BRIDGING THE GAP BETWEEN LOW, MEDIUM AND HIGH ABILITY STUDENTS THROUGH THE USE OF COMPUTER-BASED MULTIMEDIA INSTRUCTION

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Abstract
The study determined the effects of computer-based multimedia instructional package for bridging the gap between the low, medium and high ability students. The study adopted a pre-test, post-test experimental design. Sample consists of 120 second year students (SSII). Solid Geometry Achievement Test (SGAT) was used for collecting data, while Computer-Based Multimedia Instruction that comprised of Animation with Text (AT) and Animation with Narration (AN) was used as treatment instrument. The reliability coefficient of SGAT was 0.78 using Kuder-Richardson (KR-21). Data were analyzed using Analysis of Variance (ANOVA). The results revealed that, significant differences were established in the post-test mean scores of AT, AN and the conventional groups favouring AN. Also, no significant difference were found in the post-test mean scores of high, medium and low ability students taught using AT ($F = 0.218$, $df = 39$, $p > 0.05$) and CAI (AN) ($F = 1.52$, $df = 39$, $p > 0.05$). Based on these findings, it was therefore recommended that mathematics teachers be encouraged to use computer-based multimedia instruction to provide equal opportunity to students of different ability.

Keywords: Computer, Multimedia, Ability, Solid Geometry, Animation, Narration, Text

Introduction
The World Declaration on Education for All (WDEFA) defines education from the individual point of view and states that education should provide the tool, knowledge, skills, values and attitudes required by human beings to be able to survive, to develop her full potentials, to live and work in dignity, to participate fully in development, to improve the quality of their life, to make informed decisions and to continue learning. The National Policy on Education (FRN, 2008) stated that the secondary education shall provide all primary school leavers with the opportunity for education at a higher level, irrespective of sex, social status, religion or ethnic background. It will provide trained manpower in the applied science, technology and commerce at the sub-professional grades, provide technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development. These points to the fact that in as much as mathematics plays a vital role in the achievement of the broad goals of the secondary education, mathematics education is for all.

Mathematics and science have been the backbone of technological advancements and remains at the forefront of science and technological innovations. Mathematics is described as the pivot of all civilization and technological development (Zakariyya, 2008). Mwei, Too and Wando (2011) stated that mathematics plays a pivotal role in students lives and is a bridge to science, technology and other subjects offered in any formal educational system. Mathematics remains a core subject in both the primary and secondary schools (FRN, 2008). Without a credit pass in mathematics at the senior secondary school level, no student can access the tertiary education in Nigeria. In spite of the importance attached to mathematics there have been consistent poor performances at all levels starting from the primary, secondary to tertiary institutions (Agwagah, l997; Iji & Harbor-Peters, 2005; Gambari & Adeghenro, 2008).

The performance of Nigerian students in science and mathematics in particular has been unsatisfactory over the years. West African Examinations Council (WAEC) and National Examination Council (NECO) have repeatedly reported poor performance of students in mathematics (Adegunna, 2008; WAEC, 2008, 2009, 2010, 2011 & 2012). This has been a concern to stakeholders. However, this scenario has been linked to so many factors such as: negative attitudes of students towards mathematics, inappropriate teaching methods, poor presentation mode, inadequate coverage of the syllabus, social and economic influences (Bolaji, 2002; Emuhohwo, 2009; Nwagbo, 2005). The implication is that there would be shortage of manpower in science, technology and engineering which might affects the country's self-sustenance and national development (Adegoke, 2010 & Gambari, 2010).

In Nigerian schools, the high, medium, and low ability students are lumped in the same class and taught with the same concepts, under the same condition without considering their individual differences (Yusuf, 2004). The teaching and learning of mathematics at the senior secondary school level should take care of both, the low, medium and high ability students. Iji and Herbor-peters (2005) stated that instructional practices in the mathematics classroom in Nigerian secondary schools, seems to favour only the students with high ability. Abakpa and Iji (2010) assert that with the traditional method of teaching, the gap between the achievements of high and low ability students continue to widen. Thus there is need to explore approaches that will improve students achievement at all levels. Abakpa and Iji (2010) reported that there is a positive correlation between good teaching approach and students' achievement at all levels in mathematics. Iji and Harbor-peters (2005) stated that instruction can be organised in such a way and manner that all students in the class can achieve at a high level. According to Adegoke (2010) only the high ability students benefit from the conventional method of teaching. Therefore, there is need for innovative instructional methods that can provide equal achievement opportunity for science, technology and mathematics students in particular. Innovative teaching approach such as computer-based multimedia instruction has been identified as one of the recent approaches that can enhance effective teaching and learning (Adegoke, 2010; Barak, Ashkar & Dori , 2011; Mayer & Moreno, 2002; Gambari, Yaki, Gana & Ughovwa, in-press; Rahmat, 2012; Taber, Marters & Van-Merrieboer, 2004).

