

Effects of Computer-Animation among NCE Students' of Different Ability Levels in Biology Concepts in Bauchi State, Nigeria

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Abstract

Computer-animation is the use of computer device to create an illusion of moving images in sequential form. Computer-animations, when effectively used in teaching abstract and complex concepts especially in Biology, better performance could be granted. This study investigated the effects of computer-animation on NCE students with different ability levels in Biology concepts in Bauchi State, Nigeria. The objective of the study was to determine the effects of ability levels on NCE students' performance when taught biology concepts using computer-animation-package. The study adopted quasi-experimental design. The population for this study comprised 2,594 Biology students in colleges of education in Bauchi State, while the target population was 878 NCE II Biology students. There are four NCE-awarding institutions in the State of which only two run Biology Education programme at the NCE level. Sixty NCE II Biology students participated (42 for experimental of taught using animation-package and 18 for control group taught with lesson note). Six instruments were developed: animation-package, questionnaire, lesson notes, to-do lists, manual and test. The 6 instruments were validated but only the animation-package test items were pilot tested for reliability. The results were 0.432 for pretest, and 0.001 for posttest. Mean and standard deviation were used to answer research question. Analysis of Variance at 0.05 level of significance. The findings of the study revealed no significant difference in the performance of high ability, medium ability and low ability levels students,

when taught biology concepts using computer-animation. The study concluded that computer-animation strategy enhanced NCE students' academic performance in biology concepts irrespective of their ability levels. The implication is that computer-animation instructional strategies played significant role in the teaching and learning biology concepts among students with different ability levels in colleges of education in Bauchi State, Nigeria. The study recommended that lecturers of Biology in colleges of education to incorporate computer-animation into their teaching.

Keywords: Computer-Animation, NCE Students, Ability Levels, Biology Concepts

1. Introduction

Teaching is the act of imparting knowledge using a variety of instructional strategies in order to create permanency in learning. Teachers can guide students to discover new information, develop skills, build knowledge, try out new ideas and enhance students' academic performance when they employ a variety of learning opportunities in their lesson presentations (Olugbenga, 2016). A meaningful instructional discourse particularly at this age of technology requires teachers' usage of computer to aid the process of teaching and learning in schools. Computer animation is a microcosm of computer aided instruction that stimulates learning if appropriately utilized by the teachers.

In relation to this view, Bates (2017) observed that teachers' passion varies in their ability to incorporate computer animation in their lesson presentations. Even though, the most effective teacher uses a variety of pedagogies and strategies to assist their students in the learning situation (O'Day, 2008). However, Obielodan (2015) viewed this assertion and reiterated that individual teachers are always willing to use innovative technologies in their lesson presentations to enhance learning. Only that some technologies require technical expertise for their usage in instruction as it does in designing and developing animated media. Animation has its internal arrangement of visual, audio and motion related qualities that makes its integration to teaching and learning paramount (Baglama, Yucesoy & Yikmis, 2018).

Although, Hwang, Tam, Lam, and Lam (2012) contended that some teachers, due to training and expertise view animation as easier and cheaper mode of instruction, while other look at it into different dimension as a time-consuming and waste to precious classroom hours, with students exhausting their time viewing something that they do not really believe on its educational value. In addition to this limitation of animation in teaching and learning activities, however, design and development of quality animation for instructional purpose can be challenging (Hwang et al., 2012). For example, Hwang et al. (2012) and Trevison et al. (2010) remarked that animations are time-consuming to produce; viewing them also may be time consuming. Animations come in varied ways and have a significant impact on education and other social systems such as communication, leisure and entertainment (Sebastian, 2010). The areas of applying animation are boundless and one of those areas is education (Dasdemir, 2016). Specifically, animations can be used to actualize the process of learning and teaching. Computer animations are exciting trend into which education and training can easily be incorporated (Shareef, 2012).

