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Effect of Synthetic and Natural Specimen Use on Process Skills and Applications in Secondary School Biology Practical in Ekiti State, Nigeria

Oladimeji, Olaropo Ibukun* & Adebisi, Thomas Ajibade**
Dept of Science and Technology Education, Faculty of Education,
Obafemi Awolowo University, Ile-Ife, Nigeria

Abstract

Effective teaching of Biology practical entails the use of specimens. However, in Nigeria, some natural specimens are difficult to obtain when needed, hindering the learning and application of science process skills. Consequently, teachers resort to pictorial representation of specimen and to online prints for Biology practical instructions. Another possible alternative less discussed is the use of synthetic or artificial specimens. The goal of this study, therefore, was to examine the effect of using synthetic and natural specimen on practical skills- process skills acquisition and application in Biology practical in secondary schools. It sought to determine the efficacy of using synthetic specimens to complement or substitute for natural specimens in teaching Biology practical. The study employed the pre-test, post-test, control group, quasi- experimental design. A total of 212 senior secondary school (SS II) Biology students in six selected government-owned high schools in Moba and Ijero Local Government Area of Ekiti state, Nigeria, were randomly selected for the study. The schools were paired and assigned to two experimental groups (using synthetic and natural specimens) and a control group (using conventional drawings). Eight instruments were employed for the study and used at treatment stage. Data collected were analyzed using Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and Multiple Classification Analysis (MCA). The results showed that there was a significant effect of synthetic specimens and natural specimens on the proficiency of the students in basic science process skills acquisition ($F = 60.470$, $P<0.05$). However, the mean gain of 3.884 which existed between the two

*OIO oladimejiolaropo@gmail.com **TAA thomasadebisi7@gmail.com; adetom247@yahoo.co.uk

groups showed that natural specimens were slightly more effective than synthetic specimens. The results also showed a significant effect for the use of synthetic specimens on process skills acquisition and applications of Biology concept among the students (F = 74.773, P<0.05). The study concluded that synthetic specimens are equally effective as natural specimens in improving the acquisition and application of basic science process skills of students in Biology.

Keywords: Specimens, Science Process Skills, Acquisition, Application, Biology

Introduction

The poor attention given to practical Biology over the years in Nigerian schools, has contributed significantly to poor student achievements in the Senior Secondary School Certificate Examinations (SSCE) in the subject. West African Examination Council Chief Examiners' Reports (2014) noted that the low achievement of students in the sciences was largely caused by poor performances in the practical aspects of science subjects. Enebechi's study (2009) also shows that some Biology teachers in Nigerian secondary schools were not conducting Biology practical sessions alongside every topic they taught students during class lessons. Rather, they would wait until just before the final examination when they used the instructions supplied by the West African Examination Council (WAEC) for teachers to prepare specimens for the final science practical examination to conduct a last-minute practical session for their students. Manalanga and Awelani (2014) concluded from their study that absence of equipped laboratories, a lack of libraries with up-to-date Biology textbooks, and the use of inappropriate teaching methodologies contributed to poor performance of the students. Daworiye, Enaregha and Eremasi (2015), in their study of factors affecting the teaching and learning of Biology in Bayelsa state of Nigeria, also identified the main impediment as a lack of well-equipped laboratories, inadequate teaching and learning resources, non-conducive classroom environment, poor communication skills of students and poor attitude of students to Biology as a subject.

Review of Literature

The methods of doing science are through experimentation and applications and the teaching of science has always entailed practical sessions in the laboratory. Laboratory sessions ensure that science process skills are part of science instructions. Together with other physical science subjects, biology provides students with useful information that are applied to solving many daily challenges of life. Biology studies living things: plants and animals and their forms, functions, characteristics, diversity and relationship with their environment (Danmole, 2012). The study of Biology exposes students to a variety of experiences which helps them to gain the necessary knowledge and skills of science, but the teaching of Biology requires practical activities to equip the learners with meaningful and adequate laboratory and field skills (FRN, 2013).

