

EFFECTS OF WEB-BASED INSTRUCTION ON STUDENTS' ACADEMIC ACHIEVEMENT IN BASIC SCIENCE AND TECHNOLOGY

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Abstract

The study investigated the effects of Web-based Instruction on students' academic achievement in Basic science and technology in Junior Secondary Schools. Two research questions and two hypotheses guided the study. The study was conducted in Minna metropolis, Niger State. Quasi-experimental design was adopted for the study. A multi-stage sampling technique was used for the study. The sample size for the study consisted of 109 students. The study compared Web-based instructional medium to the use of conventional lecture method on identification, uses and or functions of different types of woodwork and metalwork machines. Basic Science and Technology Achievement Test (BSTAT) was the main instrument used for data collection. BSTAT consisted of standardized questions adopted from the past NECO basic technology past question papers and require no face validation. Meanwhile, content validity of BSTAT was established by five experts. The reliability coefficient for BSTAT yielded 0.88 using Kuder Richardson 20 formula. Research questions were analyzed using Mean and Standard deviation while the null hypotheses were tested at .05 level of significance using ANCOVA and t-test statistics. The findings of the study indicated that WBI was more effective in helping students to improve on their academic achievement and that no significant difference was observed in the achievement of both male and female students. Based on the findings of the study, it was recommended among others that junior secondary school teachers should make use of web-based instruction for teaching basic science and technology.

Keywords: Web-based Instruction, Students' Academic Achievement, Basic Science and Technology and Gender

Introduction

The pervasiveness in the use of network technology that is, World Wide Web (WWW) and or internet technologies in modern instructional process is assuming a recurrent decimal of change in the field of education. This is so because, the internet is more frequently becoming part of our daily lives, and its presence in education is

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unmistakable. Web-based instruction seems to dominate the attention of educators and students and as such the interest in this new instructional medium is indeed commanding (Cook, 2007). Lee (2009) explain that the Internet serves both as a communication tool and as an information resource. In fact, the most frequent classroom use of the Internet is searching for information resources (Lee, 2009). Teaching and learning are therefore experiencing a noticeable transition from the traditional, centralized, local, classroom-teacher focused approach, to a de-centralized, global, network based, student focused one as a result of powerful influence of Web-based technologies (Lee, 2009).

Kaur and Kaur (2012) and Thrasher, Coleman and Atkinson (2012) defines web based instruction (WBI) as a hypothesis- based instructional programme which utilizes the attributes and resources of the world wide web to create a meaningful environment where learning is fostered and supported. According to Şengel (2005) Web-based instruction organizes subject matter as hypertext documents on the Internet such that it incorporates text with graphics, videos or audios, which have many pedagogical advantages. This multimedia capability permits much more flexibility in the delivery of instruction by individuals selecting hypertext links, thus allowing the nonlinear interaction with information. Adaptability or flexibility advantage afforded individual learners by this medium of instruction enables students to be able to follow links or paths through the online content within the context created by the developer, or chart their own routes according to individually prescribed requirements, changing dynamically during the process of acquisition. In this case, adequate and veritable innovative medium of instruction as entailed in web-based instruction can be used to complement traditional instruction and or to provide complete courses over the Internet, especially in the basic science and technology using variety of symbols, graphics, video and simulations among other.

Basic science and technology is a composite or cluster of subject or a course of study in the revised 9-Year Basic Education Curriculum whose implementation has just commenced in September 2014 at the Primary and Junior Secondary School (JSS) levels of the 9-3-4 system of education being practised in Nigeria (Federal Ministry of Education, 2009). It is a product of the restructuring and integration of 4 Primary and JSS levels Basic Education Curriculum namely: Basic science, Basic Technology, Physical and health education, and Computer Science / Information technology. In the context of this study Basic Technology would be more emphasized. The integration of these curricula became necessary based on the recommendations of the Presidential Summit on Education (2010) to reduce the number of subjects offered in Primary and Junior Secondary Schools; feedback from the implementation of the curricular in schools that identified duplication of concepts as the major cause of curriculum overload; and the need to encourage innovative teaching and learning approaches and techniques that promote creativity and critical thinking in learners among others. For that reason, efforts were made to reduce content overload, repetition or duplications within and across subjects with little attention to the depth, appropriateness of the curricula contents (Igbokwe, 2015).