Okoli, Anazodo and Okoye, (2022) deduced that the need to adopt technology based packages to improve the teaching and learning of biology for effective performance of students is urgently required. The use of technology has made the process of teaching and learning more enjoyable through Information, Communication and Technology (ICT) tools. Computer graphics and animation instructional modes are some of such innovative teaching methods that have been found effective in teaching some school subjects like Fine arts, Religious knowledge, drama and literature. Potential applications of animations in language learning and education, on identifying evidence-based principles for their design and use, and on proposing possible research works. The animation in animation involves the use of compelling graphics, including images, audio and video in the form of technology. However, the use of animations or computers is not limited to education alone, in addition to the education sector, the economic sector, the business sector, the medical sector. However, there is a great deal of debate about the effectiveness of computer animation in various fields. The general findings of Noor, et al. (2022) can be concluded that the role of computer animation is constructive in mostly in language learning.

Shareef further stated that computer animation can be used effectively to facilitate the process of teaching any subject in school. For instance, teachers can use animation to demonstrate how things occur visually and to show how things come together and work together. It is used to explain scientific concepts (Soffar, 2017). For example, computer animation might be used to demonstrate the movement and works of the Solar system, in Mathematics computer animation might present to the students how they can algebraically manipulate specific equation, in Biology computer animation has the ability to demonstrate multifarious complex concepts by bringing them to life for students' comprehension. In the same vein, a lot of concepts in Biology, Chemistry and Physics are too miniature to be seen, handled, performing the experiment on, or even trying to imagine them, such as the atom, the molecules and the zygote.

Therefore, the biological concept that has been animated for the purpose of this study was the vertebrate anatomy and physiology (BIO 222). It is a second semester compulsory course of NCE 200 level teaches at the colleges of education in Nigeria (FRN, 2012). Vertebrates are animals with backbone or spinal column (Sohail, 2015). The backbone is a column of bones that supports the body, and also protects the spinal cord. The back is made up of separate bones, called vertebrate's supportive internal skeleton. Most vertebrates have two pairs of limbs. In fish, these take the form of fins, but in other vertebrates they are legs, arms, flippers, or wings. Some vertebrates such as snakes have no external limbs. Animals with backbones include mammals, birds, reptiles, amphibians and fishes. In another hand, anatomy deals with the study of the structure and relationship between body parts while physiology is the study of functions of the body parts and the body as a whole (CliffsNotes, 2016; Mukherjee, 2016).

Collectively, anatomy and physiology deals with the study of the vertebrates body parts and functions. Vertebrate anatomy and physiology concentrates on the functional anatomy of the different groups of vertebrates (Onken, 2017). Similarly, the entire course according to Onken focuses on the different systems and organs of the vertebrate animals, their functional importance and anatomical variability in response to different physiological or functional modification, and morphological or structural challenges.

This study investigated the effects of computer-animation on NCE students of different ability levels in biology concepts in Bauchi State, Nigeria. Specifically, the study determined the effects of ability levels on Biology students' performance, when taught biology concepts using computer-animation and lecture method in the colleges of education in Bauchi State, Nigeria. This study provided answers to the following research question. (1) What are the effects of ability levels on Biology students' performance when taught biology concepts with computer-animation in the colleges of education in Bauchi State, Nigeria? The following research hypothesis was formulated and tested at 0.05 level of significance. **H₀₁**: There is no significant difference in the mean scores of high ability, medium ability and low ability students, when taught biology concepts using computer-animation in the colleges of education in Bauchi State, Nigeria.

2. Literature Review

Research study reveals that concepts in vertebrate anatomy and physiology are difficult to teach (Ghedotti, Fielitz & Leonard, 2005). This is because some of the concepts in vertebrate anatomy and physiology require that students learn some complex terminologies that are used in different environments such as phylogenetic, developmental, and functional. These contextual perspectives according to Ghedotti et al. (2005) are critical if students are to comprehend vertebrate anatomy and physiology as a science and not simply a litany. However, to vertebrate zoologists, the opportunity to explore and compare the anatomy of the major vertebrate groups is a significant instructive and enlightening experience (Koprowski & Perigo, 2000).