Millar (2004) defines practical work as an educational activity in which students learn by handling materials and equipment, making use of them for observation and experimentation. Practical activity encloses an approach to learning that presents information in real and concrete form; going beyond the abstract and theoretical mode of learning (Nzewi, 2008). Practical science activities provide students with tactile learning experiences; the opportunity to observe, touch, count, measure, experiment, record and make inferences. Learners handle and make use of equipment for experiments; collect and analyze data, manipulate variables, verify facts and draw inferences from the data collected. This facilitates students use cognitive and psychomotor skills and the opportunity to learn at different stages of experimentation. It has been observed that students learn best by doing and they retain more knowledge by practicing what they have learnt (Kolb, 1984; Moon, 2013). Effective learning in science is enhanced by high quality and appropriate practical work. Students are excited and inspired to pursue science when they are exposed to relevant practical activities using proper equipment. Practical work helps students to develop the skills and ability to solve problems scientifically (Nwakonobi & Okoye, 2010).

Science process skills are the skills used in carrying out scientific operations, generating useful information, as well as solving problems (Aktamis & Ergin, 2008). They are fundamental to science, allowing learners to conduct investigations and reach meaningful conclusions. The basic science process skills are the skills demonstrated in practical classes which include observing, classifying, inferring, measuring, communicating and predicting while integrated science process skills include identifying variables, making hypotheses, constructing tables and graphs from data, defining variables and experimenting (Rezba, 1999). Studies indicate that purposeful use of instructional materials have positive impact on students' academic achievement by facilitating meaningful learning (Demirok, Baglama & Besgul, 2015; Palma, Russo & Egizio, 2017). Instructional materials include all the materials which appeal to the human senses and enrich learning, including pictures, non-projected still pictures, projected still pictures, and motion pictures, audio materials and three-dimensional materials (objects, models, mock-ups or dioramas etc.) (Stephen 2016).

Instructional materials have to be available and utilized effectively for a successful practical class to take place. The use of instructional materials in the classroom promotes students' understanding of the subject concept as well as facilitate retention of knowledge (Olatoye, 2017). When students have the opportunity of seeing, feeling and touching the materials, their interest and concentration in the classroom increase (Nwike & Catherine, 2013).

In a Biology Practical class, specimens are the major instructional materials that students work with. A specimen is an individual representative of a species that is collected for scientific investigation (Ikin 2011). A biological specimen is an individual organism, part of an organism (plant and animal) or micro-organism used to represent and study the characteristics of the entire population of a species or sub-species. Synthetic specimens are generated by redesigning non-living systems to represent a living system. It involves the use of artificial materials such as plastics, rubber, ceramics, marble to design specimens that look like a real organism. Synthetic specimens are designed with the aim of providing artificial specimens that look like natural biological specimens to serve as an alternative to teach students in Biology practical where the natural specimens are not available. They are designed in a simple and durable form that is easy to maintain and requires no preservative chemicals. The use of synthetic specimens thus makes experiments that would otherwise be impossible or difficult to carry out in school laboratories possible (European Academies Science Advisory Council, 2011).

Theoretical Framework

This study is based on John Dewey's theory of cognitive constructivism and Jerome Bruner's theory of discovery learning. John Dewey (1859–1952), the American philosopher and educator believed education depends on action. Dewey viewed learning as a process where the learners use their own explorative discovery and reasoning activities to generate knowledge, according much importance to the learner in the learning process (Dewey, 1966, 1974b). Dewey was against memorization by repetition in schools. He proposed a method of "directed living" whereby students would acquire knowledge by engaging in real practical activities and demonstrate it through creativity. He believed that students should be given the opportunity to think for themselves and express their thoughts clearly. He emphasized that education should be based on real experience and evidence. This experience is more useful in a social context, such as in the laboratory during practical classes when learners come together to share ideas, perform joint experiments, observe and make inferences.

The implication of John Dewey's learning theory for practical Biology is that materials (specimens) must be provided for students to work on in the laboratory so that they can have something manipulate with their hands. They would then be able to work in groups, interact and construct their own knowledge. This would facilitate creativity, innovation and insightful thinking among the learners, thereby turning the practical class into an activity center where the teacher now plays the role of a guide. This is a favorable environment for the more capable students to assist weaker others through cooperative learning in group setting.