According to Federal Ministry of Education (2009) the Basic Science and Technology Curriculum (BSTC) is expected to enable the learners: develop interest in science and technology; acquire basic knowledge and skills in science and technology; applied scientific and technological knowledge and skills to meet contemporary societal needs; take advantage of the numerous career opportunities provided by science and technology; become prepared for further studies in science and technology; avoid drug abuse and related vices; and be safety and security conscious. Thematic approach to content organization was adopted in developing BSTC (Igbokwe, 2015). In thematic approach, the topics in each theme are spirally sequenced; from simple to complex across the 9 years of schooling in order to sustain the interest of learners and promote meaningful learning and skills. The contents of the curriculum are enriched with real-life examples and further promotes guided inquiry and activity based teaching and learning (Igbokwe, 2015). Web-based instruction holds promising implications for both teacher and students in providing the needed rich learning environments for enhancing students' achievement especially with the use of blended learning approach.

According to Thrasher, Coleman and Atkinson (2012), blended learning is a method of instructional delivery that includes a mix of web-based instruction, streaming video conferencing, face-to-face classroom time, distance learning through television or video or other combinations of electronic and traditional educational models. It is otherwise known as distributed or hybrid learning. It can be implemented in a combination of ways, it always accommodates a separation of geographical locations for part (or all) of the instruction and focuses on learner-to-learner as well as instructor-to-learner interaction. A typical model for blended learning might involve an initial face-to-face orientation followed by a period of online classes and then a face-to-face wrap-up class. A web-based instruction using blended learning approach as earlier stated would be adopted in the context of this study for increasing students' academic achievements in basic science and technology.

The use of web-based instruction focuses more on "learning" than "teaching". UNESCO (2005) pointed out that the shift to student-centred learning emerged based on cognitive learning research. Cognitive learning theories focus more on what goes on inside the learner's mind during learning process (Brenda, 1998). For that reason, the underlining premise for the use of web-based instruction in the context of this study is based cognitive theory. Emphasis in cognitive theory holds the perspective that students actively process information and learning takes place through the efforts of students as they organize, store and then find relationship and scripts (Darabi & Nelson, 2004).

Learning appears to be enhanced mostly when an instruction engages the active involvement and participation of students on a well-defined and challenging set of interrelated course assignment (Okurumeh, 2008). In an web-based learning environment the students' participation or interaction with the command or control keys provide an interactive learning environment (based on face-to-face dialogue) which has a direct positive relationship with students' cognitive processes and a tendency to improve students construction of knowledge and transfer of learning (Abd-El-Aziz, 2013). This

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suggests that interacting with web-based instruction can be effective as an instructional strategy to improve students' academic achievement in basic science and technology.

Academic achievement according to Abd-El-Aziz (2013) connotes attainment in a school subject as symbolized by a score or mark on an achievement test. Abd-El-Aziz (2013) further explains that academic achievement depends on several factors among which are the instructional methods, learning environment and the learner. The brain does not pay attention to boring things. What makes Web-based Instruction a special medium is that they add complementary, multisensory events designed to improve students understanding of concepts. This helps maintain students' attention which may in turn improves cognitive achievement. As a consequence, basic science and technology teachers should strive to make use of appropriate web-based instructional environment for the purpose of improving students' academic achievement.