In his opinion with regards to the difficulty and simplicity of biology concepts, Dent (2009) asserted that vertebrate, anatomy and physiology and genetics are the two most difficult concepts in Biology as they involve memorization and lots of abstract thinking. Dent further suggested that if vertebrate anatomy and physiology would be taught using relevant instructional media, students' success and overall understanding would not be judged on how well they memorize, rather demonstration and manipulation would be given high degree of preference. Teaching vertebrate anatomy and physiology involves a variety of learning tasks, such as exploration of themes and concepts in the laboratory and lecture for experimentation being its essential gadget in the study of science and technology (Kenaley, n.d., Sakiyo & Muhammad, 2018). Even though, students are not the same in terms of their ability to comprehend certain biological concepts in school, but the actualization of instructional strategies will help improve students' learning and enhance academic performance positively.

Ability according to Ginsburg is the students' past performance (usually on a test or exams) rather than their potential. Similarly, students' past performance is thoroughly a reflection of their ability, without regard for other factors that may influence students' ability to demonstrate what they have been taught. It has been reported through research that some students learn differently from others (National Education Association, 2017; Stinebrickner & Stinebrickner, 2012; Onasanya, Asuquo, Ogunojemite, Daramola & Nicholas, 2008). In support of this view, WordPress (2013) reported that students' learning is just like an onion as each layer is created differently. A student who learns easily in the classroom is bound to have a high academic ability (Vermetten, Vermunt & Lodewijks, 1999). Vermetten et al.

went ahead to clarify that this does not mean that other students who does not comprehend from the way the course is being taught have low academic ability.

Studies have shown that different abilities have always been found in learning environment (Gupta, Pasrija & Kavita, 2015). Therefore, ability level is the natural capability shown in the students' performance which manifest in terms of falling below average or higher than an expected standard in all the school curricular activities (Stinebrickner & Stinebricker, 2012). Although, beside the influence of school structure as the strong predictors of a student's academic performance is the level of ability group in which the student is placed for instruction Abadzi (2001) and (Burks, 1994) observed that only the superior students benefit from this strategy to the detriment of the lower ranking students. Primary areas of concern are exposure to comprehending curriculum contents and the social stigma attached to the students in low-ability group (Strauss, 2013). This is because; their thinking or reasoning style is automatically differing since they vary in term of ability to assimilate a given instruction. Thus, thinking styles are different from intelligence (Hatemi & Heidarie, 2016). Intelligence refers to the individual's potential and abilities to acquire and apply knowledge (Parankimalil, 2014). Thinking styles refer to individual's preference (Sief, 2008). In general, thinking styles refer to the preferred ways that people use their abilities (Hatemi & Heidarie, 2016). This indicates that a strong relationship exists between thinking style and ability groupings.

In their experiment, Onasanya, Asuquo, Ogunojemite, Daramola and Nicholas (2008) investigated the influence of ability levels on the performance of students taught using manual and computer animated production techniques. Pretest and posttest of the students were being compared by investigating the quality of students' animation productions based on their pretest of high, medium and low ability levels. A sample of forty 300 level students of University of Ilorin and Ladoke Akinlola University of Technology, Ogbomosho took part in the study. An experimental design of intact class was used in which sixteen educational technology students were assigned to treatment group and twenty-four fine and applied arts students were assigned to the control group respectively.

In the study, a researcher designed 3-D animation skill test (APST) was administered to the students as a pretest. After the instruction, the APST was re-designed and re-administered to the duo as posttest. The findings of the study revealed that high achievement group performed significantly better than medium and low academic achievers in both the manual and computer animation instructions. Thus, the quality of instruction should be improved using computer animation and various technological trends in the tertiary institutions.

