Improvisation in Science Practicals as Means of Equipping Students with Skills in Science for Sustainable Development

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Abstract

All over the world, it has become fashionable that acquisition of education without the appropriate skills relevant to such area of specialisation is of no use to the development of a nation. Equipping students with skills relevant to their practice in their areas of specialisation has become a paramount part of learning. Nowadays, teaching without instructional materials has become a norm due to the non-availability of resources for teaching in the schools. Improvisation comes in handy as an alternative to real materials for practical activities. This study investigates students' achievement in science practicals as a result of their involvement in the production and utilisation of improvised materials. It also determines the influence of gender on students' achievement in science practicals. A total of 240 SS II students of intact classes assigned to experimental and control groups in each LGA were the participants. The treatment lasted 12 weeks. Three hypotheses were tested at 0.05 level of significance. Pre-test, post-test control group, quasi-experimental design was used. Students' science practical achievement test (r = 0.83) was used for data collection. Data were analysed using ANCOVA and Estimated Marginal Means. Treatment had a significant effect on students' post-test achievement score (F(1,232) = 390.959, P 0.05.

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Introduction

Science plays a very important role in the development of appropriate technology. It is a driver of economic and social change worldwide. Owolabi (2004) defined science as an integral part of human society. Science is the foundation upon which the bulk of present-day technological breakthroughs are built. Its impact is felt in every sphere of human life, so much that it is intricately linked with a nation's development. Science as a field of study has done a lot for mankind. For instance, life has been made a lot easier for man as a result of the advancements in science. The pursuit of science by scientists have a key role to play in sustainable development. Science for sustainable development is the focus of Chapter 35 of Agenda 21. It calls for strengthening the scientific basis for sustainable management, enhancing scientific understanding, improving long-term scientific assessment and building up scientific capacity and capability. Nowadays, nations all over the world, including Nigeria, are striving hard to develop technologically and scientifically, since the world is turning scientific and all proper functioning of lives depend greatly on science.

Biology, the study of life, is a very important science subject and is necessary in acquiring a profitable career in the biological sciences and various aspects of life. Liras (2004) declared that everyone accepts Biology as the science of the twenty-first century. According to Johnson (2006), the importance of biology will continue to have a profound impact on our lives for decades. Developments and advances in biology help to sustain development in all areas that have to do with sustenance of life. Among the West Africa Examination Council (WAEC) objectives for Biology are the following:

- understanding of the structure and function of living organisms as well as appreciation of nature;
- acquisition of adequate laboratory and field skills in order to carry out and evaluate experiments and projects in Biology;
- relevant knowledge in Biology needed for future advanced studies in biological science; and
- ability to apply biological principles in everyday life in matters that affect personal, social, environmental, community health and economic problems.

There cannot be positive outcomes in performance in Biology if the right method of teaching especially in the practical aspect where skills can be acquired, is missing. For progressive development in the area of health and to sustain this, the process of learning needs to meet up with the standards and trends worldwide. This can be achieved by making the students participate actively in the teaching and learning process. Biology teaching involves exposing students to several opportunities to enable them understand different types of concepts and principles. The implication is that biology teaching must be effective and meaningful to achieve its goals. It requires being taught with various methods especially those that are practical oriented and encourage child-centred learning mode. The teaching and learning of biology, therefore, entail making the student acquire skills that would help in self as well as national development and sustainability.

In the world today, the knowledge of biology has become paramount, relevant and indispensable. Therefore, teaching this subject without achieving the objectives will negate its usefulness in the society. The poor performance in Biology has been attributed to multifaceted factors among which are inadequate practical equipment (Onyegbebu, 2006), non-utilisation of instructional resource materials by teachers (Wilton, 2007), inability of teachers to provide opportunities for students to apply theoretical knowledge of science concepts in practical situations (Ayogu, 2007) and the use of inadequate teaching strategies for understanding difficult concepts (Nwagbo, 2008).

Mboto, Ndem and Utibe-Abasi (2011) defined improvisation as the act of providing teaching materials from our locality when there is shortage of the standard ones. According to Abolade and Olumorin (2004), most of the standard instructional materials produced in the factory are scarce and expensive to buy. Most times, materials for teaching are not readily available and so, teachers need to find means of passing across knowledge in such a way that the students will not only acquire the knowledge but will be able to apply it to their everyday life. Abolade (2009) emphasised the fact that it is when the original instructional materials are not readily available for use in teaching and learning that the teacher can come up with other forms of instructional materials. Improvisation is all about teachers acquiring and developing the skills of producing teaching materials in time of need from local materials

available in the environment to make teaching meaningful, effective and efficient.