Because of discrepancies in students' academic achievement in basic science and technology in our schools, researches have been carried out in a bid to identify factors responsible for it. Such studies are that of Uwaifo and Edigin (2011) on evaluation of basic technology instruction in Nigerian secondary schools. Abd-El-Aziz and Jimoh (2016) also assess the items used in the Basic Education Certificate Examination (BECE) multiple choice questions for Basic technology in the year 2011 to 2013 in Oyo state. Poor academic achievement of students in basic technology have been a source of concern to well-meaning individuals in Nigeria. This is so, because of its relevance in promoting good quality learning that constitute the base for future learning in a bid to build a worthwhile technological base in which economy is knowledge-driven. There is therefore the need for a serious improvement in upper basic level students' academic achievement in basic science and technology with a specific attention and or emphasis on basic technology as pre-vocational base on which future vocational choices are made. This could be done through effective instructional approach as entailed in web-based instruction.

The prevalent method of teaching as it could be seen in the practice by most basic science and technology teachers today is lecture method. This method according to Abd-El-Aziz (2013) is saddled with many limitations such as its teacher-centred and as such renders students passive as well as encouraging rote memorization of facts; and its inability to provide a variety of activities for instruction in technology education among others. Persistent use of this method over the years has shown no improvement in the students' academic achievement in basic science and technology. A special teaching approach which is student-centred as entailed in web-based instruction may be more efficacious in enhancing students' achievements in basic science and technology. This instructional approach could be useful in a classroom setting that consists of male and female students.

In this regard, gender issue is becoming an important factor capable of influencing students' academic achievement when exposed to an instructional approach (Ezeliora, 2007; Anagbogu & Ezeliora, 2007). Gender simply refers to classification of human into male and female. Researches on gender related issues have so far provide a

mixed results. For instance in Nigeria, Anagbogu and Ezeliora (2007) exposed students to different scientific trainings based on cognitive, affective and psychomotor skills and found that girls scored significantly higher than boys. In the same manner, the findings of a study by McNeese (2003) in Brunei revealed that female students outperform male students in science. Meanwhile, Abidoeye (2015) and Annetta, Mangrum, Holmes, Collazo and Cheng (2009) reported that gender has no effect on academic performance of students in Geography and physics respectively. On the note of these accounts, it would be appropriate and important for demographic details of students to be taking into consideration in the context of this study.

Statement of the Study

Discrepancies in the factors identified by the researchers as responsible for poor students' academic achievement in basic science and technology have become a source of concern to well-meaning Nigerians and demand for further researches. Observations have equally shown that the prevalent method of teaching adopted by most basic science and technology teachers today is lecture method. This method is teacher-centred and saddled with many limitations as it renders students passive, encourages rote memorization of facts and unable to provide variety of activities for instruction in technology education. Persistent use of this method over the years has shown little or no improvement in the students' academic achievement in basic science and technology. Background to the study however establishes that students' learning could be better enhanced in a web-based instruction environment. Exploring the influence of this web-based instruction on students' academic achievement in basic science and technology is therefore desirable. This study therefore investigate the effects of web-based learning on students' academic achievement in basic science and technology. Gender may equally affect the way a method enhances knowledge or skill acquisition and as such underscores the need to investigate the effect of web-based learning on students' gender academic achievement in basic science and technology.

Purpose of the Study

The main purpose of this study was to investigate the effects of web-based learning on students' achievement in basic science and technology. Specifically the study sought to:

1. Determine the effect of web-based learning package on the mean achievement scores of junior secondary school students in basic science and technology compared to those taught the same basic science and technology using the conventional lecture method.
2. Determine the difference between the mean achievement scores of male and female students taught basic science and technology using the Web-based learning.

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Research Questions

The following research questions were equally raised to guide the study:

1. What is the mean achievement score of junior secondary school students taught basic science and technology using the Web-based learning to those taught the same basic science and technology using the conventional lecture method?
2. What is the mean achievement score of male and female students taught basic science and technology using the Web-based learning package?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

- Ho₁: There is no significant difference in the mean achievement score of junior secondary school students taught basic science and technology using the 'Web-based learning and those taught the same basic science and technology using the conventional lecture method.
- Ho₂: There is no significant difference in the mean achievement scores of male and female students taught basic science and technology using the Web-based learning.

