Effect of Simulation Instructional Package on Basic Science and Technology Students’ Achievement and Retention in Federal Capital Territory, Abuja, Nigeria

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ABSTRACT
This study investigated the effect of Simulation Instructional Package on achievement and retention of Basic Science and Technology students. Simple random sampling procedure was employed to select two intact classes from two public co-education schools in Federal Capital Territory, Abuja, Nigeria. Quasi experimental research design of non-randomized pretest, posttest, post-posttest time control group design was employed for the study. Two research questions guided the study and two research hypotheses were tested at 0.05 level of significance. Basic Science and Technology Achievement Test (BSTAT) was used as instrument for data collection. The reliability of BSTAT was determined using K-R20 formula and the reliability coefficient obtained was 0.87. Mean and Standard Deviation were used to answer the research questions while the hypotheses were tested using Analysis of Covariance (ANCOVA). Multiple Classification Analysis (MCA) was used to determine the magnitude of the differences. The findings of this study revealed that significant differences were found in the achievement and retention of students taught using Simulation Instructional Package compared to that of the Conventional Demonstration Method.

Keywords: Achievement, Basic Science and Technology, Retention Simulation and Instructional Package.

INTRODUCTION
The world today is experiencing a rapid development and every nation is striving to meet up with the requirement needed to attain its development through science and technology. Science and technology education is therefore needed to produce technologists, technicians, scientists, craftsmen and skilled artisans who are required to change the economy which would in turn lead to a rapid growth and development necessary for nations to cope with the present today challenges (Ezeudu & Ezinwanne, 2013).

Science and Technology education is therefore a veritable tool for scientific and technological advancement of any nation. This fact is enshrined in the National Policy on Education of the Federal Republic of Nigeria (FRN, 2014) which states that science and technology education should among other things equip students to live effectively in the modern age of science and technology. The policy also emphasized that science and technology teaching and learning are viable instruments for inculcating necessary scientific knowledge, skills and competencies. In order to inculcate the necessary scientific knowledge, skills competencies and attitudes in various developmental strategies such as World Declaration on Education for All (EFA) are put in place in Nigeria educational system. Other strategies like the NEEDS (National Economic Empowerment Development Strategies) and SDGs (Sustainable Development Goals) were put in place. In order to meet these goals, the Nigerian Government overhauled its existing science and technology curriculum to cater for the needs of the nation as it aspires to be among the 20 top economies in the globe by the year 2020 (FRN, 2012).
Basic Science and Technology education has become one of the best avenues to meet the global challenges facing the Nigerian nation. Despite the importance of Basic Science and Technology in the country’s quest for technological advancement, there has been seeming ineffectiveness in the teaching and learning of the subject which in turn is strongly affecting the attainment of the country’s laudable objectives and goals of developing a scientific and technologically literate citizenry. Researchers such as Bukunola and Idowu (2012), Osokoya (2013), Alabi (2014), Oni (2014) Kabutu, Oloyede and Bandele (2015) and Samuel (2017) attested that that poor instructional strategies employed in the teaching of the subjects by teachers contribute to students under achievement. Students find it difficult to understand the basic concepts taught, hence a child that is not well grounded in Science and Technology at the basic level, will not show interest in offering core science and technology subjects at the Senior Secondary level.

The main purpose of teaching is to transfer knowledge to the learners. For effective teaching and learning to take place, the teacher needs to use different methods and approaches in teaching. Unfortunately, poor achievement in Basic Science and Technology has been attributed to poor approach to teaching employed by teachers (Samuel, 2017; Alabi, 2014; Osokoya, 2013). Unfortunately, the present Nigerian Basic Science and Technology classroom does not seem to provide hands-on-minds-on challenging, interactive and collaborative environment needed by new generation of students who have been exposed to internet, computer usage, hand-set and other sophisticated gadgets. This problem may best be resolved by the use of simulation instructional package.