Studies carried out on improvisation in relation to teaching and learning include those by Zarewa (2005) , which has to do with the successful Universal Basic Education (UBE) implementation through the use of locally sourced materials in the teaching of basic concepts in integrated sciences, George and Amadi (2016) on improvisation skills by mathematics teacher; Aina (2013) on instructional materials and improvisation in the physics class: implications for teaching and learning, and Ogbe and Omenka (2017) on the improvisation and utilisation of resources in the teaching and learning of science and mathematics in secondary schools in Cross River State.

Improvised instructional materials make teaching biological concepts more interesting to both students and teachers in the classroom, improvised materials are usually simple and may not have perfect finishing, because they are made from local raw materials that are acceptable to students. Improvised instructional materials help Biology and other science students to realise that science has to do with ordinary things and will possibly motivate them to carry out experiments and learning activities themselves using such improvised materials, (Johnson, 2000).

Improvisation tends to remove abstraction(s) in learning theories because the products of improvisation are tangible, handy and concrete. Improvised instructional materials must be very safe to use during demonstrations and experiments. It must be hazard free or danger-free. The product must not be capable of inflicting injuries on the user or person operating it. Improvised instructional materials should be used effectively in teaching Biology (Ahmed, n.d). This study seek to find out if the improvisation of science materials would actually produce the desired influence in the teaching and learning of science to necessitate its adoption by biology teachers.

The issue of gender is an important one in science education, especially with the increasing emphasis on ways of boosting manpower for technological development as well as increasing the population of females in science and technology fields (Ogunkola and Bilesanmi-Awoderu, 2000). Many reasons have been advanced for the low participation of girls in the sciences. Emerging evidence shows that ability is not a determining factor in whether or not females would participate in science. Strategies have been evoked to attain and

sustain gender equality. The Sustainable Development Goal (SDG) 2030, number 5, which is Gender Equality aims at achieving gender equality and empower all women and girls. Girls and boys have been found to perform equally well if instructional context is fair and conducive (Erinosho, 2008; Lawal, 2009). Researchers such as Arigbabu and Mji (2004), Bilesanmi-Awoderu, (2002, 2006) and Olasehinde and Olatoye (2014) found that there are no longer distinguishing differences in the achievements of students in respect of gender. Researchers like Christine (2004), Amoo (2011) and Kauru (2010) found that girls achieve higher in science. Oludipe (2012) compared male and female students' achievement in basic science and found no significant differences. The study of gender differences among senior secondary school students is inconclusive.

Theoretical Framework

This study hinges on the Constructivist Theory. 'Constructivism is a theory of knowledge (epistemology) which argues that humans generate knowledge and meaning from their experiences' (Azadeh, 2010). In this study, the students are exposed to the process of improvisation of instructional materials and its use in practical activities so as to bring about meaningful and significant learning. Based on this exposure, critical reasoning and practice, students are expected to build up knowledge and skills in practical activity.

Statement of the Problem

It is believed that in science subjects, males are at the forefront when compared to females. Despite the extensive efforts being made worldwide for gender equality, there still exists some gap in the learning of males and females in science. The use of improvisation in the learning of science in order to fit into global trends in the educational system can help to take care of this problem. Therefore, this study seeks to determine the effects of improvisation of science materials on students' achievement in terms of knowledge and practical skills in science (Biology) in Ibadan, Nigeria. The study also focused on how gender influences students' achievement in terms of knowledge and practical skills in science.

Purpose of the Study

The main objective of this study is to determine if the exposure of students to improvised materials and their use will bring about an improvement to their knowledge and practical skills in biology. It also seeks to determine the influence of gender on students' achievement in terms of knowledge and practical skills in science.

Hypotheses

Ho_1: Improvised materials and equipment for science teaching will not significantly improve achievement of students in science practicals.

Ho_2: Gender will have no significant effect on students' achievement in science practicals.

Ho_3: There is no significant interaction effect of the use of improvised materials and gender on students' achievement in science practicals.

Method

The study adopted a pretest, post-test control group, quasi experimental design to determine the effect of improvised materials and their use on students' achievement in terms of knowledge and practical skills in science. However, the control group which was not involved in the experimental processes, was exposed to explanations in practical science through the use of pictures and charts. The experimental groups were also exposed to explanations through the use of charts and pictures after the completion of the study.

Variables of the Study

The following variables were used in the study,

Independent Variable

(a) Instruction with improvised materials

(b) Conventional instruction (without improvised materials)

Moderator variable

Gender (Male and Female)

Dependent Variable

Students' achievement in science practical.

