

THE PERCEPTION OF PRE-SERVICE BIOLOGY TEACHERS ABOUT THE EFFECT OF THE USE OF IMPROVISED MATERIALS IN THE TEACHING AND LEARNING OF BIOLOGY

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ABSTRACT

This study explored the perceptions of pre-service biology teachers about the impact of using improvised materials in the teaching and learning of biology. The study employed a sequential explanatory mixed method research design. Purposive sampling technique was used to select 81 level 200 students in the Department of Biology Education of the University of Education, Winneba, Ghana. Data was collected through close-ended questionnaires, assessment of the samples of improvised materials and use of the improvised materials in micro-teaching biology lessons. Descriptive statistics of the SPSS version 22 was to organize the responses to the questionnaire items into frequencies and percentages and presented in tables. The qualitative data from assessment of improvised materials and their use in micro-teaching was thematically analysed. The findings highlighted the perceived benefits of improvised materials, such as making learning more tangible, appreciating local resources, reducing costs, and enhancing creativity and skills. While some respondents affirmed the positive impact of improvised materials on students' engagement and participation during instruction, others expressed reservations about the ability of the teacher to improvise materials to cover all aspects of biology comprehensively. In conclusion, improvisation of instructional materials is critical in the teaching and learning of biology in a developing country like Ghana. Pre-service teachers, therefore, should be well equipped with skills to improvise instructional materials that are not readily available. It was suggested that improvisation, while valuable in addressing resource shortages, should complement rather than replace standardized materials. The findings offer insights into the perceptions and challenges of pre-service biology teachers, providing a basis for improving teacher training programmes in Biology education.

Keywords: Biology, improvisation, improvised materials, pre-service teachers, perception.

INTRODUCTION

Biology is a foundation for the study of biochemistry, medicine, physiology, ecology, genetics, molecular biology, and many more. It has become a focal point for most human endeavours, including finding solutions to issues with food scarcity, health, hygiene, and family life. It is also pivotal in matters related to ending poverty, managing and conserving natural resources, biotechnology, ethics, and a variety of social vices (Chukwunyeremunwa, 2013).

Biology being the study of living things, requires the use of instructional materials to make life forms real to students. The teaching and learning of biology cannot be done effectively without a productive interaction between the teacher, students, and instructional/environmental resources (Ibrahim, Ibrahim, Ya'u, & Abdullahi, 2019). Instructional materials are essential and significant tools needed for teaching and learning school subjects to promote teachers' efficiency and improve students' performance. They make learning more interesting, practical, realistic, and appealing. They also enable students to participate actively and effectively in

lesson sessions. They give room for the acquisition of skills and knowledge and the development of self-confidence and self-actualization. Instructional materials are known, among other benefits, to facilitate conceptual thinking and make learning more permanent. They offer various experiences which stimulate self-activity on the part of learners. The teaching of biology without learning materials might result in poor academic achievement and a lack of interest in the subject among students. A major constraint to the teaching and learning of biology at the senior high school level is lack of necessary instructional materials which are either in short supply or inaccessible.

LITERATURE REVIEW

Instructional materials are a critical component of the instructional process. When effectively utilised, they can support learning and aid learners in concretizing the learning experience and make learning more exciting, stimulating and interactional. According to Agun (2003) learning can be reinforced with teaching resources of different varieties. Such learning aids stimulate, motivate as well as capture the learner's attention during the instructional process. A study by Adebajo (2007) confirmed that the use of instructional materials in teaching and learning science enhances students' knowledge. It encourages better retention and also promote and sustain students' interests leading to the learners discovering themselves and their abilities. These assertions prove that mastery of biology concepts cannot be fully achieved without the use of learning materials in teaching the subject.

