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Educational Attainment of Secondary School Physics Students [In Electrostatics] Under Computer-Assisted Instruction with Animation

Nwoye, Amarachukwu Nkechi
Lecturer, Department of Science Education, Nnamdi Azikiwe University, Nigeria
Okeke, Samuel Osita Chibuzo.
Professor, Department of Science Education, Nnamdi Azikiwe University, Nigeria

Abstract:
The negative perceptions of the students over physics seem to create a barrier for educating and learning of the matterat secondary school level. As a consequence, it disturbs the educational acquirement of pupils. After using different techniques and putting extensive efforts, teaching Physics is still not able to provoke interest in students which leads to extreme failure for educational success. Aimed to find solution this study tries to identify how Computer Assisted Instruction (CAI) as an innovative strategy can improve attainment rate of students in Anambra, Nigeria. Quasi-experimental design, specifically the non-equivalent control group 2X 2 factorial design has been selected here as statistical analysis. 167 senior secondary one (SS I) students from co-educational schools in Awka South and Dunukofia Local Government Area of Anambra state has been selected as sample through Multistage sampling. Valid and reliable instrument of thirty Questions as MCQ format on Electric Charge and Electric Field (p = 0.89)were used for data collection.Pre-tests were applied on groups before treatments. "Electrostatic" was taught to experimental group using CAI with animation package produced by the researcher which is based on the content of the SS I physics syllabus. Whereas traditional and old style of teaching were applied on control group. One week after the treatments were applied Post-tests were conducted. Analysis of Covariance (ANCOVA) test has been performed with 95% confidence Interval. Outcome reveals that; significant difference exists for scores of mean achievement in experimental and control groups in favour of the experimental group. Significant interaction effect has been noticed by combining treatment and gender in case of pupil achievement in "Electrostatics". Based on the findings, some recommendations were made.

Keywords: *Physics education, computer animation; academic achievement*

1. Introduction

Science has been recognized as the foundation upon which the bulk of the present-day technological breakthrough is built. Any nation that has to attain the status of self-reliance should have science and technology as important components of the knowledge to be given to its citizens irrespective of race, belief or sex (Nwoye, 2014). Abilu (2005) opined that for Nigerian citizen to avert being perpetual slaves to the developed world, they should welcome Mathematics along with science, technology.

Subjects from the domain of technology and science that would enable students have a greater understanding of science, with an ability to apply knowledge of science for solving problems in their ever-changing society include; mathematics, introductory technology, health science, biology, chemistry and physics. All the branches of science have important contributions to make in technological advancement of nations. Yet, Stephen (2010) noted that among the sciences, physics occupies a central position due to its remarkable contribution in medicine, pharmacy, engineering, industries and agriculture.

Physics is an intellectually challenging subject that requires strong practical foundations and adequate mathematical skills for a thorough understanding. Atadoga, Zara, Mari, and Danjuma (2016) observed that physics is an aspect of science that helps to explain the cause-effect relationships of matter and energy, and their application to natural phenomena. Its place in the scheme of things as far as science education is concerned makes it imperative for students to take the subject with importance. It is vital to mention that the performances of students in physics is not commensurate with its relevance in providing human basic needs and improving the quality of life. According to Mekonnen (2014), low achievement in science subjects has been associated with two factors which include quality and quantity of teaching facilities and techniques. Physics is one of such science subjects.

In spite of the importance of physics as a unifying factor for medicine, engineering and other seemingly prestigious and lucrative fields of study in life, students' enrolment and performance have not been encouraging in Nigeria. Observation by Uchenna and Patrick (2015) has shown that some schools had no candidates who would sit for physics during senior secondary school certificate examination (SSCE) for some years back. On the other hand, available data over the years indicated that there was a slight increase in students' performance in physics but is yet below average. Such

performance is not good enough for physics-oriented courses for a nation that is striving towards technological advancement and industrial development.

Chief Examiner's report from West African Examination Council (WAEC) for the past five years (2011 – 2015) has shown that the percentage of candidate's credit pass in O'level physics in the specified period is 41%, 42.8%, 48.6%, 38.3% and 42.0% respectively. This indicated slight but fluctuating increase in the students' performance. If the state of physics should continue like this, the attainment of vision 2020 in Nigeria may be difficult and impossible. The WAEC Chief external examiner's report (2015) recommended that teachers and students should be encouraged to engage with anextensive list of methodologies for teaching and learning, with particular emphasis on hands-on experimental work (including experiments supplemental to those prescribed on the course), the use of ICT and dynamic computer simulations of physical phenomena and the constant linking of syllabus material to common applications of physics.