Similarly, students' performances in the high, medium and low ability levels in a problem-solving task were compared after exposing the students to a teacher-directed problem-solving instruction (Adesoji, 2008). It was discovered that no significant difference existed in the performance of students in the three ability levels after the treatment. Thus, method of instruction was found to influence academic achievement of low achievers significantly. The study therefore, deduced that the use of a variety of instructional media should be encouraged in teaching and learning sciences. In contrast, Idowu (2008) revealed that high ability students performed significantly better than medium and low ability students. In her study, she investigated the effect of content structure on the performance of College of Education biology students in South-western, Nigeria. The study deduced that irrespective

of treatment type, scoring ability levels had a significant effect on students' academic performance in biology.

In another related study, Ala and Shehu (2015) compared Biology students' achievement in genetic concept in the three ability levels of high, medium and low after exposing them to treatment of computer aided instructional package. The study revealed a statistically significant difference in the performance of high, medium and low. However, no significant difference existed among high, medium and low ability level students. Thus, the study concluded that computer aided instructional package had a significant effect on high ability students than average and low ability groups. In the same vein, Unodiaku (2013) investigated the influence of sex and ability levels on students' mathematics readiness using Mathematics Readiness Test (MRT) as an instrument. The data generated was analysed using mean and ANOVA. The result indicated that a significant difference existed between boys and girls across the three ability levels of high, medium and low.

3. Research Methods

This study employed quasi-experimental research design type of pretest posttest equivalent, non-randomized control group. The design was a 2x3 factorial design that represented two levels of treatments (animation-package and lecture method), and three ability levels (high, medium and low). The independent variables were the instructional techniques of treatment and conventional method, whereby the dependent variable was the students' performance in the pretetest, posttest in the three ability levels. The research design is represented schematically on table 1.

Table 1: Research Design Layout

Groups	Pretest	Treatment	Posttest
Experimental Group	O ₁	X	O ₂
Control Group	O ₃	-----	O ₄

Where; O₁ and O₃ represent means pretest score of experimental and control groups respectively; X = represents treatment for experimental group; O₂ and O₄ represent means posttest score of experimental and control groups respectively; ----- = represents non-randomized, equivalent subjects; --- = represents lecture method for control group. Thus, the table represents assignment variables as used in this study. The experimental group was exposed to pretest prior to treatment of computer-animation strategy and subsequently followed with a posttest. Similarly, the control group was pretested prior to the application of no treatment using conventional lecture method and followed with a posttest.

Table 2: Population, Target Population and Sample Size

Name of Institutions	Population	Target Population	Sample
	NCE I, II & III Biology students	NCE II Biology students	Sample size
College A (Experimental)	1,910	671	42
College B (Control)	684	207	18
Total	2,594	878	60

Sources: Office of the Academic Secretaries of College A and B (2018)

The population for this study comprised 2,594 Biology students in the colleges of education in Bauchi State, Nigeria. This two colleges of education was chosen because they have a whole department for Biology and so that one was the control group while the other was the experimental group. The target population comprised of colleges of Education students from the department of Biology in the two sampled institutions of learning. The entire population of NCE 200 level Biology students in the colleges of education in Bauchi State, Nigeria was 878. The NCE 200 level students were sampled for the study as the content of the designed computer animation package on Vertebrate, Anatomy and Physiology was for the NCE II curriculum. There are four NCE-awarding institutions in the State of which only two run Biology Education programme at the NCE level. The study also employed a purposive sampling technique to select two colleges of education in the State.

Table 3: The 3-way factorial design layout of 2x3

Group	Ability Levels
Experimental Group 1	High 1
	Medium 2
	Low 3
Control Group 2	High 1
	Medium 2
	Low 3

The Table 3 displayed the factorial design layout of 2x3 with two levels of treatments (experimental for animation-package technique and control for lecture method), and three ability levels (high, medium and low). A sample of forty-two students were drawn from college of education “A” and eighteen students from college of education “B” using proportionate sampling technique as contained in the population for the study. The total sample for the study was sixty students in all the two colleges of education. The procedure employed for the selection of sample for the study was proportionate and stratified random sampling techniques.

