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Research Article

USING IMPROVISED SCIENCE TEACHING MATERIALS TO ENHANCE STUDENT ENGAGEMENT AND LEARNING

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Abstract
Science education plays a crucial role in equipping students with the knowledge, skills, and practical competencies necessary for technological and societal advancement. In Nigeria, science is offered across multiple levels of education, including elementary science at the primary level, integrated or basic science at the junior secondary level, and specialized subjects such as physics, chemistry, biology, and mathematics at the senior secondary level. These subjects form the foundation of Science, Technology, Engineering, and Mathematics (STEM) education, which is essential for national development. The primary objective of science education is to provide learners with hands-on experience, enhance their understanding of scientific concepts, develop critical thinking, and prepare future scientists capable of applying scientific knowledge to solve real-world problems. Effective science teaching requires the use of practical, innovative, and student-centered approaches, including improvised teaching materials, to foster engagement, comprehension, and skill acquisition. This study underscores the importance of practical-oriented science instruction in transforming learners into competent individuals who can contribute meaningfully to technological progress and societal improvement.
Keywords: Science Education, Practical Learning, STEM, Student Engagement, Teaching Materials

INTRODUCTION

Science is the systematic and acceptable way of life. It tentacle cut across different field such as physics, chemistry, Biology, agricultural science, mathematics, integrated science, technology and so on. In Nigeria, various science subjects are offer by student at different levels of education such as elementary science in primary schools, integrated science or basic science, health education, basic technology are offer at the junior secondary school level, while physics, chemistry, Biology and mathematics are peculiar to senior secondary schools and as such they are the key subjects that form Science, Technology, Engineering and Mathematics (STEM) on which the technological advancement of our dear country depends (Adeosun, 2021) . Science education is a field of study that provides student opportunity to learn the scientific processes and product through the acquisition of practical knowledge gain from the various science subjects and application of same in relevant aspect of life (Jablon, 2020). Science teaching and learning in schools is basically put in place to bring transformation to individual learners. The aim of teaching science in Nigeria schools is to give practical and current knowledge of subject matter to student, give basic skill and right understanding to student, to develop the mental capacity of student in science field, train scientist who can use the knowledge of science gain in one field to solve problem encountered in the society just to name a few (Biology Explorer, 2020). To achieve the objectives of science education, its teaching must be practically oriented. Science teaching and learning is one of the processes of education which needs additional materials to assist in its meaningful knowledge gains. Over time, it has been established that teaching of science without relevant instructional materials contributes to its abstractness. Mbaba

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Columbia Journal of Education and Social Sciences

Research Article

and Atuzie (2024) described instructional materials as vital instruments used for enhancing learning of different subject within the school curriculum. These instructional materials could be equipment, charts, tools, model and so on which are supposed to be procure/ already made teaching materials available in the school for learning processes. However, one of the challenges facing the teaching and learning of science subjects is inadequate or non-available of laboratory equipment to complement teachers' efforts. This has been found to be a major limitation to effective teaching-learning process of science subjects at the secondary school levels. Science teaching becomes more interesting, easy to teach and understand with availability of right and functional instructional materials. This implies that it is one thing to teach and it is another thing to enhance the effectiveness of what is being taught in the science classrooms. Science teaching is very effective when teachers teach student with manipulation of tools and equipments in the course of teaching and performance of experiments. There can't be effective science teaching where useful equipments and materials are not readily available, as such provision must be made for these teaching and learning materials for meaningful learning to take place in science classroom at this point improvisation of instructional material is necessary (Abidoye, Ahmed, Ahmed, & Aliyu, 2022). Improvisation is the act of making or utilizing similar available material or closely related material to aid teaching learning process due to inadequate or unavailable original instructional material. It can also be referred to as the process of using an alternative material in teaching in place of the original material such that it performs the same function that the original material supposed to perform. It can be called the use of teachers' made material in teaching where the actual material is not readily available. This involves the use of locally made material from the environment to bring about learning of any concept especially in science. However, improvisation can be viewed from different perspectives based on different people's outlook to it. Shaibu, Shuaibu, Obaje and Atawodi (2020) defines improvisation as a way of using materials or equipment gotten from local personnel to promote learning. This in other words indicates that improvised instructional materials are those teaching and learning materials produced using locally available resources with the help of experts. This simply implies the provision of a replacement made from locally or readily available raw materials for producing real or original equipment. The substitute materials are expected to function as the real or original materials with high precision as time, money and other facilities. In the view of Sam-Kayode (2020), improvisation is the ability to produce teaching materials from the rich resources in the environment which can be teacher or student made. In a nut shell, improvised instructional materials are teaching materials design and produce from the available local materials in order to enhance effective teaching and learning in schools when the procure materials are not readily available (Mbaba & Atuzie, 2024; Ahmed, 2017). A recent study carried out by Adeosun (2021) showed that some laboratory facilities and equipment are not adequately available in some secondary schools used as the study areas. Most secondary schools that claimed to have these teaching tools reported that they are not in good conditions. Previous studies revealed that laboratory facilities affect quality of teaching and learning in schools, which also affect teachers' creativity, delivery as well as critical thinking for problem solving (Abidoye & Adedeji, 2022; Abas, Hanifa & Marasigan, 2022). It was equally pointed out in another finding that insufficient laboratory equipment contributed greatly to students' poor performance in Biology (Nijimeijer, Kabue & Valdivia, 2023). Outcomes of the previous researches stated above made it clear that there is a need to improvise