Researchers (Eriba&Sesugh, 2006; Michael, Omola, Anoyemi& Mohammed, 2014) have investigated on CAI packages and its effectiveness compared with conventional method in mathematics, English language, chemistry among others. CAI proved to be more effective compared to traditional way of teaching and learning. Based on the perceived effectiveness of CAI packages in other fields of education it becomes imperative for researchers to examine the efficacy of computer in enhancing achievement in many difficult concepts of physics. This is because computers offer exciting approaches to teaching that were not dreamt of many years ago (Yusuf &Afolabi, 2010). Yet the extent to which the educational potential of computer technology will be realized remains to be examined. It has been observed that CAI among others is one of the teaching methods which can easily embed scientific knowledge to the learners.CAI stands for Computer Assisted Instruction or Computer Aided Instruction which discussed the use of computer as a tool in teaching and learning. Authors like Rabia (2014) highlighted it as areciprocal instructional tool which presents instructional material through computer for presenting and learning of concepts. Okundaye (2005) pointed out that in CAI, students accept feedback from the computer as well as maintain some degree of control. This means that CAI is a strategy in which the topics to be taught are carefully planned, written and programmed in a computer unit and it allows each student to one computer terminal. The instructions are also programmed in a computer disc (CD), this could be played in either audio or video system for student to learn the programmed instructions at their leisure and own pace. CAI has been also viewed as a tool to increase scopes for student to learn (Mayer, 2009), using drill and practice, tutorial, games and simulation activities, animation, and many others.

Animation is processed as a part of visual information. It has been defined as images in motion (Dwyer & Dwyer, 2003). Computer animation seems to attract learners' attention and increase their motivation to learn. In this study, the animations are used to deliver lesson contents with planned instructions. This involves the teacher projecting and explaining the planned instructions in form of graphics, text, audio and visual files. At the end of each topic of instruction, the animation related to the concept(s) taught will be played to enhance internalization and meaningful learning. Students are meant to attempt the evaluation questions that follows before moving to the next topic. On the other hand, CAI with animation was readily available for the learner's use during the lessons for this study and after the study the package was made available to students to learn at their own convenient and pace.

The conventional method refers to other methods used by the teacher in lesson delivery which are teacher centred. Typical examples are chalk-talk method and lecture techniques. Needless to say, that teacher-centred teaching and lecture is the most common and conventional teaching behaviour found in schools everywhere. It is really effective where sharing information need to be done in quick manner. Moreover, it is effective to teach learners who learn best by listening. Science teachers embrace conventional method in teaching the sciences because it presumably leads to easy coverage of science syllabus. Although convectional method could be effective it also presents several challenges. Ezeani (2004) pointed out that conventional method does not promote much achievement because it appeals mainly to the sense of hearing which encourages rote learning and regurgitation of information without necessarily aiding the learners to construct their own meaning that are consistent with their prior ideas.

According to Igweh(2012),Students' academic achievement refers to performance in a school subject as designated by a score or mark obtained in an achievement test. The main outcome of education can be expressed in terms of learning, which is the change in knowledge, skills and attitudes of individuals happening inside school boundary. In the context of this work academic achievement is being taken as the secondary school student's overall performance in Electric Charge Electric Field Achievement Test (ECEFAT). The students' achievement could be enhanced using instructions of animated programmed.

According to authors like Ploetzner & Lowe (2012), mixed types of outcome can be seen in case of academic achievement by using animations. While conducting studies they have compared the effects for both static and animated displays for many fields. The result has somewhere shown positive effect, somewhere no effect, even some studies have resulted negative effects. Based on the opinion from these authors animation does not provide significant changes in case of educational attainment.

Other researches highlighted the successfulness of animation depends on the way it isbeing used as well as the quality or learning capacity of students.

For Scheiter's (2014) the way of using is the main key of success for animation, whereas for Lowe & Boucheix (2016), animation will face failure if the target audience cannot process it successfully and correctly.Chances of inundations increase when the concept is complex as information processing has direct relation with visual perception and cognition. The above-mentioned study also revealed that the pace may exceed the pace at which the students can process it.

Hence it can be well understood that quality of learning can't be increased by mere usage of animation, textual clarification is also very important. As a remedial measure Rosen (2009) suggested some control aspects like speed at which they are being played, labels, sound and commentary are need to be balanced such that target students can relate with it.