Research Methods

Research Design

A quasi-experimental design using non-randomized, non-equivalent, pretest, posttest experimental group design was adopted for this study. The population for the study consisted of 2,550 students from educational zone "A" junior secondary school two (JSS II), otherwise known as Upper Basic II students in Minna metropolis. The sample size for the study consisted of 109 Upper basic II students. Multi stage sampling technique was used for the study. In the first stage, simple random sampling technique was used for selecting three co-education junior secondary schools. In the second stage, purposive sampling technique was used to select seven junior secondary schools with well-equipped computer and internet facilities with little or no interrupted internet network. Thirdly, simple random sampling technique was used to select two junior secondary schools out of seven. Lastly, simple random sampling technique was used to allocate one of the two schools to experimental and the other one to control group by balloting. Intact class in each of the two schools was used for the study.

The instrument used for data collection in the study was Basic Science and Technology Achievement Test (BSTAT) adopted from the past NECO basic technology past questions for Junior Secondary School levels otherwise referred to as Upper basic level. BSTAT consisted of twenty multiple choice items with four options (A-D). The items in BSTAT consisted of standardized questions adopted from the past NECO basic technology past question papers and require no face validation. Meanwhile, content validity of BSTAT was established by giving BSTAT and its table of specification to five

experts to check the spread of the items' conformity with the concepts covered. Modifications were made based on their comments. The instrument was trial tested using twenty students from a similar junior secondary school in Abuja Metropolis. The reliability co-efficient of BSTAT using Kuder Richardson 20 formula was 0.88.

Two lesson plans were developed for the purpose of this study. One of the lesson plans was developed to guide web-based instruction and the other one for conventional lecture lesson. The pre-test was administered on both experimental and control groups to draw a base line for data generated before the commencement of the study. Experimental group was taught in the computer laboratory on a direct linkage with the relevant website(s) for the needed information. Teacher makes use of Liquid Crystal Display (LCD) projector to take a lead in facilitating the classroom activities on basic science and technology contents presented to the students. The teacher presents information and displays relevant video clips and animations of the contents by direct connection to the web and asked the students to do the same on the web. Each student worked or was allocated to a workstation for the classroom activities. Web-based instruction was compare to conventional lecture method on identification, uses and or functions of different types of woodwork and metalwork machines.