Jerome Bruner's learning theory suggests that learning is an active process which includes acquisition and transmission of information, making decision, formulating hypotheses and deriving meaning from information and experiences. Learners build on past and current knowledge to synthesize new ideas. Bruner emphasized the importance of categorization in every aspect of learning. This is achieved by grouping and interpreting information in terms of similarities and differences. Bruner embraced the method of participatory learning rather than one-way method of instruction where students are only passive listeners (Bruner, 1979). Bruner postulated three modes of intellectual development; enactive - learning about the environment through interaction with physical objects and the effect of these interactions; iconic - learning through the use of images and models; and symbolic - learning through the use of symbols. Effective learning is achieved when a learner utilizes the combination of concrete, pictorial and symbolic activities. These three modes of representation are integrated and translate into one another. These apply to all categories of learners including adult learners. The implication of Bruner's learning theory for Biology Practical is that teacher should let instructional sequence progress from enactive to iconic to symbolic manner. Learners should be encouraged to find alternative ways to solve the same problem. Also, learners should assume more responsibility for learning as instruction proceeds while rich and genuine supportive environment should be provided for learning. Applying these theories in accessing science process skills in Biology Practical teaching will yield a lot of educational benefits like generation of self-confidence, curiosity, motivation for solving problems and ability to think creatively. All these can only be possible when enough instructional resources are available.

Statement of the problem

Effective teaching of Biology practical entails the use of specimens in order to facilitate the learning and application of science process skills in and outside the classroom. However, the practical class in most Nigerian schools face several limitations to the use and provision of natural specimens for instructing students; ranging from unavailability of the specimens when needed to the problem of preserving available one. Teachers have consequently resorted to the use of pictorial representation of the specimen as well as to online prints for Biology practical instructions. There is therefore a need for alternative sourcing of specimens other than pictorial and online prints that could still be used for equipping students with the necessary science process skills. It is the use of this alternative that the current study investigates. The objectives that guided the study are to:

a. ascertain the difference in proficiency of basic science process skills acquisition of secondary school students exposed to synthetic specimens and those exposed to natural specimens in Biology practical;

b. examine the effect of using synthetic specimens and natural specimens on process skills application of Biology concepts among the students in the study area.

Hypotheses:

The following hypotheses were generated from the objectives above:

$H0_1$: There is no significant difference in proficiency of basic science process skills acquisition of secondary school students exposed to synthetic specimens and those exposed to natural specimens in Biology practical.

$H0_2$: There is no significant difference in the effect of using synthetic specimens and natural specimens on process skills application of Biology concepts among the students in the study area.

Methodology

Research Design

The quasi-experimental non-randomized pre-test, post-test, control group design was employed for the study. There were three groups of students, two experimental groups and one control group as illustrated below.

Table 1: Groups assigned for the research

Groups	Pre-test	Treatment(x)	Post-test
Synthetic specimens Group (E1)	A1	B1	A2
Natural specimens Group (E2)	A3	B2	A4
Control	A5	C	A6

Where:

E1=Experimental Group 1 (synthetic specimens)

E2 = Experimental Group 2 (Natural Specimens)

A1 = Pre-test for Experimental group 1

A3 = Pre-test for Experimental group 2

A5 = Pre-test for Control group

B1 = Treatment given to Experimental group 1

B2 = Treatment given to Experimental group 2

C = Hand drawing of specimens for control group

A2 = Post-test for Experimental group 1

A4 = Post-test for Experimental group 2.

A6 = Post-test for Control group

The variables in the study consist of:

- Independent Variables which are: synthetic specimens and natural specimens.
- Dependent Variables are Basic Science Process Skills Acquisition and Basic Science Process skills Application.