Easier and learning with great speed can take place through well-designed animations. They are brilliant support tool for faculties when it comes to explain difficult concepts as well as subjects due to the involvement of mathematics or imagination. For example, concept like the electric charges is invisible. At the beginning, phenomenon of electrostatics is difficult for students to understand but with the aid of computer animations, learning and teaching might become easier, faster and attractive.

1.1. Objective

Finding the outcome of CAI with animation in physics on students of secondary school in case of educational attainment is the focus area of this research.

Following are some objectives of this study:

- To check whether mean of achievement scores for physics changes with gender or not.
- To find out if mean of achievement scores for physics differs with introduction of animation compared to previous conventional way.
- Not only individual effect but to check the effect of interaction of achievement score and gender is significant or not while teaching physics.

1.2. Hypothesis

Following are the alterative hypothesis at 95% confidence interval.

- Mean achievement scores taught using conventional method has significant difference from the mean achievement scores taught using CAI with animation for physics.
- For physics male's mean education attainment score is statistically different from the mean education attainment score of females.
- Interaction effect caused due to teaching methods and gender has significant role on student's achievement score in physics.

2. Methodology

Quasi-experimental design has been used for this study, specifically, non-equivalent control group 2 X 2factorial design. The population is total of 3,438 Senior Secondary one (SS 1) students from all the state government owned co – educational secondary schools in Awka Education Zone of Anambra state. The logic behind selection of co-educational secondary schools is to create the same study environmental condition for both genders. While SS 1 students were chosen because SS 1 is the foundation class for science students and if captured at that level the students might likely study physics in SS 2 and SS 3. Total of 167 (77 males and 90 females) SSI pupils were used for this research as a sample. 30 multiple items questions about electric charge and electric field were used as data collection tool.

After the classroom teachers who acted as research assistants had been adequately briefed and had demonstrated competence in the successful implementation of the instructions, pretest was applied on groups a week before the actual teaching of the electric charge and electric field concepts. Experimental groups were taught using CAI with animation. Conventional lecture method was used for groups which are known as control groups. Posttests were administered to both groups one week after the treatments. In analysis of data, descriptive and inferential statistics were used. Two-way ANCOVA was used for testing the hypotheses because the study involves two independent variables of non-equivalent control group design. In this case, pre-test scores serve as covariate measures. In the study, step below were observed with control and experimental groups in 5 weeks of process.

At the end of pretest, subjects of electric field, types of charge, charge and charge interaction, charge as a quantity and production of charges were taught to both groups by their class teachers who served as research assistants in line with the lesson plan prepared by the researchers. Control groups were exposed to the physics concepts using conventional method. Experimental groups were taught using CAI with animation package produced by the experimenters from the same field with the lesson plan. The package adopted the tutorial modes of CAI.