Population and Sample

Three Local government areas were randomly selected from the Ibadan metropolis for this study. From these, six schools were purposively selected and intact classes were used. The researcher used 240 Senior Secondary School Two (SS II) students of intact classes for this study. Schools were assigned as experimental and control groups using the random sampling technique. The research assistants for the study were the biology teachers of the schools.

Instruments

The following instruments were used for the study:

(a) Students' Achievement in SciencePractical Test (SASPT)
(b) Teachers' Guide on Instruction using Improvised Materials (TGIIM)
(c) Instructional Guide for Teaching with Conventional Instruction (IGTCI) – without teaching materials
(d) Evaluation Sheet for Assessing Teachers (ESAT)

Students' Achievement in Science Practical Test (SASPT)

The instrument was developed by the researcher to measure the cognitive achievement of students in SciencePractical Test before and after the implementation of the intervention. The instrument consists of three sections. Section A consists of personal data of the students showing name, sex, age bracket, name of school. Section B consists of ten (10) multiple choice questions options a - d. Section C consists of ten (10) true or false items. Each correct answer in sections B and C was awarded one (1) mark, making a total of twenty (20) marks. To ensure uniformity in the scoring of all items, a marking guide was prepared for the marking and scoring the SATB. The reliability coefficient of the 20 items was determined using Kuder Richardson 20 (KR-20) formula. A reliability estimate of 0.82 and an average difficulty index range of 0.4 to 0.6 was obtained.

Teachers' Guide on Instruction Using Improvised Materials (TGIIM)

The instrument was developed by the researcher to guide the production and use of improvised materials in the teaching of Science Practical Test. The teachers were trained to be able to guide the students during the production and use of improvised materials to learn ecology. The instrument was validated using the Pi's inter-rater, Reliability index with the value of 0.77

Teachers' Instructional Guide on Conventional Strategy (TIGCS) – without teaching materials

The instrument was prepared according to the behavioral objective of the teaching of ecology with the lecture method. The teachers were instructed not to use any instructional materials both for teaching and practical activity. The instrument was used in schools representing the control group. The instrument was validated using the Pi's inter-rater Reliability index was 0.78

Evaluation Sheet for Assessing Teachers' Performance During Training

The instrument was developed by the researcher to determine the teachers' knowledge and skills of improvisation of materials and use for teaching.

Procedure for Data Analysis

Data obtained were analysed using descriptive statistics such as mean, standard deviation and frequency count and inferential statistics such as Analysis of Covariance (ANCOVA). The result was used to test the research hypotheses. The Estimated Marginal Means (EMM) was used to show the magnitude of the posttest mean score.

Table 1 displays the scores of students' achievement in descriptive statistics. Included here are the number of students involved in the study, the mean score and standard deviation obtained from the research. The table reveals that the mean score of the conventional instruction group in knowledge acquisition was less than that of the group taught with the learner centered form of instructional delivery. The availability of more learning resources (i.e., improvised materials) may have contributed to this.

Table 2 displays the descriptive statistics of the students' achievement scores with respect to gender. The male students performed better than their female counterparts in the instruction with improvised material group and the control group in science practicals. Despite this difference, the result was subjected to further test to ascertain if the difference is significant or not.

Testing of Hypothesis

Ho_1: There is no significant main effect of treatment on students' Achievement in Science Practical

The result of the 2 x 2 Analysis of Covariance on Table 3 reveals that there was a significant effect of treatment on students' achievement in Science practicals. CF (1,232) = 390.95, P < 0.05, χ^2 =.771).This means that there is a significant difference in the achievement of students exposed to improvisation and use of instructional materials and the students taught without instructional materials (control group). This shows that students in the experimental groups were more predisposed to learning than those in the control group after their exposure to the treatment. Therefore, Hypothesis 1 was rejected. The mean scores of students across the experimental groups and control group is presented below.

Table 4: Estimated Marginal means of the Treatment group on Students' Achievement in Biology practical

A further clarification on achievement of students exposed to improvisation in practical biology using the Estimated Marginal Means (EMM) as shown in Table 4 revealed that the experimental groups had higher mean scores ($\bar{x}$ = 22.736) than the conventional instruction group ($\bar{x}$ = 14.424). The treatment is observed to have contributed to students' achievement in science practical. The source of the significant difference obtained was traced using Scheffe post-hoc test, as shown in Table 5.

Ho 2: There is no significant main effect of gender on students' achievement in Science Practical.

Table 3 reveals that the effect of gender on participants" achievement in science practicals was not significant (F (1,232) = 0.685, P > 0.05, χ^2=.006).Therefore, hypothesis Ho 2 was not rejected.