Table 2: Nature of treatment provided for the groups

S/N	Groups	Male	Female	Total
1	1st Experimental group (using synthetic specimens)	32	51	83
2	2nd Experimental group (using natural specimens)	25	42	67
3	Control (using conventional drawing)	21	41	62
	Total	78	134	212

Participants

The study population comprised of all Senior Secondary School Two (SS II) Biology students in two Local Government Areas of Ekiti State, Nigeria (with the total number of twenty-seven (27) schools in the area). The sample for the study comprised of 212 students in six SS II intact science classes. Multi-stage sampling technique was used as follows; two senatorial districts were randomly selected for the study (Ekiti North and Ekiti Central) and two Local Government Areas (LGAs), one from each senatorial district (Moba and Ijero LGA). Six senior secondary schools were randomly selected; three each from the government owned schools in Moba and Ijero LGAs respectively. The six schools were assigned to three groups; A, B and C (two schools in each group). Group A served as the experimental group 1, Group B served as the experimental group 2, while Group C served as the control group. Experimental group A was taught with synthetic specimens, experimental group B was taught with natural specimens while the control group did not have any practical treatment and used hand drawings. The selected schools were far apart from each other in order to eliminate diffusion of information among the groups.

Research Instruments

A total of eight instruments were used for this study. These include two response instruments and six stimuli instruments. The two response instruments used were:

1. Science Process Skills Acquisition Test (SPSAT)
2. Science Process Skills Application Scale (SPSAS)

While the six stimuli instruments used were:

3. Synthetic Specimens Kit (SSK)
4. Natural Specimens Kit (NSK)
5. Conventional Drawing Kit (CDK)
6. Teacher Instructional Guide on the use of Synthetic Specimens Kit (TIGUSSK)
7. Teacher instructional Guide on the Use of Natural Specimens Kit (TIGUSSK)
8. Teachers Instructional Guide on the Use of Conventional Diagrams Kit (TIGUCDK)

1. **Science Process Skills Acquisition Test (SPSAT):** The instrument was developed by the researchers to assess students' ability to use the Basic Science Process Skills acquired in solving Biology questions. The SPSAT was based on the contents of what the students were taught and it contained thirty five (35) multiple choice objectives test items, each item having four options (A, B, C, and D). The instrument was developed based on the six Basic Science Process Skills. Observing has 7 items, inferring 7, measuring 3, communicating 8, classifying 7, and predicting 3. Questions were adapted from past standard national examinations conducted by the WAEC and NECO's

(National Examination Council) past questions. These two instruments were used for the pre-test and after reshuffling they were also used for the post-test.

2. Science Process Skill Application Scale (SPSAS)

This was developed by the researchers using bloom's taxonomy (table of specification). The contents include: Skeletal System in Mammals, Digestive System in Mammals and Respiratory System in Mammals on the vertical axis, while on the horizontal axis are the basic science process skills (Observing, Inferring, Measuring, Communicating, Classifying and Predicting). Percentage was assigned to each basic science process skills accordingly to form the total number of questions required. It consisted of structural in form of fill-in-the gap type questions, also compiled from WAEC and NECO Biology practical past questions, based on the contents that were taught to the students. Total score was Eighty (80) marks.

Table 3: Table of Specification for Science Process Skill Application Scale (Practical)

CONTENT AREAS	**BASIC SCIENCE PROCESS SKILLS**						
	Observing (20%)	Inferring (20 %)	Measuring (10%)	Communicating (20%)	Classifying (20%)	Predicting (10%)	Total
Skeletal System in Mammals (50%)	8	8	4	8	8	4	40
Digestive System in Mammals (25%)	4	4	2	4	4	2	20
Respiratory System in Mammals (25%)	4	4	2	4	4	2	20
Total	16	16	8	16	16	8	80

3. **Synthetic specimens Kit (SSK):** These stimuli instruments were provided by the Department of Science and Technology Education, Faculty of Education, Obafemi Awolowo University, Ile-Ife, Nigeria. The synthetic specimens used included

i. whole mammalian lungs (with tracheal and bronchi attached), mammalian heart, whole mammalian thoracic cage, tongue, oesophagus, liver (with gall bladder and bill duct), stomach sac, small and large intestines.

ii. whole mammalian skeleton (Man and Dog). All the parts were intact and could its individual elements could be detached as required.

These synthetic specimens were engineered through the use of artificial and chemical substances to produce non-living matter that replicated biological entities and natural specimens. They were used at treatment stage for experimental group A after pre-test for five weeks before post-test.