In the face of the current global economic crisis and its attendant effects on educational provisions in schools, teachers can alleviate the inadequate supply of instructional materials through improvisation (Eminah, 2009). Improvisation is one of the recognized and reliable ways of minimizing the challenges posed by the absence of actual or factory-made instructional materials (Ajayi, 2008). It is also an inexpensive method of widening the scope of scientific inquiry at the classroom level. A study found that improvisation offers the clearest, least-edited representation of one's thoughts as they are encoded in action (Pressing, 1984). In all spheres of human activity, including science, improvisation is essential to the emergence of novel ideas (Adeniran, 2006). Science teachers in such situations are expected to take up the challenge by improvising materials for their lessons. According to Oyediran (2010), improvisation involves employing resources or tools created locally or acquired by the instructor with help from local artisans to enhance education. Students, teachers, and biology laboratory technicians can develop instructional materials by using resources readily available in their surroundings. This makes it possible for science teachers to perform experiments and demonstrations on a budget. Improvisation, therefore, should not be the sole privilege of teachers. Instead, students should also be involved as a pivotal part of the process (Aina, 2013). As important as instructional materials are for the teaching and learning of first and second-cycle schools, the reality of the situation is that in most schools, instructional materials are either inadequate or are not available rendering science learning abstract. Obanya (2004) bemoaned the poor state of the supply of curriculum and educational materials in Africa in general. He opined that that was one of the major challenges for curriculum and instruction for Africa in the twenty-first century. An intervention, therefore, is necessary for a developing country like Ghana.

Globally, teachers have been acknowledged as one of the panaceas to educational problems. Due to this, concentrating on pre-service teachers' creative skills during their training is one credible way of increasing the pool of data required to address the issue of the lack of instructional materials in schools by turning to improvisation. To enhance the quality of education within our educational system, we must focus on the improvisation of instructional materials during the teaching and learning process. This is the reason why improvisation of

instructional materials is a course in teacher training institutions. It is, therefore, desirable to assess pre-service biology teachers' perceptions and attitude towards improvisation. The data obtained would be helpful to the lecturers to facilitate improvisation among the students and to equip them with the skills needed for improvisation. This study was therefore designed to determine the perception of pre-service biology teachers on the effect of improvisation in the teaching and learning of biology and their attitudes towards the development of improvised materials.

The research questions that guided the study were:

1. What is the perception of pre-service biology teachers on the effect of improvisation in the teaching and learning of biology?
2. What is the attitude of pre-service biology teachers towards improvisation of instructional materials?

METHODOLOGY

The study adopted a sequential explanatory mixed research design which is a two-phase design where quantitative data collected is analysed first before qualitative data is analysed based on the quantitative results (Creswell, 2011). The purpose of the second qualitative phase according to Toyon (2021) is often to explain the results discovered in the first quantitative phase, and occasionally to explain outliers that are not entirely consistent with the data collected.

The study employed a purposive sampling technique to sample 81 level 200 biology education students. The purposive sampling technique was employed because these students took improvisation techniques in science as a course in their second semester of level 200.

The data collection instrument used in the study was a closed-ended researcher-made questionnaire. The questionnaire consisted of five (5) items requiring students to indicate their agreement to the items on the use of improvised materials to teach biology. To ensure validity, two lecturers in the Faculty of Science Education examined and determined the suitability of the wording of each of the items. Suggestions received from them were used to refine and sharpen the content, making them more relevant and valid for the study. A pilot test was conducted with a sample of level 200 integrated science students who were also studying improvisation techniques at the time of the study. Data from the test was used to determine reliability of the questionnaire. The reliability was found to be 0.75 which was an acceptable level of reliability according to George and Mallery (2003). The pilot test also enabled the researcher to identify areas of difficulty and ambiguity in the questionnaire, which were addressed before it was administered to the respondents.

All 81 students answered the questionnaire on improvisation in the teaching and learning of biology. The students were also tasked to design an improvised materials for a chosen biology topic to be taught at the senior high school (SHS) level. They gave presentations on how the improvised materials were developed and how they would use them to teach the concepts. Also, challenges they faced during the development of the improvised materials were presented.

Data Analysis

Data generated from the questionnaire was analysed using descriptive statistics function of SPSS version 22 to organize the responses into frequency counts and percentages and presented in tables. Frequency and percentages were used because they are useful statistics for expressing relative frequency of survey responses and other data (Why are percentages important, 2021). Qualitative data were obtained from students' presentation on how the

improvised materials were developed, how they could be used to teach the concepts, the quality, and durability and how attractive the improvised materials were. The data was thematically analysed and presented.