Computer-based multimedia instruction has been identified as one promising approach towards enhancing science, technology and mathematics achievements (Kuti, 2006; Mayer & Moreno, 2002; Taber, Marters & Van Merrieboer, 2004 and Adegoke, 2010). Multimedia instruction can be defined as the presentation of words, sound and pictures (motion and static) aimed at promoting learning (Mayer & Moreno 2003). Multimedia instruction can come in the form of words (written or on screen text), sound (audio or spoken) and pictures (static or motion). Effective use of animation and its positive results on instructional message design is evident by many researches (Clark & Mayer, 2003; Barak, Ashkar & Dori , 2011). Mohammed (2006) and Rahmat (2012) found that the computer animation learning courseware had given a positive effect on students' academic performance. However, Dancy and Beichner (2006) found that good verbal skills (narration) tended to increase performance on the static version but not on the animated version of the test. Studies on narration with text showed that students who received the narration tutorial performed better on the transfer task compared with students who received the text tutorial (Nihalani, Mayrath & Robinson, 2011). Similarly, Igbafe (2001) reported that a combination of audio and print media mode of instruction is more effective than the audio or print mode alone.

Empirical studies on students' ability levels have been conflicting. Some reported high abilities performed better than medium, while some reported otherwise. For instance, Yusuf (2004) revealed that ability levels have no influence on academic performance of the learners, while, Aluko (2004), Fajola (2000), Ige (2004), Gambari (2010), Yusuf, Gambari and Olumorin (2012) reported that high ability students performed better than medium and low students when taught chemistry, biology, and physics respectively. However, Wing-Yi, Lam, and Chung-Yan (2008) reported that high and low ability students benefited than medium achievers.

In Nigeria, emphasis has not been laid on innovative strategies that can bridge gap between the high, medium, and low ability students. In addition, very few empirical studies exist in Nigeria regarding the use of Computer-Based Multimedia Instruction (CMBI) in mathematics. Thus, much remain to be empirically studied on the effects of CMBI on students' ability levels in mathematics education in Nigeria.

Research Questions

(i) What are the differences in the post-test mean achievement scores of students taught solid geometry using Animation with Text (AT), Animation with Narration (AN) and the conventional method?

(ii) What are the differences in the post-test mean scores of low, medium, and high ability students taught using Animation with Text (AT)?

(iii) What are the differences in the post-test mean scores of low, medium and high ability students taught using Animation with Narration (AN)?

Research Hypotheses

(i) There are no significant differences in the post-test mean scores of students taught solid geometry using CAI, Animation with Text (AT), Animation with Narration (AN) and the conventional method.

(ii) There are no significant differences in the post-test mean scores of low: medium and high ability students taught using Animation with Text (AT).

(iii) There are no significant differences in the post-test mean scores of low, medium and high ability students taught using Animation with Narration (AN).

Methodology

Research Design

This study adopted an experimental design using a pre-test, post-test, experimental group. Three levels of independent variables (two treatments and one control group), three groups of academic ability (low, medium, and high) were employed in this study. The two experimental groups (Animation with On-screen Text) and Animation with Narration (AN), and one control group (conventional teaching method) were administered a pre-test before treatment and post-test after treatment. The experimental group 1 (AT) was subjected to treatment using Animation with Text (AT), the experimental group 2 was subjected to treatment using Animation with narration (AN) and the control group was taught using the conventional teaching method. The design layout is as shown in Table 2

Table 1: Research design layout

Groups	Pretest	Treatment	Posttest
Experimental Group I	O_1	Animation with On-screen Text (AT)	O_2
Experimental Group II	O_1	Animation with Narration (AN)	O_2
Control Group	O_3	Conventional Teaching Method	O_4

Sample and Sampling Technique

One hundred and twenty second year (SSII) students (60 male and 60 female) participated in the study. A four-stage sampling techniques was employed in selecting the sample. Firstly, a purposive sampling technique was employed in selecting three senior secondary schools based on: school type (public school), facility (ICT facilities), school location (Minna metropolis). Secondly, a simple random sampling technique was used in assigning the three selected schools to two experimental groups and one control group respectively. Subjects were stratified into different ability levels based on their performance in the previous mathematics examination. The criteria for high ability students were based on students whose previous average in the mathematics examination fell within the first 25% (1st quartile), the medium ability students' score within the middle 50% while the low ability level students fell within the lower 25%.