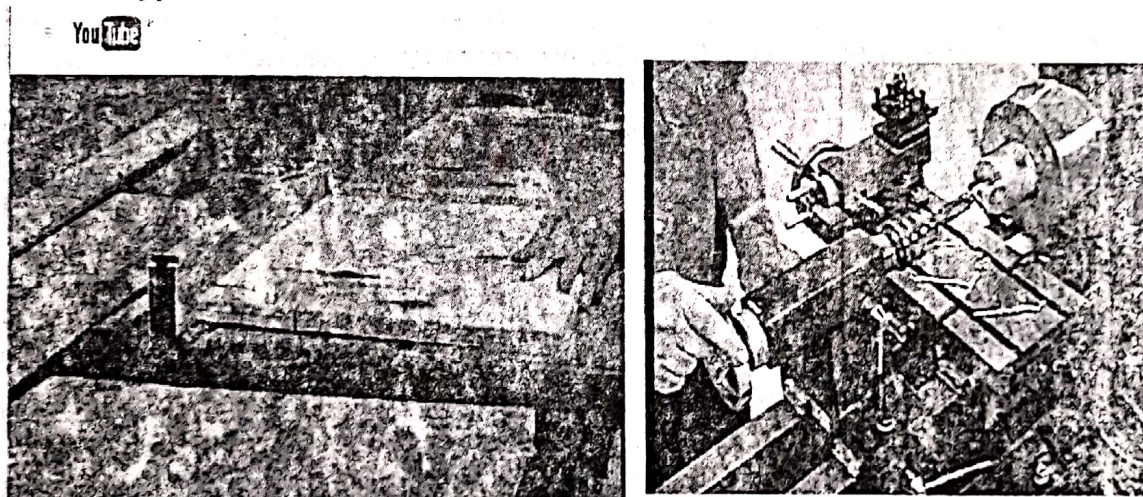


Figure1: Screen Shots of Web-based Video showing how to make use of Woodwork Circular Saw and a Metalwork Lathe Machine

In the control group, teacher wrote the topic on the chalkboard and introduced the lesson by asking questions based on the previous lesson. He stated the specific learning objective(s) of the lessons; discussed and demonstrated the content of the lesson while the students listened to the teacher writes down the necessary information in their note books and are allowed to ask questions on areas of the topic which is not clear to them. Teacher asked few questions and randomly picked students to answer them. Teacher recognized and praised the correct responses and guided wrong responses to correct answers. The study lasted four weeks and BSTAT was reshuffled and administered immediately at the completion of treatment as posttest to measure the achievement of the sample students in each group. The data collected were analyzed using mean and

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standard deviation to answer research questions while Analysis of covariance (ANCOVA) and t-test were used to test the hypotheses.

Results

Table 1: Mean Scores of Students' Academic Achievement in Basic Science and Technology based on the Modes of Instruction

		Academic Achievement				
		Pretest		Post-test		
Group	N	Mean	SD	Mean	SD	Mean Gain
Experimental	52	6.270	4.5334	18.550	11.6374	12.280
Control	57	7.050	4.6254	13.300	7.9288	8.250

Table 1 reveals that students taught with web-based instruction had a pre-test mean score of 6.270, post-test mean score of 18.550 and mean gain of 12.280. On the other hand, student taught using conventional lecture method had a pre-test mean score of 7.050, post-test mean score of 13.300 and mean gain of 8.250. This shows that using web-based instruction produces better result.

Table 2: Mean Scores on the Effect of Gender on Students' Academic Achievement in Basic Science and Technology when taught using Web-based Instruction

		Academic Achievement				
		Pretest		Post-test		
Group	N	Mean	SD	Mean	SD	Mean Gain
Male	23	6.35	4.732	20.75	10.350	14.40
Female	29	6.19	4.225	16.35	9.928	10.16

Table 2 reveals that male students taught with web-based instruction had pre-test mean score of 6.35, post-test score of 20.75, and mean gain of 14.40. Female students who were equally taught with web-based instruction alongside with their male counterparts had a pre-test mean score of 6.190, post-test score of 16.350, and mean gain of 10.16. This shows that males have a higher mean score than female.

Table 3: Summary of Analysis of Covariance (ANCOVA) of Students' Cognitive Achievement Scores in Auto- Mechanics based on Modes of Instruction

Source	Type III Sum of Squares	df	Mean Square	F	Sig of F
Correct Model	71.360 ^a	2	23.787	9.561	0.000
Intercept	3649.742	1	3649.742	117.963	0.000
Pretest	743.232	1	74.232	2.399	0.126
Groups	64.642	1	64.642	5.563*	0.000
Error	2134.840	107	5.810		
Total	107545.825	109			
Corrected Total	1654.350	108			

*Significance at Sig of F less than 0.05

Table 3 shows the F-calculated value for the effect of instruction on the academic achievement of students in Experimental group and Control group. The F-cal value for the group is 5.563 with a significance of F at .000 which is less than .05. The results indicated that there is a significant difference between the mean scores of Experimental group and Control group in the academic achievement of students in Basic science and technology. Therefore, the null hypothesis of no significant difference in the mean achievement score of junior secondary school students taught basic science and technology using the 'Web-based learning and those taught the same basic science and technology using conventional lecture method is rejected. Thus, there is a significant difference significant difference in the mean achievement score of junior secondary school students taught basic science and technology using the 'Web-based learning and those taught the same basic science and technology using conventional lecture method.