Proportionate sampling was employed due to the fact that the population was composed of subgroups that differ in their numbers, so that one group did not have advantage over the other. After selecting the NCE II Biology students proportionately, they were stratified into three scoring ability levels of high, medium and low academic ability levels based on their scores in the previous Biology examinations in NCE I. Thus, Cumulative Grade Point Average (CGPA) of NCE I was used as a determinant for grouping students into ability levels of high, medium and low. This gave a sample size of forty two students from College “A” (fourteen high, fourteen mediums and fourteen low). Furthermore, the stratification of students into academic ability levels was based on their Cumulative Grade Point Average (CGPA) in their 100 level Biology courses.

The researcher adapted the academic ability levels bench-mark developed by Idowu (2008) and formed the basis for the selection of high, medium and low academic ability groups. Thus, in this study, bench-mark for ability grouping at the NCE level, CGPA is ranging from 4.0-5.0 as high ability students; 2.40-3.90 medium ability students while 0.99-2.39 served as low academic ability group. According to Idowu (2008) the students’ CGPA is the appropriate index of academic ability because it illustrates students’ mean weighted score rather than an isolated score in only one course. Students’ ability levels was schematically represented in Table 4.

Table 4: Stratification of Research Sample Based on Academic Ability Levels

S/No.	Sample	Students' CGPA	Academic Ability levels	COE-A	COE-B
1.	20	4.0 to 5.0	High Ability Level	14	6
2.	20	2.40 to 3.9	Average Ability Level	14	6
3.	20	0.99 to 2.39	Low Ability Level	14	6
Total	60			42	18

Source: Adapted from Idowu (2008)

The researcher designed and developed six instruments and used them to gather the necessary data for the study. They are: treatment instrument (animation-package), test Instrument (VAPAT), experts' validated questionnaires, lesson notes, to-do list for the study and training manual for the co-researchers and students. The VAPAT test instruments comprised 20 questions on Vertebrate, Anatomy and Physiology which the respondents are to answer as assessment of their performance after using the computer animation package for instruction.

Thus, of all the six instruments validated by expert, only the modified version of computer-animation was pilot tested on 20 NCE II Biology students from non-participating college of education. The twenty randomly selected NCE II Biology students were assigned to experimental and control groups respectively. Both the groups were pre-tested prior to the application of treatment of computer-animation and conventional instructional strategies in the first week. The six lessons were treated to both experimental and control groups in the second, third and fourth weeks. Thus, in each week, two lessons were being taught. The fifth week was meant for the administration of posttest using VAPAT.

Ethical consideration were considered in this study. It is crucial that respondents participate voluntarily in the study. Additionally, if they choose to, participants are free to leave the research at any time. Respondents gave their informed consent in order to participate. In order to comply with the principle of informed consent, researchers must provide participants with enough information and assurances regarding their participation so they may understand the potential consequences and freely decide whether or not to participate, free from undue pressure or coercion. The creation of the test group questions did not involve the use of any language that was insulting, discriminatory, or otherwise improper. Respondent confidentiality and anonymity are of utmost importance. Additionally, the Data Protection Act was observed. Furthermore, Using the APA reference style in accordance with the Dissertation Handbook, it was assured that any other authors' works cited in the dissertation were acknowledged. All conversations and analyses were conducted with the utmost objectivity throughout the project.

The data generated from the tests of the two groups were statistically analyzed using Analysis of variance (ANOVA). Thus, the result of the pilot study revealed that the animation-package strategy had a significant effect on students' performance. After the pilot study, a slight change was made on the computer-animation-package for improvement. Consequently, this was replicated in the actual study in which Mean and Standard Deviation were used to answer the research question and Analysis of variance (ANOVA) statistical analysis was used to test the only hypothesis at 0.05 level of significance.

4. Results and Discussion

A total of 60 NCE Biology students from colleges of education in Bauchi State, comprising of 18 students for the control group and 42 students in the experimental group made up the sample for this study. The 60 respondents were pretested with the test items, and eventually were available for the posttest amounting to 100.0% response rate. The sample size for this research was sufficient and representative.