Research Instrument

The research instruments consist of two treatments and one testing instrument. The instruments covered topics in solid geometry that include: surface area, total surface area and volumes of cubes and cuboids, curved surface area, total surface area and volume of cone, cylinder, sphere, hemisphere and pyramids.

Treatment Instrument: The treatment instruments were developed by the researchers and programmer using suitable programming languages such as micro-media flash, dream-weaver, fireworks 8, flash 8 and MS office software in bringing out the animation showing the formation of the different shapes in a way that the students will see the major properties of these shapes. Both treatments consist of animation of the major concepts in solid geometry and on-screen texts with lesson objectives, examples, illustrations in animation format, quizzes to be answered before navigating to the next topic. The only difference between the treatments was the addition of on-screen text (T) in the first treatment and narration (N) in the second treatment.

Test Instrument: The instrument that was used in collecting data for the study was researcher adopted Solid Geometry Achievement Test (SGAT). The SGAT consists of 30 multiple choice objective items with four options (A–D) adopted from past examinations of West African Examination Council (WAEC, May/June, 2000-2012) and National Examination Council (NECO, June/July, 2000-2012). SGAT was pilot tested on 30 students who are not part of the study, its reliability coefficient determined as 0.89 using Kuder Richardson (KR-21).
Experimental Procedure

Pre-test was administered on the three groups, followed by six weeks treatment on the two experimental groups (AT) and (AN) and at the same time teaching the control group with the conventional method. Students in Experimental Group I were exposed to Animation with Narration (NA) package where computer displayed animations depicting the explanations of the geometry concepts along with concurrent teacher-narration voice. Students in Experimental Group II were exposed to Animation with on-screen Text (AT) package where computer displayed animations depicting geometrical concepts with concurrent presentation of on-screen text along side. To reduce cognitive load, the corresponding words and graphics animation were presented near each other on the same page. Students in Control Group were taught using Conventional Teaching Method where researcher presented the concepts of geometry using chalkboard as a medium of instruction. Questions were entertained at the end of the lesson after which assignment were given. Post-test was administered immediately after the treatment. Data obtained from post-test were subjected to data analysis using Analysis of variance (ANOVA), t-test and scheffe's post-hoc test .

Results
To test for the hypotheses, t-test, one-way ANOVA and Scheffe's test were used.

Table 2: ANOVA comparison of mean achievement scores of experimental and control groups at pre-test

Source	Sum of Square	df	Mean Square	F	Sig (P)
Between Group	466.127	2	233.064		
Within Group	17536.93	117	149.888	1.555^{ns}	0.216
Total	18003.06	119			

ns: not significant at the 0.05 level.

From Table 1, the F-value of 1.555 was not significant at the 0.05 level. This indicates that there are no statistically significant differences among the performance of students taught using Animation with on-screen Text (AT), Animation with Narration (AN) and control group (F = 1.555, df = 117, p = 0.216). This implies that there are no significant differences among sampled students before the commencement of the experiment. This means the students are comparable.

Hypothesis One

There is no significant difference in the post-test mean scores of students taught solid geometry using CAI, animation with text (AT), animation with narration (AN) and the conventional method. In order to test this hypothesis, ANOVA was used. The summary of this analysis is shown in table 3.

Table 3: ANOVA comparison of post-test mean achievement scores of experimental and control groups

	Source	Sum of Square	df	Mean Square	F	Sig (P)
Pre-test	Between Group	466.127	2	233.064		
	Within Group	17536.93	117	149.888	1.555^{ns}	0.216
	Total	18003.06	119			
Post-test	Between Group	5360.949	2	2680.474		
	Within Group	2734623	117	233.728	11.468	0.000^{*}
	Total	32707.18	119			

ns: Not significant at 0.05 level

*: Significant at the 0.05 level.

Table 3 shows the pre-test result of ANOVA comparing two experimental groups and control group. From the table, the F-value (1.555, df = 117, p = 0.216) was not significant at 0.05 alpha level. This implies that there was no significant difference among the mean scores of the experimental group I; experimental group II and the control group at 0.05 level of significance. This implies that the groups are comparable.

Still on table 3 is the posttest result of ANOVA comparing two experimental groups and control group. From the table, the F-value (11.468, df = 117, p = 0.000) was significant at 0.05 alpha level. This indicates that significant differences were established among the experimental groups and control group. Hence the null hypothesis one (Ho_1) was rejected.

Scheffe's post-hoc analysis was further carried out to determine the area of differences. The analysis of post-hoc is shown in Table 4.