Natural Specimens Kit (NSK)

These are bio-specimens which included guinea pigs and rabbits (dissected with all their abdominals and thoracic cage contents displayed); whole lung, liver, stomach and small and large intestines of goat; whole skeleton of dog (all the parts intact) and some pieces of bones from a goat. Chloroform was used to anesthetize the guinea pigs and rabbits before dissection while formalin was used to preserve them. The skeleton used was sun dried by the researchers and kept in a big dry carton. These stimuli instruments were used at treatment stage for experimental group B.

Conventional Drawing kit (CDK)

The researchers taught the students by themselves. The specimens where drawn on the white board for the students to see according to the topic taught. All the features of the specimens drawn were well represented in form of view (anterior, posterior, lateral, dorsal and ventral) details and magnification. Drawings were used at treatment stage for control group C and these were done with the use of temporary markers of different colours on the white board.

Other instruments used include;

i. Teacher Instructional Guide on the use of Synthetic Specimens Kit (TIGUSSK)

ii. Teacher instructional Guide on the Use of Natural Specimens Kit (TIGUNSK)

iii. Teachers Instructional Guide on the Use of Conventional Diagrams Kit (TIGUCDK)

These three instruments that were developed by the researchers comprised of teachers and students' activities arranged in steps according to the contents of the topics that had been taught to the students. The instruments were used at treatment stage for experimental groups A and B and control group C respectively.

Validation of Research Instruments

The content and face validity of the response instruments (SPSAT and SPSAS) were carried out by one expert in the Institute of Education, Obafemi Awolowo University Ile-Ife, and two others who are have graded Biology practical for National Examinations (WAEC and NECO) for about ten years. Test-retest method was used to estimate the reliability coefficient of the instruments by comparing the scores of the first test and second test for each of the instruments. The school used for establishing the reliability of the instruments was excluded from the final study. The test-retest reliability coefficient for SPSAS is 0.81 using Pearson Product Moment Correlation Measure. SPSAT was pilot tested by administering the test on thirty-two (32) senior secondary school II (SSSII) students outside the study area. The data collected was subjected to item analysis, the difficulty indices obtained ranged from 0.00-0.75 and the Kuder-Richardson (KR-20) value was 0.63. Based on this result, five items with difficulty index below 0.20 and above 0.75 were dropped from 40 questions, four were adjusted, after which the reliability test was carried out again. The final KR-20 value of 0.72 for the remaining thirty-five (35) objective items was adjudged good for the study.

Synthetic Specimens Kit (SSK) and Natural Specimens Kit (NSK) were found to be adequate, relevant and in good state, so they were considered good for the research. The content and face validity of Instructional Guide Instruments (TIGUSS, TIGUNS and TIGUCD) were also carried out by an expert in the Institute of Education, Obafemi Awolowo University Ile-Ife, and two other experts that have been marking National Examinations (WAEC and NECO) Biology practical for not less than ten years.

Procedure for Data Collection

The research was carried out in three different stages:

a. **The pre-treatment stage**: The researchers went to the selected schools to seek approval from the schools' principals and biology teachers. The researchers then addressed the students on what will be required of them during the entire research work. The researchers later returned to the schools the following week and administered SPSAS and SPSAT questions to the students. This lasted for one week.

b. **The treatment stage**: Both the experimental groups and control group were taught by the researchers using teachers' instructional guides and specific kits for each of the groups.

Experimental Procedure. The treatment for the experimental group A was synthetic specimen (SS) while natural specimen (NS) was the treatment for the experimental group B and the conventional drawing (CD) was the treatment for the control group. This stage lasted for five weeks.

c. **The post treatment stage**: the SPSAS and SPSAT questions were reshuffled and administered to the students in the seventh week of the study.

Method of Data Analysis

The data collected was analyzed using Analysis of Co-variance (ANCOVA), Multiple Classification analysis was used to further explain the basic findings of the study. The hypotheses were tested at a significance level of 0.05 using a two-tailed test.

Results

The results and findings of the study based on the generated hypotheses are as presented below:

Table 4: ANOVA table of proficiency difference in basic process skills before treatment

ANOVA

Pre-test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	225.345	2	112.673	1.405	0.248
Within Groups	16765.542	209	80.218		
Total	16990.887	211			

Table 4 shows that there was no significant proficiency difference in basic science process skills of the respondents from the three groups before the instruments were administered. ($F= 1.405$, $p>0.05$).