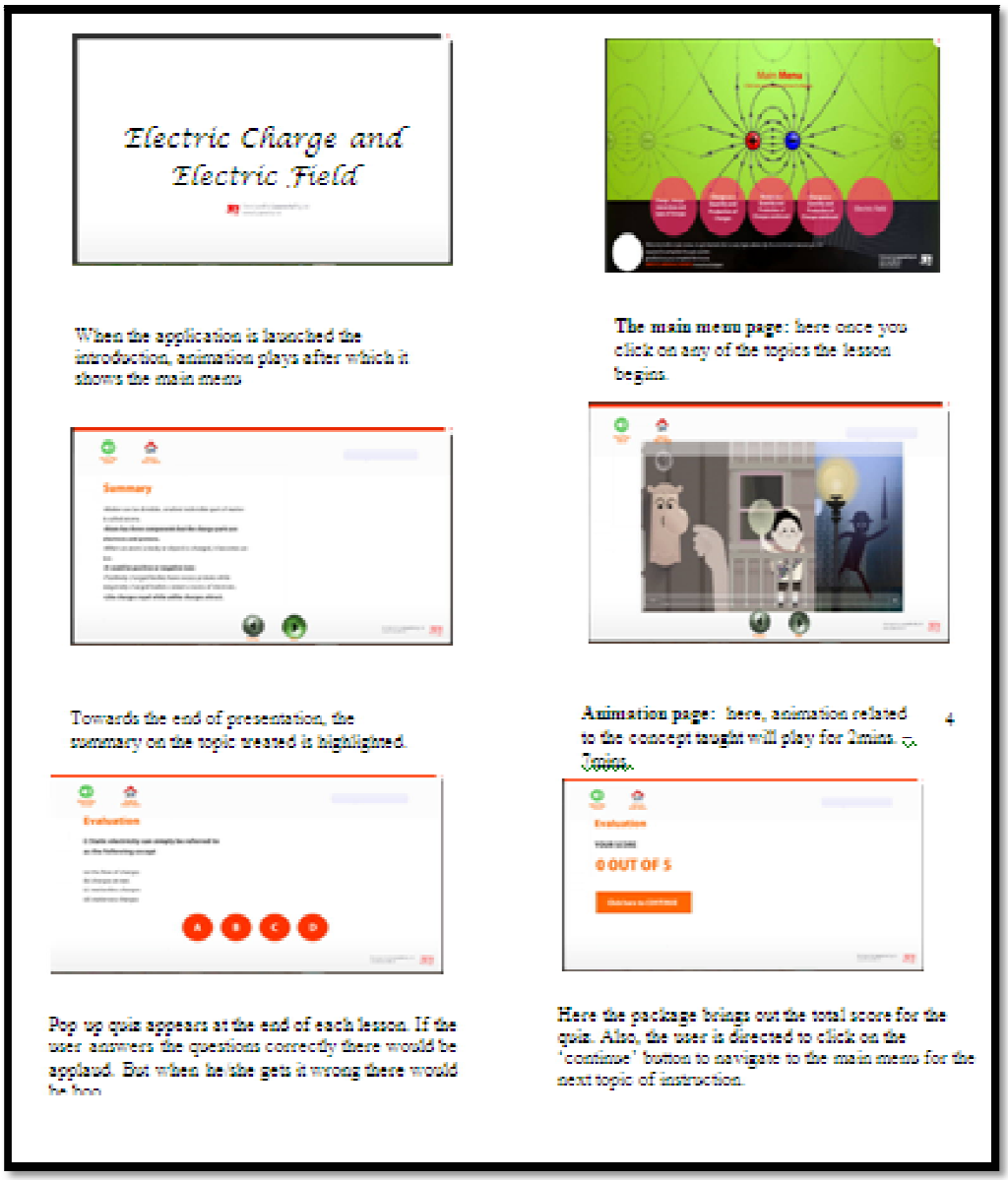

Figure 1 Sample of CAI Package (Programmed by Lusaworks Nigeria Limited Https://M.Vconnect.Com)

3. Results

H_{a_1}:Mean achievement scores of students taught using CAI with animation has significant difference from the mean achievement scores of students taught physics concepts conventional method.

Table 1 portray the findings obtained in testing the hypothesis.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	30784.789[a]	4	7696.197	107.782	.000
Intercept	22762.906	1	22762.906	318.786	.000
Pretest	1039.409	1	1039.409	14.557	.000
Method	29409.103	1	29409.103	411.863	.000
Gender	45.951	1	45.951	.644	.424
Method*Gender	472.337	1	472.337	6.615	.011
Error	11567.618	162	71.405		
Total	561148.000	167			
Corrected Total	43352.407				

Table 1: ANCOVA Summary of Students' Academic Achievement in Physics

Table 1 shows that the value of the significance of F (411.863) on achievement is 0.000 compare to $p<0.05$ alpha level. The null hypothesis one is rejected. This implies that the use of CAI with animation in teaching physics concepts (ECEF) is effective for improving academic attainment of students.

H_{a_2}:Mean achievement scores of malesaredifferent from mean achievement scores of female students while physics concepts were taught. Table 1 shows F value (0.644) on gender effect is 0.424 greater than p-value of 0.05. The null hypothesis two can't be rejected. This implies that students' achievement in physics is independent ongender.

H_{a_3}: Statistically significant interaction effect exists for students' achievement in physics for teaching methods and gender.

From Table1it can be observe that the significant of F (6.615) for the 2-way interaction (method*gender) is 0.011, $p<0.05$. Facts emerging from the table show that there exists a significant interaction effect between methods of instruction and gender on students, achievement. Thus, the null hypothesis three is rejected and we upheld that there is significant interaction effect of methods and gender on students' achievement in physics.The mean scores are displayed graphically (Fig. 2) and it is evident that there is an interaction.