Table 4: Summary of Scheffe's post-hoc analysis of the mean achievement scores of experimental and control groups

Groups	Mean Scores	Group I (AT)	Group II (AN)	Group III (cont)
Group I (AT)	65.38		0.052	0.071
Group II (AN)	73.80	0.052		0.000*
Group III (Cont)	54.43	0.071	0.000*	

* The mean is significant at the 0.05 level.

The result in Table 4 indicates that there was no significant difference in the mean achievement scores of students exposed to AT (X = 65.38) and those exposed to AN (X = 73.80). It also indicates no significant difference in the mean achievement scores of students exposed to AT (X = 65.38) and those exposed to conventional (54.43). Significant difference was established in the mean achievement scores of students exposed to AN (X = 73.80) and those exposed to conventional (X = 54.43).

Hypothesis Two

There are no significant differences in the post-test mean scores of low, medium and high ability students taught using animation with text (AT). To test this hypothesis, ANOVA statistics was used. The summary of this is shown in table 5.

Table 5: ANOVA comparison of mean achievement scores Ability levels in AT group

Source	Sum of Square	df	Mean Square	F-value	p -value
Between Group	94.207	2	47.103		
Within Group	8010.011	37	216.487	0.218^{ns}	0.805
Total	8104.218	39			

ns= not significant at .05 level.

Table 5 presents the ANOVA comparison of the post-test mean achievement scores of high, medium and low ability students taught using animation with narration (AN). From the Table, the F-value of 0.218 was not significant at the 0.05 level. This indicates that there are no statistically significant differences among the performance the high, medium and low students taught with Animation with on-screen Text (AT) (F = 0.218, df = 37, p = 0.805). This implies that there are no statistically significant differences among the high, medium, and ability students when exposed to Animation with Text (AT) multimedia instructional package. On this basis, hypothesis two was upheld.

Hypothesis Three

There is no significant difference on the post-test mean scores of low, medium and high ability students taught using animation with narration (AN).

To test this hypothesis, ANOVA statistics was used to analyze the mean achievement scores. The summary is shown in table 6.

Table 6: ANOVA comparison of mean achievement scores Ability levels in AN group

Source	Sum of Square	df	Mean Square	F -value	p-value
Between Group	484.022	2	242.011		
Within Group	7773.515	37	210.095	1.152^{ns}	0.327
Total	8257.538	39			

ns= not significant at .05 level.

Table 6 presents the ANOVA comparison of the post-test mean achievement scores of high, medium, and low ability students taught using animation with narration (AN). From the Table, the F-value of 1.152 was not significant at the 0.05 level. This indicates that there are no statistically significant differences among the performance the high, medium and low students taught with Animation with Narration (AN) ($F = 1.152$, $df = 37$, $p = 0.327$). This implies that there are no statistically significant differences among the high, medium, and ability students when exposed to Animation with Narration (AN) multimedia instructional package. On this basis, hypothesis two was upheld.

Discussion of Results

Hypothesis one revealed that there are significant differences in the learning achievements in favour of the group taught solid geometry concepts with animation with narration (AN). This result agrees with the findings of Mayrath (2009) and Jung-Chuan, Chun-Yi and I-Jung (2012), Taber, Martens and VanMerrieboer (2004) and Adegoke (2010 which reported that students taught with animation with narration performed significantly better than those in control group. The result of this study validates the findings Mayer's (2001) multimedia modality principle. Generally, it supports the findings of Mahmood (2002) which revealed that CAI involving Animation with Text (AT) and Animation with Narration (AN) improves students' achievement in mathematics.

Hypotheses two and three revealed that there are no statistically significant differences among the performances of high, medium, and low ability students taught with Animation with Narration (AN). This finding disagreed with the works of Aluko (2004), Fajola (2000), Ige (2004), Gambari (2010), Yusuf, Gambari and Olumorin (2012) who reported that high ability students performed better than medium and low ability students when taught chemistry, biology, and physics respectively. Similarly, it disagreed with the findings of Wing-Yi, Lam, and Chung-Yan (2008) who reported that high and low achiever students benefited than medium achievers.

Conclusion

This study revealed that computer-based multimedia instruction involving Animation with Text (AT) and Animation with Narration (AN) enhanced students' performance in mathematics. Animation with Narration (AN) generates more learning outcome than Animation with on-screen Text (AT). The use of AT and AN computer-based multimedia instructional packages improved high, medium, and low ability students performance equally. This can serve as a medium of bridging the gaps between low, medium and high ability students in mathematics.

Recommendations

Based on the findings of this study, it is recommended that the computer-based multimedia instruction involving Animation with Narration (AN) package should employed in teaching mathematics. Computer-based multimedia packages should be used to arouse the interest of the low and medium ability students. Also, mathematics teachers should be trained on the effective use of computer-based multimedia instruction through seminars, workshops and conferences.

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