Table 5: ANOVA on Mean Scores of High Ability, Medium Ability and Low Ability Levels Students when taught Vertebrate, Anatomy and Physiology using Computer-Animation

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remarks
Corrected Model	34.714 ^a	2	17.357	.794	.459	
Intercept	20064.857	1	20064.857	918.000	.000	
Ability levels	34.714	2	17.357	.794	.459	Not Significant
Error	852.429	39	21.857			
Total	20952.000	42				
Corrected Total	887.143	41				

a. R Squared = .039 (Adjusted R Squared = -.010)

The analysis on significant difference in the mean scores of high ability, medium ability and low ability Biology students, when taught Vertebrate, Anatomy and Physiology using Animation-package is displayed in table 14. The null hypothesis was not rejected as $F(2, 41) = 0.794$ and $p = 0.459 > 0.05$. Since the p-value of 0.459 was greater than the significance value of 0.05, the hypothesis was not rejected. Thus, there was no significant difference in the mean scores of high ability, medium ability and low ability level students, when taught Vertebrate, Anatomy and Physiology using Animation-package in colleges of education.

The hypothesis states that there is no significant difference in the mean scores of high ability, medium ability and low ability Biology students, when taught Vertebrate, Anatomy and Physiology using Animation-package in colleges of education. However, the finding revealed no significant difference in the posttest mean scores of high ability, medium ability and low ability levels students, when taught Vertebrate, Anatomy and Physiology using computer animation in colleges of education. This indicated that the innovative instructional media had stimulated learners' interest to learn at the same rate irrespective of their academic ability levels.

This finding corroborates with the result findings of Okoli, Anazodo and Okoye, (2022) who established that computer graphics and animation instructional modes had significant effects on the achievement and retention scores of students in genetics. Based on their findings, it was recommended among others that biology teachers should adopt the use of computer graphics and animation in the teaching of genetics in order to enhance the performance of students and retention of knowledge in genetics. Government and education authorities should sponsor biology teachers to workshops and seminars to learn how to

improve their teaching skills using computer graphics and animation. The finding was in conformity with Adesoji (2008) who compared students' performances in the high, medium and low ability levels in a problem-solving task after exposing the students to a teacher-directed problem-solving instruction. It was discovered that no significant difference existed in the performance of students in the three ability levels after the treatment. Thus, method of instruction was found to influence academic achievement of low achievers significantly.

This finding is in line with the studies of Bamidele & Yoade (2017); Falode et al (2016); who in their separate studies found that the adoption of computer animation as an instructional mode greatly improve students' academic achievement. However, the finding of this study was in contrast with that of Idowu (2008) who revealed that high ability students performed significantly better than medium and low ability students. In her study, she investigated the effect of content structure on the performance of College of Education Biology students in South-western, Nigeria. The study deduced that irrespective of treatment type, scoring ability levels had a significant effect on students' academic performance in Biology.

Noor, et al. (2022) established that with the rapid development of technology, software has evolved and become one part of the real-life stimulation. Various of the software was developed and used by the animator to design a good digital image. Onasanya et al. (2008) investigated the influence of ability levels on the performance of students taught using manual and computer animated production techniques and established different opinion with the current study. The finding of their study revealed that high achievement group performed significantly better than medium and low academic achievers in both the manual and computer animation instructions and deduced that the quality of instruction should be improved using computer animation and various technological trends in the tertiary institutions.

5. Conclusion

The instructional value of computer-animation strategy has been established in this research. This is because; students exposed to instructional contents using computer-animation performed significantly irrespective of ability levels. The study concluded that ability levels have no influence on students' academic performance while learning with animation-package. Teachers should be made to understand that high, medium and low academic achievers can learn a given concept of Biology at the same rate. Thus, ability level is not a barrier for student learning with animation-package. The study thus recommends that Biology lecturers should employ animation-package strategy as a viable tool for enhancing the teaching and learning of abstract and complex biological concepts in the colleges of education since is gap between the three ability levels is bridged by the instructional strategy. Also, teachers' professional development should be extended to Inclusive Education Training by the Management of colleges of education, specifically on academic ability levels.

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