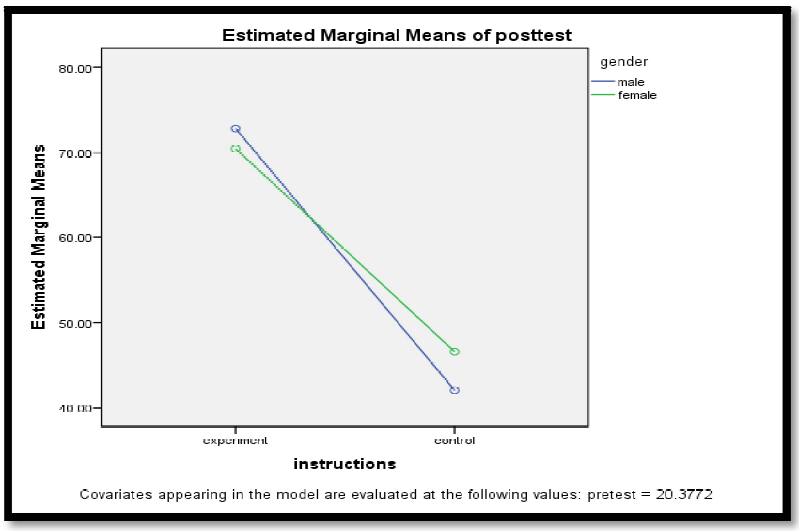

Figure 2: Effect of Interaction of Teaching Method and Gender on Students' Attainment in Physics

4. Findings

Some of the findings derived from this study mentioned below:

1. Statistical significant difference is present for mean achievement score in physics for using CAI in comparison with conventional teaching method.
2. Male students have significant difference in mean achievement score compared to female students.
3. Students' achievement score in physics has significant interaction effect of both teaching methods and gender.

5. Discussion

Talking about major outcome, significant difference of educational achievement has been found between experimental and control groups' students. This implies that CAI with animation teaching –learning strategy is efficacious for improving efficiency as well as for increasing attainments in physics. The efficacy of CAI over conventional methods of instruction could be as a result of its ability to provide both audio-visual presentation of the material. The use of CAI involved more of students' sense organs and also exposed them to a variety of graphics, pictures and animation pictures, which capture their attention. The finding is in line with the findings of Mudasiru and Adedeji (2010) who found that CAI improved students' performance in biology either individually or cooperatively. Also, the result of this study agrees with that of Adedamola (2015) that students taught biology using CAI perform better rather than teaching using conventional lecture method. Moreover, Izzet and Ozken (2008) mentioned the findings through their research. Authors revealed that CAI is more effective in enhancing 7th grade physics student's achievement than traditional instruction which made them recommended that an informative education should be provided to faculties about the usages, characteristics of CAI along with usage of computer such that CAI use can be made effective.

Although no significant difference has been observed for gender difference in case of achievement score of physics but Table 1 provides the evidence that significant interaction effect of teaching methods and gender is present in favor of the experimental groups. This is seen in Fig. 2. The plot in Fig. 2 shows that for experimental groups, male students achieved higher on Electric Charge and Electric Field Achievement Test (ECEFAT) in comparison with students from female category. However, for control groups male students achieved lower on ECEFAT compared to female students. This implies that female students achieved better than male students using conventional method of instruction. Both male and female students benefited positively, when exposed to Computer Assisted Instruction (CAI) with animation method of instruction, but female students seemed to achieve lesser than male students (Fig.2).Maintaining the same tone, Pepple (2015) ascertains that the effect of CAI with animation on students' academic achievement depends on gender in favor of

male in chemistry. Hence, CAI though it enhances student level of achievement it is gender sensitive. Male students are predicted to benefit more than female students. This is in conflict with the findings of Michael, Omiola, Awoyemi and Mohammed (2014), found no significant interaction effect of methods and gender for mathematics. The inconsistency in the findings of studies reviewed is an indication that the gender factor in achievement remains an issue requiring diversified attention.

6. Conclusion

Based on the findings, it was deduced that CAI with animation has proved to be effective in enhancing educational attainment for physics irrespective of gender.

7. Suggestions

With reference from the outcome of this research, the following suggestions have been provide as mentioned below:

- Seminars and workshops should be arranged by the Federal and State Ministries of Education where teachers, textbook authors and curriculum planners will be taught in schools how to use CAI with animation as a better tool for teaching and learning of physics.
- The textbook authors should be encouraged to work with programmers so as to put animation effects to their books which can be attached to their books in CDs.
- Curriculum planners and curriculum development bodies in Nigeria like NERDC should design curriculum (and make policies) that will incorporate at secondary school level about the use of multimedia strategy for teaching physics more effectively.

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