Simulations are tools that facilitate learning through representation and practice in a repeatable, focused environment. It helps students to identify and understand factors which control the system and or predict the future behaviour of a system. It can bring into the classroom, aspects of the world or universe that are too expensive, dangerous, abstract, difficult or too slow or too fast in occurrence to be comprehended. (Goldsim, 2011). The use of simulations in the teaching and learning of Basic Science and Technology could help the understanding of abstract and difficult concepts by allowing students to develop their own understanding. Umoke and Nwafor (2014) and Ezeudu and Ezinwanne (2013) observed that the use of simulations to teach science gives positive results over time and permits the learner to manipulate variables or parameters and then observe the consequences of their actions.

Achievement is the action of accomplishing an academic task successfully. Its purpose is to find out the stand of a student at a given moment (Akani, 2017). It has to do with testing the knowledge acquired by the student which helps the teacher and the student to evaluate and predict the degree of learning attained. It is useful in testing the retention of information and skill. It is also a determinant of the efficacy and efficiency of a given instruction (Kabutu, Oloyede & Bandele, 2015).

Learning is said to have occurred when what is learnt remains relatively permanent in the mind of the learner. Hence, it is pertinent for students to retain what is learnt. Retention is the capability to replicate the concept learnt when need arises. It is the ability to reproduce a learned behaviour by the learner in due time. Therefore, a learner who repeats an acquired knowledge with less error is said to have retained the material learnt. Similarly, when what is not retained or fades with time, learning becomes incomplete. Exploring mode of lesson delivery which could help students retain materials learnt becomes absolutely important (Asogwa, Muhammed, Asogwa & Ofoegbu, 2016).

The aim of the present study was to determine the extent to which classroom exposures of students to simulation as an instructional strategy could enhance Basic Science and Technology students’ achievement and retention. Specifically, the study sought to find out:

1. The effect of Simulation Instructional Package on achievement of Basic Science and Technology students.
2. The effect of Simulation Instructional Package on retention of Basic Science and Technology students.
Research Questions
1. What are the mean achievement scores of students taught Basic Science and Technology using Simulation Instructional Package compared with those taught using Conventional Demonstration Method?
2. What are the mean retention scores of students taught Basic Science and Technology using Simulation Instructional Package compared with those taught using Conventional Demonstration Method?

Research Hypotheses
H₀₁: There is no significant difference in the mean achievement scores of students taught Basic Science and Technology using Simulation Instructional Package and those taught using the Conventional Demonstration Method.
H₀₂: There is no significant difference in the mean retention scores of students taught Basic Science and Technology using Simulation Instructional Package and those taught using the Conventional Demonstration Method.

METHODOLOGY
Quasi experimental research design was employed for the study. The sample for the study comprised eighty-eight JSS III Basic Science students from two intact classes randomly selected from public co-education schools in Federal Capital Territory, Abuja, Nigeria. The experimental group was taught using Simulation Instructional Package while the control group was taught using the Conventional Demonstration Method.

Basic Science and Technology Achievement Test (BSTAT) was developed as instrument for data collection. The BSTAT was a 50 item instrument with options A – D that tested the students’ knowledge, comprehension and application of selected topics in Basic Science and Technology. These topics included Radio-activity and Metalwork Practice. The selection of these topics is based on the fact that they have often been considered difficult to understand by students and also because of lack of adequate facilities for students’ practice. The items were allotted 1 mark each, giving total score of 50 marks. The test was validated by experts in Science and Technology and was trial tested on a representative sample which did not participate in the final study. Kuder-Richardson formula 20 (K-R₂₀) was used to determine the reliability of BSTAT and the reliability coefficient was found to be 0.87 implying that the instrument was reliable enough for the study. Mean and Standard Deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the research hypotheses at 0.05 alpha level of significance. Multiple Classification Analysis (MCA) was used to determine the magnitude of the differences among the groups.