RESULTS

Research Question 1: What is the perception of pre-service biology teachers on the effect of improvisation in the teaching and learning of biology?

Descriptive statistics of the sample's responses of the questionnaire items on benefits of improvised materials in teaching and learning biology are presented in Table 1.

Table 1. Respondents' perceived benefits of improvised materials in teaching and learning biology

Benefits	Frequency	Percentage (%)
Improvised materials help in making teaching and learning real rather than being abstract.	81	100
Improvised materials help to appreciate materials that are found in our environment.	70	86
It cuts down cost as improvised materials are not as expensive as the standardized materials.	65	80
Improvisation exposes the creativity and skills of both the students and the teacher.	79	97.5
Total	295	363.5

NOTE: Multiple responses accounted for differences in total percentage responses

Data in Table 1 indicates the importance or relevance the pre-service teachers placed on the use of improvised materials in teaching and learning of biology. All the respondents (100%) indicated that improvised materials help in making teaching and learning real rather than being abstract, while 86% indicated that improvised materials help teachers to appreciate materials that are found in our environment. Again, 80% also talked about the cut down in cost as improvised materials are not as expensive as the standardized materials and 97.5% of the respondents said, improvised materials reveals the creativity and skills of both students and teachers. Students were asked if improvised materials could truly replace standardized teaching and learning materials in biology. Their responses were analysed and presented in Figure 1.

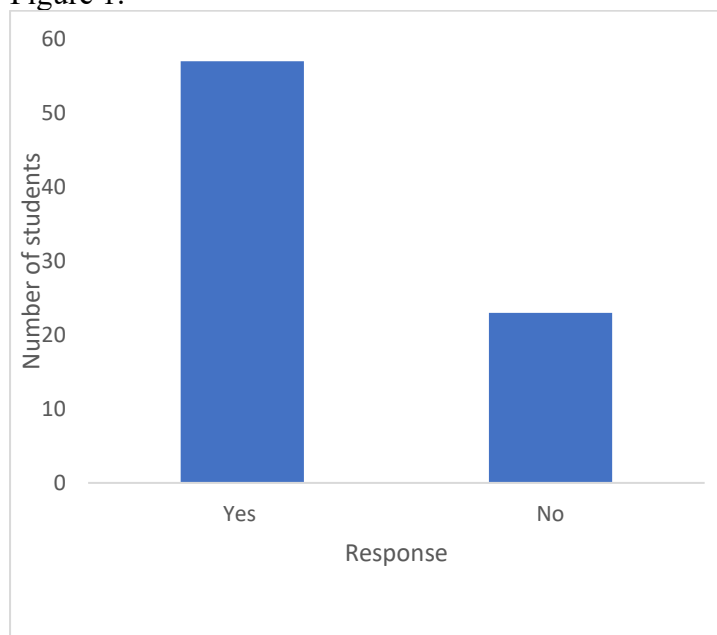


Fig. 1: Responses on substituting standardized materials with improvised materials

Fig 1 shows that 70.37% (57) of the respondents were of the view that improvised materials could utterly replace standardized teaching and learning materials in biology. Their reasons given are presented in Table 2.

Table 2. Respondents' reasons improvised materials can replace standardized materials

Reasons	Frequency	Percentage (%)
Standardized materials are absent in most schools, improvised materials are used in place of the standard materials	45	78.9
They also function the same way as the original materials.	48	84.2
Biology as a subject, deals with structures and these structures can be improvised in the absence of standardized materials.	11	19.3
They can be used to convey understanding to students the same way the standardized materials will.	57	100
Total	161	282.4

NOTE: Multiple Responses accounted for differences in total percentage responses
From Table 2, the reasons given for saying improvised materials can replace standardized materials are: biology as a subject deals with structures and these structures can be improvised in the absence of standardized materials (19.3%), improvised materials can be used to convey understanding to students the same way the standardized material will (100%), standardized materials are absent in most schools, improvised materials are used in replace of the standard materials (78.9%) and improvised materials can function the same way as the original materials (84.2%).