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Columbia Journal of Education and Social Sciences

Research Article

most of these teaching materials where possible for effective teaching and learning of science subjects. These previous researches made it clear that improvisation is necessary at every opportunity to teach science.

NEED FOR IMPROVISATION

Teaching and learning materials are improvised for various reasons as identified by previous studies. Some of these reasons are hereby discussed:

Non availability of instructional material in schools. Many schools in the resent are faced with challenge of lack of right equipment to facilitate science teaching which makes learning of some concepts difficult to understand by students. Non availability of relevant materials has been identified as one of the major factors causing poor academic achievement in science subjects. This is displayed in carrying out teaching and learning of science concepts using rote learning, which resulted in students' cramming and not having real pictures of what is being learnt (Adeosun, 2021).

Inadequate teaching and learning material. This may be due to shortage of standard teaching materials such as laboratory equipment, teaching aids and other useful teaching resources in schools. Shortage of teaching materials may also arise due to large number of students compare to the available materials. When this occurs, students are found to exhibit a display of competitions of 'survival of the fittest' in getting hold of the available equipment. This can also lead to having difficulty in controlling the class or not able to carry all the students along as the teaching is going on.

High cost of original material or equipment. High cost of science equipment is a big challenge that limits the availability or supply of such equipment in school. When instructional material that is expected to be used by teachers in the course of instruction is too expensive the school authority may not be able to provide such teaching material for teaching of the subject in quote. This will lead to short supply of science equipment in secondary schools especially for subjects like physics, chemistry and biology which are practical oriented subjects, where students must be exposed to both theory and practical aspects of such subjects before they can be eligible to write school certificate examinations which will qualify them for gaining admissions into higher institutions for further study. To fulfill the objective of teaching the fore mentioned, improvisation becomes a necessity for both the teachers and the students at this junction when the real materials to be used are too expensive.

Materials are improvised in other to make abstract concept real. Teaching is expected to be from known to unknown, simple to complex, real to abstract in order to enable learners get the best from the concepts taught (Ibrahim, Mohammed, Abdullahi, Uzoma & Bizi, 2021). Presentation of instructional material to students makes this possible. When dealing with complex concept(s) in the classroom, it is advisable for teachers to use everything within his / her reach to make the concept(s) taught simple enough for students to understand. Improvised instructional material can serve such purposes where the procure material(s) is/are not available.

To develop creative ability in learners. This comes to play when learners are involved in the production of the materials to teaching. The exercise can be done individually or in groups where team leaders can be assigned to each group who will be responsible for reporting the activities of his/her group in the production of the instructional material(s). Learners become creative when they are involves in improvisation of material.

IMPORTANCE OF IMPROVISATION

ISSN: 3064-8491

Columbia Journal of Education and Social Sciences

Research Article

Improvisation has contributed to teaching learning processes tremendously and as such become a force to reckon with in science teaching. Some of the importance of improvisation are as follows: 1. it makes teaching learning interesting. When teaching is done with the use of right teaching aids, student are able to get easy understanding of the concept at hand, this stimulate their interest to learn more since they are involved in hand on activity during the teaching session. Likewise, students develop interest in a concept when they are able to manipulate tools and equipment, demonstrate what the teacher taught them alongside with their mates. It is cost effective. That is, it is very cheap compare to the procured material. In most cases procured instructional materials are very expensive to purchased, this hinders the availability of such materials in schools. Teaching material that are made from local available resource in the environment are very cheap to construct.