RESULTS
Research Question One: What are the mean achievement scores of students taught Basic Science and Technology using Simulation Instructional Package compared with those taught using Conventional Demonstration Method?
The mean and standard deviation of students’ achievement in Basic Science and Technology taught using Simulation Instructional Package and Conventional Demonstration method are presented in Table 1.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Type of Test</th>
<th>No. of Students</th>
<th>Mean</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation Package</td>
<td>Pre-test</td>
<td>40</td>
<td>36.23</td>
<td>3.42</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>40</td>
<td>64.49</td>
<td>3.98</td>
</tr>
<tr>
<td>Demonstration Method</td>
<td>Pre-test</td>
<td>48</td>
<td>33.81</td>
<td>2.34</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>48</td>
<td>56.47</td>
<td>3.14</td>
</tr>
</tbody>
</table>
From Table 1, it is observed that there was a significant mean gain in the achievement between students taught Basic Science and Technology using Simulation Instructional Package and the Conventional Demonstration Method with mean gains of 28.26 and 22.66 respectively. The variation of spread or distance from the mean scores is slightly sparse in the Demonstration Method with a (difference of 0.8) than in the Simulation Instructional Package group (with a difference of 0.56) in terms of standard deviation.

**Research Question Two:** What are the mean retention scores of students taught Basic Science and Technology using Simulation Instructional Package with those taught using Conventional Demonstration Method?

The mean and standard deviation of students’ retention in Basic Science and Technology taught using Simulation and Conventional Demonstration method are presented in Table 2.

### Table 2. Mean and Standard Deviations of Students’ Scores Using Simulations and Conventional Demonstration Method

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Type of Test</th>
<th>No. of Students</th>
<th>Mean</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation Package</td>
<td>Post-test</td>
<td>40</td>
<td>64.49</td>
<td>3.98</td>
</tr>
<tr>
<td></td>
<td>Post-post-test</td>
<td>40</td>
<td>69.52</td>
<td>4.11</td>
</tr>
<tr>
<td>Demonstration Method</td>
<td>Post-test</td>
<td>48</td>
<td>56.47</td>
<td>3.14</td>
</tr>
<tr>
<td></td>
<td>Post-post-test</td>
<td>48</td>
<td>59.67</td>
<td>3.67</td>
</tr>
</tbody>
</table>

Table 2 shows that there is a significant mean gain in the retention between students taught Basic Science and Technology using Simulation and the Conventional Demonstration Method with mean gains of 5.03 and 3.20 respectively. The variation of spread or distance from the mean scores is slightly sparse in the Demonstration Method (with a difference of 0.53) than in the Simulation Instructional Package group (with a difference of 0.13) in terms of standard deviation.

**Hypotheses**

**H₀₁:** There is no significant difference in the mean achievement scores of students taught Basic Science and technology using Simulation Instructional Package and those taught using the Conventional Demonstration Method.

The data generated from the test of this hypothesis is provided in Table 3.

### Table 3. Result of Analysis of Covariance on Students’ Achievement in Basic Science and Technology Using BSTAT

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Squares</th>
<th>Sum of Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected model</td>
<td>7483.931</td>
<td>2</td>
<td>2139.568</td>
<td>83.962</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Intercept</td>
<td>5691.426</td>
<td>1</td>
<td>6195.328</td>
<td>404.218</td>
<td>0.001</td>
<td>S</td>
</tr>
<tr>
<td>Pretest</td>
<td>7.502</td>
<td>1</td>
<td>7.502</td>
<td>3.404</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Group</td>
<td>6597.806</td>
<td>1</td>
<td>4378.294</td>
<td>57.015</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Error</td>
<td>19780.665</td>
<td>83</td>
<td>15.469</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Significant at P<0.05

Table 3 shows a significant difference among the learning strategy under investigation. F= ratio of 57.015, P<0.05. This implies that the method of instruction produced a significant effect on the achievement (posttest) scores of students when covariate effect (pretest) was controlled. The null
The hypothesis of no significant difference was therefore rejected indicating that there is significant difference in the achievement of the two groups.

**H0**: There is no significant difference in the mean retention scores of students taught Basic Science and Technology using Simulation Instructional Package and those taught using the Conventional Demonstration Method.

The data generated from the test of this hypothesis is provided in Table 4.