Figure 1 also indicated that 24 (29.63%) suggested improvised materials cannot utterly replace teaching and learning materials in biology. The reasons given by the respondents are presented in Table 3.

Table 3. Respondents' reasons improvised materials cannot replace standardized materials

Reasons	Frequency	Percentage
Some improvised materials are costly to develop and lack of finances will be a hindrance	19	79.2
Some improvised materials demand high expertise, therefore, teachers with low expertise cannot improvise those materials to replace the original	23	95.8
Most teachers who do not have enough time may not be able to improvise materials that demand much time in construction.	24	100
Chances in experimental error may increase, results that would be obtained from the use of improvised materials may be approximates and uncertainty in measurements could arise since these materials are not standardized.	15	62.5
Total	81	337.5

NOTE: Multiple Responses accounted for differences in total percentage responses

Data from Table 3 reveal reasons why improvised materials cannot replace standardized materials. These reasons include some improvised materials being costly to develop and a lack of finances will hinder the improvisation of the materials (79.2%). Also, improvisation demands high expertise therefore teachers with low expertise cannot improvise those materials to replace the original (95.8%), and teachers who do not have enough time may not be able to improvise materials that demand much time in construction (100%). Also, respondents indicated that the chances in experimental error may increase, results that would be obtained from the use of improvised materials may be approximates and uncertainty in measurements could arise since these materials are not standardized (62.5%).

When asked if improvised materials can be rigorous and lead to a systematic approach to teaching Biology, 65% (53) of the participants responded yes, while 16.05% (13) disagreed. Respondents who said 'yes' gave these reasons. They reasoned that since improvised materials

are developed by both the teacher and the students, the latter's curiosity about how the materials work may lead to their full involvement and attention.

Respondents who said no gave the following reasons: Though improvised materials can help in several ways they may not lead to effective teaching because not all materials needed to teach some biology topics or concepts can be improvised. Again, even though improvised materials improve the teaching and learning process, they cannot be used as a main resource in teaching some biology concepts.

Students were asked if there was any negative effect of improvisation on teaching and learning biology. Out of 81 respondents, 33 (40.74%) indicated that improvised materials have negative effects on the teaching and learning of biology with 48 (59.26%) of the respondents saying that improvised materials have no negative effect on the teaching and learning of biology. Reasons given for saying 'yes' are that students do not have a feel of the original material/objects which deprives them of the actual practicality of the material since it's an improvised material presented to them. Also, students cannot compete with their peers who have been introduced to standardized materials.

Respondents who indicated that improvised materials have a positive effect on learning argued that they will introduce the students to practical work and also enable them to have a fair idea of how to use the standard instrument.

Research Question 2: What Improvisational Skills Did the Pre-Service Teachers Exhibit During the Improvisation of Instructional Materials.

Research question two required the respondents to develop improvised materials that could be used to teach named concepts in Biology as a way to determine their improvisational skills. The improvised materials were evaluated to ascertain the quality and suitability to concepts to be taught. While a number of the pre-service teachers were curious and eager to develop the instructional materials, others were reluctant to improvise. Few complained about finances and the fact that they had no idea of what and how to improvise. The results are presented in themes.

Development of Improvised Materials

Improvisation though is either by construction, modification or substitution, pre-service teachers were specifically asked to construct or develop teaching materials to show their creativity and innovation. A few of the respondents were very innovative and developed a range of instructional materials. A greater number of the pre-service teachers did not exhibit any form of creativity in their development of materials. Their excuse mainly was that, they did not know exactly what to improvise. These pre-service teachers just drew images of organisms on paper or cardboard, others cut plastic bottles to represent beakers or funnels without any creativity while others picked items from the environment. Only a few of the pre-service teachers were able to describe how they developed or constructed the teaching materials. Majority of them could not describe the developmental process. Teaching materials improvised include models of unicellular organisms (*Amoeba*, *Paramecium*, *Euglena*, bacteria, etc.), models of the system in mammals (respiratory system, circulatory system, digestive system), models on cell division, models on DNA replication, models of the structure of the cell membrane and Spirogyra among other materials. Some students just picked or purchased materials from the environment (wire mesh was presented as quadrat, plastic containers were presented as beakers). Some also developed materials that couldn't be used to teach any concept in biology (set-up for separation of mixtures, set-up for alcohol distillation).