2. It makes teaching and learning real as concepts taught becomes practicable with the provision of materials for almost all topics. Availability of teaching material allows learners to participate maximally in teaching activity at the teachers' instruction and as it is commonly said that "what I see I remember, what I hear I forget, what I do I understand". When learners are involved in teaching learning process, they can easily understand the concept especially in the performance of any experiment during practical session for subject like physics or chemistry. The use of improvised instructional materials enables students to learn by doing which helps to remove abstractness of concept thereby making teaching and learning more practical.

3. It enhances hands on activities in science classroom. Science teaching can be taught in two ways:
Theory and practical aspects, whatever is taught theoretically will be supported with practical session which demands that student carry out the task of the teaching as demonstrate by the teacher.
With improvised materials students are able to take part in performance of practical activities.

4. It quickens or stimulates learning and understanding of concepts. Availability of instructional materials is crucial for science teaching and learning. The presence of teaching materials during teaching session makes teaching- learning easy for both learners and teacher thereby eradicating boredom and as such quickens student understanding. Improvised instructional materials makes this possible as it is available for use.

5. It makes teaching and learning easy for both the teacher and the students. Teaching is done with ease without any stress when instructional materials are used to explain concepts. Students are able to grasp and understand the concept at hand as they manipulate equipments and tools to ensure they perform science experiment as directed by the teacher since practice makes perfect and we learn by doing. Improvised materials help to simplify teaching learning process for learner as seeing is believing.

6. It leads to development of problem-solving skills especially in Mathematics. Teaching with instructional material help to develop in learners' ability to apply knowledge gain in one subject to other aspect of life so as to provide solution to their challenges. For instance, mathematics is filled with solving problems, learners are able to tackle mathematical expression they come across in other science subject with ease using the problem-solving skill gained in mathematics. Likewise, students have hope that they can provide solution to the world problem through logic thinking and involvement in production of instructional materials (Educorpus, 2024).

7. It leads to development of creative and innovative abilities in teachers and learners. Improvisation of materials is not limited to teachers alone, as both the teacher and the student should be involved in improvisation of instructional material where the procure material is not available or too expensive. Involvement of learners in

ISSN: 3064-8491

Columbia Journal of Education and Social Sciences

Research Article

the production of instructional materials makes them to be creative with objects. This creative ability leads to development of innovative ideas in learners whenever they come across any useful material. For instance, student fashion chalk into dice in mathematics class when they are taught probability, this they practice repeatedly at home and use it to play their own improvise ludo game.

8. It brings about cultural relevance as students from different cultural background learn together and share ideas as they are involved in improvisation of materials.
9. It fosters the development of relevant skills in teachers and learners such as critical thinking and problem-solving skills. Creative skill, problem solving skill among many others are developed in students and teachers as they embark on production of instructional material
10. It provides an avenue for teacher to get feed-backs from students. Teachers are able to detect how best student understand what they were taught during the course of teaching. Skillful students are also detected in the process.
11. It ensures that students are engage in production of instructional materials as it can be giving to students to carry out inform of project work in science class. Production of improvised instructional material should not be limited to teachers alone but can be extended to student inform of project work, group assignment etcetera.
12. It leads to development of student-teacher relationships and student-student relationships. When good relationship is instilled in learners towards the teacher, it helps to promote smooth relationship between them. Spirit of cooperation is also developed as students work together in groups as well leads to development of emotional intelligent as they respond to others effectively.
13. It adds to the stock of instructional materials in schools thereby increasing the level of instructional materials in schools (Sam-Kayode, 2020). Improvisation provides the opportunity for teacher to equip the school laboratory thereby increasing the number instructional material available in school.
14. It provides links between practical and theory teaching of scientific concept taught. Concept taught theoretically becomes real when student are taught with improvised material where the procure material is not available. With this student have better understanding of such concept and are able to connect between theory and practical knowledge of scientific concepts.
15. Achievement of science educational objectives becomes possible through the use of improvised instructional materials in teaching. Goals and objectives of science teaching in school is possible with the aid of improvised instructional in this era of lack or insufficient laboratory equipment that can make hand on activity possible in science classroom.