Table 4: Summary of t-test Analysis of the Mean Achievement Scores of Male and Female Students Taught Basic science and technology Using Web-based Instruction

Variable	N	Df	\bar{X}	SD	t-value	P-value
Males	23		20.750	10.350		
Females	29	50	16.355	9.928	0.758 ^{NS}	1.96

NS=Not Significant at $P > 0.05$

Table 4 shows that the calculated t-value is 0.758 while the critical t-value is 1.96 at .05 alpha level of significance. This implies that the null hypothesis that there is no significant difference in the mean achievement scores of male and female students taught basic science and technology using the Web-based learning is not rejected. Hence, there is no significant difference in the mean achievement scores of male and female students taught basic science and technology using the Web-based learning.

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Summary of Findings

The summary of findings of the study includes:

1. Students taught with web-based instruction produce higher mean score than those taught with conventional lecture method
2. Male students performed better than female students when taught web-based instruction.
3. There is significant difference between the mean scores of students taught with web-based instruction and those taught using conventional lecture method.
4. There is no significant difference between the mean scores of male and female students taught with web-based instruction.

Discussion of the Results

Data obtained from this study indicated that students in the experimental group obtained a higher post-test mean score than those in the control group. The difference between the mean scores was statistically significant as shown in Table 3. The results of this study agree with earlier studies by Kaur and Kaur (2012), Güzeller and Akın (2012) and Thrasher, Coleman and Atkinson (2012). These studies revealed that web-based instruction is effective in the recall of learnt materials.

Also, the findings of this study regarding the achievement of male and female students in basic science and technology show that males were ahead of female by a difference of 4.24, but it was found to be statistically significant in the test of hypothesis. This is in line with the studies by Abidoye (2015), Gambari, Yussuf and Balogun (2012) and Annetta, Mangrum, Holmes, Collazo and Cheng (2009). These researchers did not establish any significant difference in the achievement of male and female students when taught using different methods and technique. The lack of significant difference in the achievement of male and female in basic science and technology arises probably from the fact that the web-based instruction is not gender biased. Rather, with the effective application of web-based instruction, good results can be achieved by both male and female.

Conclusions

On the basis of the findings emanating from this study, web-based instruction was found to be more effective than the conventional lecturing method on students' achievement in basic science and technology. The mean score of the students taught with WBI was found to be significantly higher than those taught with conventional teaching method. It can be confirmed from the findings of this study that the teaching method had a significant effect on students' academic achievement in basic science and technology. One can therefore conclude that understanding of basic science and technology can be enhanced by incorporating WBI into basic science and technology teaching and learning.

Also, males had a mean score higher than the female students, the difference in the mean scores was not statistically significant. The result indicated that both males and females benefitted equally when exposed to this WBI instructional medium. Hence, if

well utilized, WBI could serve as an effective approach to achieving the desired learning outcomes especially when equal treatment are required for both male and female students.

Recommendations

1. The use of WBI was found to be effective in promoting academic achievement in basic science and technology, junior secondary school teachers should therefore be encouraged to make use of web-based instruction for teaching basic science and technology.
2. Seminars, conferences and workshops should be organized to sensitize and train teachers on the use of web-based instruction for teaching and learning.
3. Government should provide computer facilities, projectors, and good internet network connectivity in schools so that the learners can learn at their own pace on the web.
4. Curriculum planners should incorporate the use of web-based instruction as part of instructional medium for teaching basic technology in the next review of the curriculum.
5. Teachers of basic science and technology should provide equal opportunities for male and female students to learn as both can achieve similar results with the use of appropriate instructional medium. Thus, the use of WBI which is prone to gender biased when used effectively should be employed.

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