The male students had higher mean score ($\bar{x}$=19.228) while the female students had a lower mean score ($\bar{x}$=18.067) but the difference was not significant. The males are, therefore, not significantly better in their achievement in science practical than their male counterparts.

$H0_3$: There is no significant interaction effect of treatment and gender on students' achievement in science practical.

Table 3 reveals that there was no significant interaction effect of treatment and gender on students' achievement in science practical (F (1,232) = 0.141, P > 0.05, η^2 =.001). The effect size of 0.01% was negligible. Hence, hypothesis 3 was not rejected. This shows that treatment does not interact with gender to have an effect on students' achievement in science practicals. On the basis of this finding, the hypothesis was (therefore) not rejected.

Discussions

studies Previously carried out on the production and utilisation of instructional materials in teaching and learning have been found to be very effective in imparting knowledge. This present study was carried out to investigate the effect of improvisation of science materials on students' achievement in terms of knowledge and practical skills in Biology in Ibadan, Nigeria. The study also focused on how gender influences students' achievement in terms of knowledge and practical skills in Science.

Students were exposed to the process and procedure of improvisation and they were allowed to use the materials in carrying out measurements in the area of ecology. This was embarked upon with the aim of allowing the students gain some form of experience, construct knowledge and build up practical psychomotor skills that will help and enable them to be effective in their future endeavors. They will also be able to contribute their quota to sustainable development, especially if they end up in the biological sciences such as medicine and pharmacy. The treatment used produced a tremendous positive effect on the students' achievement in practical biology. This may be due to the nature of the presentation which involved demonstration and activity that has a greater advantage than the conventional lecture method that involves only an impartation of information by the teacher without making use of instructional materials, which eventually forfeits the achievement of expected learning outcomes.

The findings agree with the submissions of Aina (2013) that teachers making use of local materials to improvise physics teaching instructional materials can improve learning in physics.George and Amadi (2016) in their findings revealed that professional and experienced mathematics teachers possess more improvisation skills which helped to promote learning in their class than the non-professional and less experienced mathematics teachers. The findings are also supported by Abolade (2009) who emphasised that it is when the original instructional materials are not readily available for use in teaching and learning that the teacher can come up with other forms of instructional materials to make learning effective. This is in line with the suggestion of Oludipe (2012) that to encourage more women into pure sciences and science-oriented courses, interventions need to be designed that focus not only on the academic achievement of girls but also on how to make science-related occupations more interesting for young, high-achieving girls.

Gender had no significant main effect on the achievement of the students in practical biology. Although the male students had a higher mean score, it was not significant. This shows that gender does not significantly influence the achievement of students in science practicals. This also reveals that female students are now having positive interest in science and technology. There was no significant two-way interaction effect of treatment and gender on students' achievement of in science practicals. The result suggests that the interaction

effect of treatment and gender does not necessarily make a significant contribution to the achievement of the students in science practicals.

Implications of Findings

Results obtained from this study give the impression that exposing students to the process of improvisation and utilisation of materials produced in the process of learning can bring about great, positive strides in (terms of) achievement and interest in science. It was clearly demonstrated in the study that improvisation was very effective in enhancing students' learning outcomes. In order to advocate the adoption of the strategy for use in secondary schools, teachers need to be trained very well on improvisation, especially in all the sciences. This may be done through workshops, short courses, seminars and or conferences.

The implication for the school authorities or heads is that they need to allocate more time on the school time-table to accommodate the buildup of psychomotor skills in students.

Conclusion

Learning requires effort by learners to actively construct their own meaning that is consistent with prior ideas. Such ability requires that learners should learn how to integrate theoretical knowledge with practical activities that relate to real-life situations. This can be described as meaningful learning. This findings has shown that learners who construct their own meaning can more be effective than the traditional or conventional teaching method. This was because the instructional mode enhanced critical thinking, active involvement in learning activities and effective interaction among students. It is noteworthy that students showed a higher level of commitment to solving the problems in their practical class. Hence, this method of instruction can be used to foster the learning of selected concepts in science subjects.

Recommendations

1. There is the need for curriculum planners to include more activities in the curriculum so as to bring about effective impartation of knowledge.

2. Having brought about a significant improvement in students' achievement, this method of instruction should be recommended for the teaching and learning of various concepts in science.
3. More time should be allocated to science subjects on the school time-table to make it possible to use the method of instruction to foster the learning of selected concepts.
4. Teachers should be properly updated and trained, through special short courses, seminars and workshops, on how to improvise and use resources in the environment to bring about effective learning by sudents.

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