MATERIALS THAT CAN BE IMPROVISED IN SCIENCE CLASSROOMS

- **Equipment/ instruments:** These can be categorized into; Glassware such as beaker (use glass cup), test tube (disposable syringe), pipette (infant drug dropper), reagent bottle (drug bottle), specimen bottle (wide mouth transparent container of biro, Bama bottle) , measuring cylinder (granulated feeding bottle), reagent bottle (empty drug bottle) and so on
- **Heating equipment**: Equipment that are used for warming of substance during performance of experiment in science such as Gas or Stove, tripod stand, Bunsen burner these can be improvised using candles, lantern, alcohol burner, coal pot and so on.

ISSN: 3064-8491

Columbia Journal of Education and Social Sciences

Research Article

- **Measuring equipment:** This includes glass cylinder (granulated infant feeding bottle, syringe), burette, pipette (children drug dropper) meter rule (a piece of calibrated tie rod)
- **Reagent and chemicals:** they are important for performance of biological experiments few of which can be improvised. Potassium per manganese solution can be improvised using pen ink, Eosin solution can be improvised with solution of red dye, and nutrient medium can be improvised with custard.
- **Models of organs:** these include vital organs from plants and animals. They can be improvised using paper marsh, sawdust, starch dye, paint and other useful materials (Ogunbowale & Afolayan, 2011). Improvisation in this case required that such organ must be drawn on a ply-wood with pencil before sawdust or paper match is placed on it. Model with paper match, soak old newspapers or waste paper in water for about two days. Marsh the soaked paper with hand or with mortar and pestle, mix the paper with cooked or cold-water starch to make it stick together. Gently place the paper match on the already drawn diagram and allow it to dry. The same method can be used for saw dust only mix sawdust with water and add starch to it, place it gently on already drawn diagram of desired organ and allow it to dry. Various ecological instruments could be improvised locally in the environment such as rain gauge, wind vane, insect net, quadrant, and anemometer and so on.

Improvisation of a Typical Instructional Material: A Quadrant in Biology

A quadrat is an instrument used in biology for population studies. It is used for estimating the species and number of plants in an area.

Materials Needed: Wood or tie rod, string or twine, nail, cello tape or black tape, **Procedure:**

Cut tie rod or wood into four equal sizes and make it into four square shaped like a photo frame

✞ Nail each edge with small size nail or bind together with cello-tape or black tape

Source: McPherson, 2015

✞ With the aid of tape rule divide each length of the frame into equal sizes, and mark these points with a pen.

Source: McPherson, 2015

Pin or tie four lengths of string or thread across the frame to divide the quadrat into many squares. The material is ready for use.

ISSN: 3064-8491

Columbia Journal of Education and Social Sciences

Research Article

Source: McPherson, 2015

Materials that can be improvised in Chemistry

Tripod stand can be improvised with an unused stove frame for supporting during heating substances.
Bunsen burner Kerosene stove Source of heat
Funnel Plastic bottle open at base for transferring liquid
Litmus paper can be represented by blue and pink cardboard
Round bottom flask can be represented with Electric bulbs and can be used for measuring liquid volume (Ahmed, 2017). Measuring cylinder: Graduated feeding bottle for measuring liquid volume. Test-tube holder the use of peg or clip for holding test-tube during qualitative analysis. Spatula a piece of flat wooden part of an ice cream sachet can be used for putting chemicals and salt into a test-tube during quantitative analysis. problems associated to improvisation include: lack of financial support from the school principals, lack of skills and strategies for improvisation and large class size arising from free and compulsory Secondary education, school location where most Secondary Schools are located in rural areas, time constraint, unavailability of producer goods or tools, inability to identify local materials and lack of exposure on improvisation on the part of teachers. Inadequate training, poor funding, lack of functional workshops, lack of regular supervision of teachers, poor motivations are among the factors hindering effective production and utilization of teacher-made instructional materials (Ahmed, 2017).

Materials that can be improvised in Mathematics

Different types of shapes for teaching mensuration, such as the use of tin of baby food for cylinder, use of match box for cuboid, the use of cube of sugar for cube shape, cardboard can be fashion into cone, Sphere can be represented by orange, hemisphere can be represented by half of an orange, card board or carton of soap can be cut into different shapes such as triangle, rectangle, square, circle. Flash card can be improvised with card board, dice can be improvised by cutting piece of chalk and mark the numbers on it with pen respectively. Graph can be improvised by constructing graph board and so on.