The use of Improvised Materials to Teach a Named Concept

The presentation by the pre-service biology teachers revealed that very few of them were able to describe how the improvised material could be used to teach with majority of them not knowing how they could use it to teach the named concept. When asked how they came about the idea of improvising that particular teaching material, they indicated that they saw the material on-line and decided to improvise since it was easy to develop. Some of the pre-service teachers who were also able to describe how their improvised materials could be used to teach specific biology concepts had few challenges during their presentation. Further checks revealed that some of the pre-service teachers who were able to describe how to teach with the improvised materials were trained teachers.

The Quality, Durability and Attractiveness of Improvised Materials

The quality of some of the materials used was questionable with few of them durable. Some were colourful and attractive. Some of the concepts were not well depicted and students were asked to work on them but some were reluctant. Pre-service teachers indicated that they had technical challenges during the process of improvisation so achieving the necessary exactitude with the materials improvised was difficult. Also, they lacked the right tools needed to create certain materials leading to unattractive and substandard production of improvised materials.

DISCUSSION

The study has revealed the perception of pre-service biology teachers about the effects of the use of improvised materials in the teaching and learning of biology. Eminah (2009) indicated that concrete experience is essential for effective learning. When instructional materials are included with lessons, students are encouraged to learn through multi-sensory modalities and associative mechanisms. Therefore, the requirement for creativity and efficient use of instructional materials by students gives them first-hand experience rather than the stone of abstract theory.

The benefits pre-service teachers placed on the use of improvised materials in teaching and learning of biology were emphasized by Chukwunyeremunwa (2013). He intimated that improvisation allows inexpensive local materials to be used instead of pricey imported. This he said reduces educational institutions expenditure on equipment, allows teachers and students to show off their creative abilities and also students are given the chance to familiarize themselves with the resources in their surroundings, thereby improving their scientific inquiry skills. Students, therefore, should be engaged in the process of improvisation and should not be the privilege of teachers only (Aina, 2013). Instructional materials whether standardized or improvised are of great importance in the teaching and learning process. Studies have shown that instructional materials of any form lead to high learner achievements when used efficiently and adequately by teachers during the instructional process. Also, since most of the raw materials can be obtained by the students themselves, it promotes student participation in class, engages them in interactive production activities, and piques their curiosity because the products are made of materials they see daily (Osei-Himah, Parker & Asare, 2018). Employing improvised resources allows teachers to implement interactive activities that facilitate student collaboration and encourages active learner participation (Ramaila, 2022).

Though, improvisation can be a viable alternative to standardized materials in science teaching, especially in situations where the original materials are not available or where they are available but not functional, it should not be used to replace standardized materials but rather as a complementary approach to science teaching and learning (Ogbe & Omenka, 2017) to address the inadequacy of standardized instructional materials. Improvisation should be the

exclusion but not the norm because of some inadequacies of improvised materials including durability, appropriateness and unavailability or scarcity of some raw materials needed for improvisation. Most science teachers according to Ogbe and Omenka (2017), are not inventive enough to improvise instructional materials. This he said could be due to the lack of creative skills and lack of knowledge of improvisation. Nwagbo (2008) asserted that most science teachers (biology inclusive) cannot improvise biology equipment and materials because they lack creativity and resourcefulness. This was emphasized by Ezeasor et al., (2012) that improvisation is not maximized because many teachers lack the creativity and motivation to improvise science instructional materials. Also, according to Asadu and Eze (2005), a lot of time is wasted on improvising a single item that can be purchased and if learners are involved, it may disrupt the school activities.

