is a hub for educational activities with a blend of urban and rural communities. The area has fourteen public secondary schools and numerous primary and private schools.

2.1. Population and Sampling

The population comprised all 2,540 Junior Secondary School (JSS III) students studying Basic Science in public secondary schools in Uyo Local Government Area during the 2024/2025 academic session. The sample consisted of 120 junior secondary three school students, selected using a multistage sampling technique. In the process, urban and rural schools were segregated based on the availability of qualified science teachers and a functional laboratory. A simple random sampling was used to select an intact class used as a dependent treatment group in the study.

2.2. Instrumentation and Research Procedure

The instruments used in this study were the Basic Science Achievement Test (BSAT) and Observation Checklist for Assessing Students' Engagement and Usability of Improvised Instructional Resources (OCASEUIR) in Basic Science. The BSAT contained 20 multiple-choice questions drawn from the JSS III Basic Science curriculum using the concept of light and optics. The checklist consisted of ten dichotomous (Yes/No) items divided into two constructs: engagement and usability. In the BSAT, each correct answer earned one point, with a maximum score of 20. In OCASEUIR, the engagement and usability constructs were dichotomously. Three experts in assessment and evaluation validated the instruments (face and content validations), ensuring alignment with curriculum objectives. The BSAT reliability was determined using the split-half method, yielding a coefficient of 0.95, indicating high internal consistency. The checklist reliability was determined using the Kuder-Richardson formula 20 (KR20), and the reliability index was 0.82, high enough to guarantee the reliability of the instrument. Observations were conducted during practical Basic Science lessons involving improvised materials. Students' activities were scored on the checklist. After the observation, the BSAT was administered to measure the academic achievement of students in the concept of light and optics. The datasets were normalized, and a Levene test was conducted to ensure the use of parametric test statistics. Pearson Product-Moment Correlation Coefficient (r) was used to answer the research questions, and the t-test statistic was used to test the null hypotheses at a 0.05 level of significance.

3. RESULTS AND DISCUSSION

3.1. Relationship between Engagement and Academic Achievement of Students

Table 1 shows the analysis of the relationship between students' engagement in the design and development of improvised instructional materials and their academic achievement in Basic Science, correspondingly.

Table 1. Relationship between Engagement and Academic Achievement of Students

Variables	N	r	R^2	df	t_{cal}	t_{cri}	Decision
Engagement in DD							$MSPR^*$
Academic Achievements	120	0.65	0.42	118	9.38	0.16	Sig^*

Moderately Strong Positive Relationship (MSPR), Significant at p < 0.05

In **Table 1**, the PPMCC yielded a moderately strong positive relationship (r = 0.65) between students' engagement and academic achievement in Basic Science. The relationship is statistically significant (t(118) = 0.38) with a coefficient of determination $(R^2 = 0.42)$. This indicates that 42% of the increase in students' academic achievements is contributed to by their engagement in improvisation practices, both in design and development (DD). This result is supported by literature (Botes & Blennis, 2025), as they reiterated that improvised instructional material ensures active, experiential learning in physical science, since learners are engaged in concrete activities, such as constructing models and conducting hands-on experiments.

3.2. Relationship between Usability of Improvised Resources and Academic Achievements

Table 2 shows the analysis of the relationship between students' usage of improvised resources (IR) and their academic achievement in Basic Science, correspondingly.

Table 2. Relationship between Usage of IR and Academic Achievement of Students

Variables	N	r	$R - squaredR^2$	df	t_{cal}	t_{cri}	Decision
Usage of IR							$VSPR^*$
Academic Achievements	120	0.83	0.69	118	16.13	0.16	Sig^*
							.

Very Strong Positive Relationship (VSPR), Significant at p < 0.05

In **Table 2**, the PPMCC yielded a very strong positive relationship (r = 0.83) between students' usage of improvised resources and academic achievement in Basic Science. The relationship is statistically significant (t(118) = 16.13) with a coefficient of determination (R^2 = 0.69). This indicates that 49% of the increase in students' academic achievements is contributed by their usage of the improvised instructional resources in Basic Science. This result is in line with the literature (Zenk *et al*., 2022), as they reported that active engagement and usage of improvised instructional materials can accommodate diverse learning styles, and promote learner understanding of abstract topics, while sparking motivation and interest in the learners.

4. CONCLUSION

Engaging students in the design and development of improvised instructional materials serves as a way of improving their academic achievement through adaptation to the learning environment by using the available resources for teaching and learning. Similarly, the use of improvised instructional material predicts a strong positive relation with the academic achievement in Basic Science, correspondingly. These factors collectively enhance comprehension, creativity, critical thinking, and problem-solving skills, making them indispensable components of effective science teaching in resource-constrained environments. Hence, integrating student-led improvisation into the science curriculum can significantly improve learning outcomes in Basic Science.

The State Secondary Education Board and curriculum developers should incorporate student-led improvisation activities into the Basic Science curriculum to enhance engagement and understanding of scientific concepts. Teachers should be trained through workshops and seminars on guiding students in the design, development, and use of improvised instructional materials to ensure their safety, usability, and relevance. School administrators should provide supportive resources and locally available materials that facilitate improvisation. Education policymakers should promote policies that encourage improvisation practices in schools as a cost-effective means of delivering quality science education.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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