### Table 4. Result of Analysis of Covariance on Students’ Retention in Basic Science and Technology Using BSTAT

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected model</td>
<td>3857.317</td>
<td>2</td>
<td>1467.635</td>
<td>96.790</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Intercept</td>
<td>474.252</td>
<td>1</td>
<td>3892.328</td>
<td>217.523</td>
<td>0.001</td>
<td>S</td>
</tr>
<tr>
<td>Posttest</td>
<td>9.952</td>
<td>1</td>
<td>9.952</td>
<td>6.240</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Group</td>
<td>754.306</td>
<td>1</td>
<td>3546.502</td>
<td>68.871</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Error</td>
<td>3455.106</td>
<td>83</td>
<td>25.7352</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8550.933</td>
<td>88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Significant at P<0.05

Table 3 shows that there is a significant difference among the learning strategy under investigation. F= ratio of 68.871, P<0.05. This implies that the method of instruction produced a significant effect on the retention (post-posttest) scores of students when covariate effect (posttest) was controlled. The null hypothesis of no significant difference was therefore rejected indicating that there is significant difference in the retention of the two groups.

Based on the established significant difference in the retention scores of the groups, MCA was used for analysis to determine the magnitude of the difference. The results of the analyses are as shown in Table 5.

### Table 5. Multiple Classification Analysis (MCA) of Students’ Retention According to Treatment

<table>
<thead>
<tr>
<th>Teaching strategy</th>
<th>N</th>
<th>Unadjusted Deviation</th>
<th>Eta</th>
<th>Adjusted for indept+ covariates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation Instructional Package</td>
<td>40</td>
<td>3.51</td>
<td>1.68</td>
<td></td>
</tr>
<tr>
<td>Conventional Demonstration Method</td>
<td>48</td>
<td>10.23</td>
<td>.76</td>
<td>-9.96</td>
</tr>
</tbody>
</table>

Result of the Multiple Classification Analysis (MCA) as presented in Table 5 was used to determine the magnitude of the mean retention scores of students exposed to Simulation Instructional Package and the Demonstration Method. The result shows that Simulation had a positive effect on the students’ retention in Basic Science and Technology.

**DISCUSSION**

The findings of this study revealed that the use of Simulation as a medium of instruction had a significant effect on students’ achievement and retention in Basic Science and Technology. The students taught using Simulation Instructional Package achieved and retained concepts taught more than those taught using the Conventional Demonstration Method. This result is in agreement with that of Asogwa, Muhammed, Asogwa and Ofoegbu, (2016); Umoke and Nwafor (2014) and Ezeudu and Ezinwanne (2013). They found out that the use of Simulation Instructional Package to teach science subjects enhances achievement and could give positive results over time. The trend of high achievement and retention by the treatment (Simulation Instructional Approach) group could be as a result of remedial activities provided for the students as they were actively involved in the experiential learning.
Another revelation of this study was that the standard deviation scores for both the treatment and control groups were moderate and not at much variance implying that the efficacy of the treatment is sustainable. The probability of the methods discriminating across other moderator variables could be ruled out. That is to say that the Simulation Instructional Package is not only efficient but also stable in fostering students’ achievement and retention in Basic Science and Technology.

These findings have strong implications for the teaching and learning of Basic Science and Technology in Secondary Schools in Nigeria. Simulation Instructional Package should therefore, be given strong emphasis in the teaching of Basic Science and Technology in Secondary Schools of Nigeria.

CONCLUSION
The findings of the study, among others have shown that using Simulation Instructional Package is a way of improving achievement and retention in Basic Science and Technology at the Junior Secondary School level in Nigeria. The present conventional demonstration method employed by teachers should drastically be minimized and only used to compliment more student-centered approaches.

RECOMMENDATIONS
1. Basic Science and Technology teachers should be encouraged to adopt Simulation Instructional Package as means of instruction to enhance the teaching and learning of Basic Science and Technology. This is because it is an innovative approach and has the potential to motivate learners towards learning Science and Technology.
2. Government should set up special centres to develop Simulation Packages or software on abstract topics in Science and Technology for the purposes of enhancing instruction in schools.

REFERENCES