The pre-service biology teachers' negative attitude towards improvisation corroborated Tsuma (1998) that though improvisation serves to minimise educational costs, many science teachers are either unwilling or unable to improvise teaching materials for lack of skills, motivation or appreciation of the need to do this. Asadu and Ameh (2002) also asserted that the lack of instructional materials in most schools can be ascribed to several factors such as the laissez-faire attitude of some science teachers, inadequate knowledge of the skills and strategies for improvisation and lack of financial support from the school administrators to encourage teachers to improvise teaching/learning materials. Igwe, Arop, and Ibe (2013, p. 32) noted that "the problems teachers have with improvisation of instructional materials mostly relate to their failure to give a thought on what to construct, functionality and precision of the instructional material, motivational and financial problems". Chukwunyeremunwa (2013) also noted that some technical factors challenge the degree of accuracy and precision that can be achieved with the improvised materials and equipment. This problem he said is crucial at the secondary and tertiary levels of education where experiments that are more sensitive and observations are carried out.

CONCLUSION

This study examined perceptions of pre-service biology teachers about improvisation and the use of improvised materials in the teaching and learning of biology. The findings underscore the vital role instructional materials play in effective biology education and highlighted the persistent challenges of resource inadequacy in many schools, particularly in developing countries like Ghana. The study advocates for the adoption of improvisation as a strategic response to the shortage of instructional materials, emphasizing the need for both teachers and students to actively engage in the creative process.

While pre-service teachers acknowledged the benefits of improvised materials, including cost reduction, enhanced creativity among teachers and students, and increased student participation, concerns about financial constraints, expertise requirements, and time limitations were raised. The research suggests that improvisation can be a valuable complement to standardized teaching materials, particularly in situations where resources are scarce. However, it cautions against viewing improvisation as a wholesale replacement for standardized materials, as some challenges and limitations persist.

The study contributes valuable insights into the importance of incorporating improvisation skills into pre-service teacher education. Overall, the research advocates for a balanced approach, recognizing the potential of improvised materials to enrich the learning experience while acknowledging the continued significance of standardized resources in comprehensive and systematic biology education

RECOMMENDATIONS

Technology, a leading part of the 21st-century learning experience can be used to supplement teaching and learning and provide support to those with needs when well incorporated in the classroom. However, implementing educational technology in the classroom come with its own challenges. Many teachers have impediments that preclude them from sourcing, installing, and using technology that can be used to improve their students' academic prowess. Pre-service teachers, therefore, should explore how the integration of technology, such as digital resources and on-line platforms, can enhance the process of improvisation in the teaching of biology. Also, assess the effectiveness of technology-supported improvised materials in promoting interactive and engaging learning experiences.

Improvisation of science instructional resources is the sole responsibility of the classroom teacher. The refusal of the science teacher to improvise will be detrimental to effective teaching and learning. Since pre-service teachers acquire improvisation skills during their training, lecturers should investigate the extent pre-service students are involved in the development of improvised materials and assess the impact of student participation on their learning experiences and outcomes.