Research Hypothesis One

There is no significant difference in proficiency of basic science process skills acquisition of secondary school students exposed to synthetic specimens and those exposed to natural specimens in Biology practical.

Table 5: ANCOVA Table of differences in basic science process skills acquisition of the three groups

Tests of Between-Subjects Effects

Dependent Variable: Post Test Scores (by SPSAT)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1197.963[a]	3	399.321	24.526	.000	.261
Intercept	2376.644	1	2376.644	145.974	.000	.412
Pretest ACQ	486.540	1	486.540	29.883	.000	.126
Type	516.967	2	258.484	15.876	.000	.132
Error	3386.504	208	16.281			
Total	48263.000	212				
Corrected Total	4584.467	211				

a. R Squared = .261 (Adjusted R Squared = .251)

Table 5 shows that there is significant difference ($F= 15.876$, $p<0.05$) in the effect of using synthetic specimens versus natural specimens on the acquisition of basic science process skills measured by SPSAT on the students; a significant difference. It also shows that 13.2% of the difference in the skills' acquisition of students exposed to these treatments is accounted for by the type of specimens used as shown by the partial eta squared value of 0.132. Hence, the null hypothesis was rejected.

The degree of difference was then determined as showed by the Multiple Classification Analysis Test below.

Table 6: Multiple Classification Analysis to compare the proficiency of the respondents in Basic Science Process Skills Acquisition

Multiple Comparisons

Dependent Variable: post test scores

Scheffe

(I) type	(J) type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Synthetic	Natural	-3.8824	1.95006	.140	-8.6901	.9252
	conventional	17.6957*	1.95006	.000	12.8880	22.5033
Natural	synthetic	3.8824	1.95006	.140	-.9252	8.6901
	conventional	21.5781*	2.07765	.000	16.4559	26.7003
Conventional	synthetic	-17.6957*	1.95006	.000	-22.5033	-12.8880
	Natural	-21.5781*	2.07765	.000	-26.7003	-16.4559

Based on observed means.

The error term is Mean Square (Error) = 138.132.

*. The mean difference is significant at the 0.05 level.

Table 6 shows that there is no significant difference in the proficiency of b**asic** science process skills acquisition of those exposed to synthetic specimens and those exposed to natural specimens ($p>0.05$) but a mean difference score of 3.884 exist between the two groups with those exposed to the natural specimens having a higher mean score. It also shows that there was a significant difference in the mean scores of those exposed to synthetic specimens versus conventional method (hand drawing of specimens) with those exposed to synthetic specimens having a higher mean score by 17.70. Also, there was a significant difference ($p>0.05$) between the proficiency of those exposed to conventional method (hand drawing) and those exposed to natural specimens with those taught using natural specimens having a higher mean score of 21.58.

Research Hypothesis Two

There is no significant difference in the effect of using synthetic specimens, natural specimens and conventional drawings on process skills application of Biology concepts among the secondary school students. The Science Process Skills Acquisition Scale (SPSAS) was used to test for this hypothesis and the scores obtained from these instruments are presented in table 6 and 7 as follows.

Table 7: ANCOVA Table of Difference in Basic Science Process Skills Application (Psychomotor Skills) of Respondents Measured by SPSAS.

Tests of Between-Subjects Effects

Dependent Variable: post test scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	13603.514[a]	3	4534.505	66.800	.000	.491
Intercept	16813.177	1	16813.177	247.682	.000	.544
pretestspsat	2554.065	1	2554.065	37.625	.000	.153
Type	10151.475	2	5075.738	74.773	.000	.418
Error	14119.481	208	67.882			
Total	108297.000	212				
Corrected Total	27722.995	211				

a. R Squared = .491 (Adjusted R Squared = .483)

Table 7 above shows that there is significant difference (F= 74.773, $p<0.05$) in the effect of using synthetic and natural specimens on the application of basic science process skills by the students measured by SPSAS. This shows that the application of basic science process skills of the respondents differs significantly based on the type of specimens used. It also shows that 41.8% of the difference in the skills application of students exposed to these treatments is accounted for by the type of specimens used as shown by the partial eta squared value of 0.418. Hence, the null hypothesis was rejected. The magnitude of difference was then determined as revealed by Multiple Classification Analysis.