Materials that can be improvised in Physics

Weighing balance can be improvised by hanging two containers with load at both ends of the hanger with cloth hanger.
Meter ruler can be improvised with a piece of ply wood calibrated with markers.
Boiling point equipment can be improvised with: beaker, thermometer and hot plate
Measuring cylinder: a calibrated feeding bottle Beaker: a piece of transparent glass cup Funnel: cut a portion of bottle water.

Challenges of Improvisation problems associated to improvisation of instructional materials is faced with many problems which limit the rate at which it is carried out in schools, some of which are as follows:

ISSN: 3064-8491

Columbia Journal of Education and Social Sciences

Research Article

1. Lack of financial support or inadequate fund: money is required for improvisation of any material as some item to be used in improvisation may be purchased. When money is not readily available it will hinder production of such material that is to be improvised. This financial support is to be provided by school management, government, and parent in some cases when students are assigned to improvise instructional material as project work. Where money is not released by government to school, or the school management fail to release money to teacher to embark on improvisation of instructional material production of such material will not be possible.
2. Lack of skills and strategies for improvisation: knowledge is power. Improvisation of instructional materials requires some skill from the one to improvise the material. Some teachers lack the required skill and as such may not be involved in improvisation of material or task learners to do so since you can't give out what you don't have, also you can blame them if you don't teach them.
3. Inadequate training and functional workshops: training of teachers should be continually. It should not be limited to the training they have received during their undergraduate time alone. Inservice training informs of seminal presentation and workshop for teacher enable teachers to be well informed and acquire relevant skills in the classroom that can promote teaching-learning process is no longer common now adays. Knowledge required for improvisation is achieved in most case during seminal and workshop training. Organization of seminal and workshop has almost become impossible these days especially in public schools and this limit the rate at which instructional material in been improvised in public schools.
4. Lack of regular supervision of teachers: inability of school management and other agent saddle with monitoring of teachers are no longer monitoring teachers when they are discharging their duties any amore. This makes teachers to relent their effort of getting the instructional material needed to teach the various science subjects ready unlike when they know that the supervisory team will request for their instructional material whether it is available or provided for by school management or not available (Ahmed, 2017).
5. Lack of motivation is one of the factors hindering effective production and utilization of instructional materials by teachers. Provision of incentive for teachers can motivate them to embark on improvisation of material or sustain it. In some cases when improvisation is assigned to student as project, teachers are been blamed by school authority especially where student need to contribute money among themselves to purchase items needed for completion of such project. Such teachers that received the blame will not want to be involved in improvisation nor involve the student any longer.
6. Time constraint: is a major limiting factor to improvisation of instructional material. The broad nature of some science subject like biology does not encourage teacher to be involved in improvisation of materials as it is supposed to be. This is because teachers have to meet up with the coverage of selected concepts as required in the scheme of work. As such it is required of such teacher to finish a particular set of topics as student must be able to compete with their counterpart and pass both internal and external examination with good grades. Here no time will be allowed to be wasted on improvisation as it consumes time.

Conclusion

In concluding this piece, the need for improvisation cannot be overemphasized since inadequate instructional material in terms of equipment and materials has been identified by previous studies as one of the challenges of effective science teaching and learning in schools. This paper discussed Improvisation of instructional materials

as effective means of providing solution to the afore mention problem. Needs and importance of improvisation of instructional materials were discussed. The paper also discussed how to improvise instructional materials in various science subjects, the challenges of improvisation and suggestions on how to manage the challenges were also made for effective teaching and learning of sciences.

Suggestions

It is suggested that various stakeholders should play their parts to make improvisation of instructional materials possible in schools to make teaching of various science subject effective.

1. Government and other stake holders should provide fund or financial support for teacher.
2. Teachers should develop themselves by reading more on how to improvised instructional materials, study more on the use of technology as means of getting instructional materials for teaching science subject. This will expose them to good knowledge and strategies of improvisation of instructional materials.
3. In-service trainings should be organized for teachers regularly to enable them to require right shills required for improvisation of instructional material though seminal sans functional workshops.
4. School management, teaching service commission and ministry of education should regularly monitor classroom teaching so as to enable teacher to improvised instructional materials.
5. Teachers should be motivated with good words, commendation letter, awards and cash at times to encourage them to do their best in improvising instructional materials.
6. Improvisation of instructional material should be included in the school curriculum to enable quality of time to be allotted for it.

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