REFERENCES

- Adebanjo, A. A. (2007). Effect of instructional media on the learning of computer in JSS. *African Journal of Educational Research*, 1(2), 71-75
- Adeniran, M. A. (2006). Strategies and utilization of improvised Biology Instructional materials and students' achievement and attitude in Ekiti secondary school, Nigeria. *International Journal of Research in Education*, 3(2), 91-96
- Ajayi, P. O. (2008). Evaluation of the Implementation of Senior Secondary School Physics Practical Activities in Nigeria. *Research in Curriculum Studies*, 5(1), 105 – 120,
- Bello A. A., & Olowonefa, G. (2004). The role of instructional materials in the teaching-learning process. *Nigerian Journal of Curriculum Studies*, 11(2), 252–255.
- Aina, K. J. (2013). Instructional Materials and Improvisation in Physics Class: Implications for Teaching and Learning. *IOSR Journal of Research & Method in Education (IOSRJRME)*, 2(5), 38-42.
- Asadu, C., & Ameh, O. (2002). Constraints of teaching and learning Government in Secondary Schools in Olamaboro Local Government of Kogi State. Thesis. In the Department of Science Education, University of Nigeria, Nsukka.
- Eminah, J. K. (2009) Rationale and approaches for improvisation in science. *UMYU Journal of Educational Research*, 1(1), 131–134
- Ezeasor, M. E. N., Opara, M. F., Nnajiolor, F. N., & Chukwukere, C. G. (2012). Assessing teachers' use of improvised instructional materials in science education. *International Researchers*, 1(3), 107-114.
- George, D., & Mallery, P. (2003). SPSS for Windows step by step: A simple guide and reference. 11.0 update (4th ed.). Boston: Allyn & Bacon
- Ibrahim, S. A., Ibrahim, A., Ya'u, S. & Abdullahi, S. A. (2019). Improvisation in teaching and learning biology in senior secondary schools: prospects and challenges. *International Journal of Scientific Research in Multidisciplinary Studies*, 5 (11) www.isroset.org
- Obanya, P. (2004). The dilemma of education in Africa. Ibadan: Heineman Educational Books.
- Osei-Himah, V., Parker, J. & Asare, I. (2018). The Effects of Improvised Materials on the Study of Science in Basic Schools in Aowin Municipality – Ghana. *Journal of Research on Humanities and Social Sciences*. www.iiste.org ISSN 2224-5766 (Paper) ISSN 2225-0484 (Online) 8(8), 20-23

- Chukwunyeremunwa, M. A. (2013). *Effect of Students Improvised Instructional Materials on Senior Secondary School Students' Achievement in Biology*. Unpublished M. Ed. Submitted to Department of Science Education University of Nigeria, Nsukka.
- Nwagbo, C. (2008). Science, Technology and Mathematics Curriculum Development. Focus on Problems and Prospects of Biology Delivery. In Udofia, N. A (Eds) 49th Annual Conference Proceedings of STAN on Science Curriculum development (77-81), and Ibadan Heinemann.
- Ogbe, A. O. & Omenka, j. 2017. improvisation and utilization of resources in the teaching and learning of science and mathematics in secondary schools in Cross River State. *Global Journal of Educational Research*, 16, 2017: 21-28, www.globaljournalseries.com; info@globaljournalseries.com
- Oyediran, "Improvisation of Science Teaching Resources", Proceedings of the 40th Annual Conference of Science Teachers' Association of Nigeria (STAN) (PACS'10) Kano, Nigeria, 55–60, 2010.
- Phelps, M., White, C., Xiang, L., & Swanson, H. I. (2021). Improvisation as a Teaching Tool for Improving Oral Communication Skills in Premedical and Pre-Biomedical Graduate Students. *Journal of Medical Education and Curricular Development*, 8, 23821205211006411.
- Pressing, J. (1984). Cognitive processes in improvisation. *Advances in Psychology* 19, 345-36 <https://www.sciencedirect.com/science/article/pii/S0166411508623584>
- Ramaila, S. (2022). The use of improvised resources in science classrooms in south african township schools. *Education and New Developments*. https://doi.org/10.36315/2022v1_end083. Pg 367-370
- Tsuma, O. G. K. (1998). *Science education in the African context*. Jomo Kenyatta \ Foundation, ISBN 9966-22-145-X.
- Toyon M. A. S. (2021). Explanatory sequential design of mixed methods research: Phases and challenges. *International Journal of Research in Business and Social Science* 10(5) 253-260. https://www.researchgate.net/publication/363294843_Explanatory_sequential_design_of_mixed_methods_research_Phases_and_challenges [accessed Apr 25 2024].
- Ugwu, T., & Ogbu, R. (1998). Strategies for improving teaching and learning of Government in Secondary Schools in Nsukka Education Zone. Thesis. In the Department of Science Education, University of Nigeria, Nsukka.
- Why are percentages important in frequency distributions? (2021). Retrieved February 1, 2023 from <http://sage-answer.com/why-are-percentages-important-in-frequency-distributions?> – Sage-Answer.