Table 8: Multiple Classification Analysis (MCA) on Application (Psychomotor Skills) of Basic

Science Process Skills of Respondents**.**

Multiple Comparisons

Dependent Variable: post test scores (SPSAS)

Scheffe

(I) type	(J) type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Synthetic	Natural	-2.6124	1.48198	.214	-6.2660	1.0413
	Conventional	14.4189*	1.48198	.000	10.7652	18.0726
Natural	Synthetic	2.6124	1.48198	.214	-1.0413	6.2660
	Conventional	17.0312*	1.57894	.000	13.1385	20.9240
Conventional	Synthetic	-14.4189*	1.48198	.000	-18.0726	-10.7652
	Natural	-17.0312*	1.57894	.000	-20.9240	-13.1385

Based on observed means.

The error term is Mean Square (Error) = 79.778.

*. The mean difference is significant at the .05 level.

The multiple classification analysis test on the application of basic science process skills of the respondents shows that there is significant difference in the application of basic science process skills of students taught using synthetic and natural specimens ($p<0.05$). Both treatments were more effective when compared with those taught using conventional drawing. However, there was a slight difference between the performance of students in the synthetic and natural specimen groups with students exposed to natural specimens performing slightly better by a mean difference score of 2.614.

Discussion of findings

Before the treatments were administered, there was no significant proficiency difference in basic science process skills of the respondents from various groups. The three groups were homogeneous at the beginning of the study. The results show a significant difference in the proficiency of acquisition of basic science process skills between students exposed to specimens (synthetic and natural) and those who had no treatment, i.e., the control group with conventional drawings of the specimens. The study supports Olutola, Daramola, and Bamidele (2016) report that students exposed to specimen in Biology practical had higher science process skills than other students who are not. Further analyses revealed that the difference between the two experimental groups (synthetic specimen group and natural specimen group) is not statistically significant. The three-dimensional nature of the materials - visual, tactile instructional - both synthetic and natural specimens clearly helped to arouse students' attention and interest in learning. Both synthetic and natural specimens are suitable and appropriate, affording students access to all the necessary views of an object (posterior, anterior, lateral, dorsal and ventral). Learners could also view the two sessions (longitudinal and transverse) as well as line of symmetry (bilateral or radial) where necessary when working with either natural or synthetic specimens. This finding agrees with Ifeoma (2013) who found that there is statistically significant difference in the educational performance of students taught with instructional materials compared with those that are not taught with them. All this aligns with John Dewey's learning theory (1966) that students should engage in real practical activities with their "minds on" and "hands on"-i.e., as learners perceive the knowledge with their minds, they can also lay their hands on it and manipulate it.

The results show that both synthetic and natural specimens increase the basic science process skills applications of Biology concept among the students. This implies that students were not only able to make better use of their psychomotor skills but also their application of basic science process skills increased significantly after they were exposed to both synthetic and natural specimens compared with conventional drawings.

Conclusion and recommendations

Based on the findings of this study, we conclude that synthetic specimens are equally as effective as are natural specimens in improving the acquisition and applications of basic science process skills in Biology practical. Teachers should therefore be encouraged to embrace the use of synthetic specimens as instructional materials to conduct Biology practical especially for topics for which natural specimens are difficult to obtain. The availability of synthetic specimens in the laboratory will facilitate teachers conducting adequate practical activities in parallel with theoretical classes. Encouraging teachers to embrace the use of synthetic specimens in the laboratory will also reduce the risk of exposure to chemicals used in preserving the natural specimens (e.g. formalin and ethanol). The environmental benefit of this is that it will help to reduce the pressure of demand on the natural population of organisms that would otherwise be harvested for practical activities, thus enhancing conservation of biodiversity. We recommend that curriculum developers proactively introduce the usage of synthetic specimens into the Biology curriculum and, administrators accordingly to make synthetic specimens available to teachers to facilitate the process skills acquisition and application of students in Biology practical.

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