Effects of Intelligent Tutoring Method on Students' Achievement and Interest in Basic Science and Technology

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Abstract

The study investigated the effect of intelligent tutoring method on students' achievement and interest in basic science and technology. Intelligent tutoring allows students to discover specific information by themselves before they make generalization. Three research questions and three null hypotheses guided the study. Quasi-experimental design was adopted for the study, specifically, non-equivalent control group design. The study was carried out in Bida Education Zone of Niger State. The sample for the study comprised 80 JSS II students from two intact classes in two secondary schools in Bida Education Zone of Niger State, drawn using multi stage sampling techniques. The experimental group was taught using intelligent tutoring method, while the control group was taught using conventional lecture method. The treatments lasted for four weeks. Two instruments were used for data collection in the study namely: Basic science and Technology Achievement Test (BSTAT) and Basic science and technology Interest Inventory Scale (BSTIIS). Data collected were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The results revealed that intelligent tutoring instructional method was superior to conventional instructional method in facilitating students' achievement and interest in basic science and technology. There was no significant difference in the mean scores of male and female students in basic science and technology after the treatment, although male students performed slightly better than their female counterpart. Intelligent tutoring method was more effective than the conventional method. Based on the findings of the study, the educational implications of the findings were highlighted and the following recommendations were proffered among others: that basic science and technology teacher educators should adopt intelligent tutoring instructional method when teaching in order to enhance students' achievement and interest in basic science and technology.

Keywords: Intelligent tutoring, Basic Science and Technology, Achievement and Interest

Introduction

Teaching methods are ways used by teachers to create learning environment and to specify the nature of the activity in which the teacher and the learner will be involved during instructional delivery process. It is primarily a description of learning objective oriented activities and the flow of information between the teacher and the learner(s), O'Banon (2002) categorized teaching method into two approaches; namely; student centered approach and teacher centered-approach. Teacher-centered approaches are grounded in behaviorism and include all the teaching methods that see the teacher as possessor of knowledge. These methods include lecture /expository, demonstration, discussion, recitation, while student centered approaches are grounded in constructivism and includes all the instructional methods that underscores teachers as decision makers and problem solvers but rather as a guide in the learning process.

The teacher's role in a student-centred learning environment is, at most, one of facilitator and guide. The students are in control of their own learning and the power and responsibility are the students concern. Learning may be independent, collaborative, cooperative and competitive. The utilization and processing of information is more important than the basic content. Learning takes place in relative contexts and students are engaged in constructing their own knowledge (Theroux, 2011).The teacher who utilizes the student centered method effectively is constantly on the move. The teacher may be engaged with the students as a classroom collective individually or in groups. Their involvement would include questioning, disciplining, guiding, validating, monitoring, motivating, encouraging, suggesting, modeling and clarifying (McKenzie, 2015). This student centered method is in line with the National Policy on Education.

While Intelligent Tutoring System (ITS) may be somewhat effective in helping learners, it does not provide the same kind of personalized attention that a student would receive from a human tutor (Mohammed & Finch, 2015). In order to achieve a more efficient learning environment and to deliver the best learning process, research on ITS in basic science and technology education is focusing on the area of Artificial Intelligence (AI). Mohammed & Finch (2015) asserted that AI is able to prepare a more human-based interactive learning environment for students. A human based interactive learning environment is important because it involves students in active learning. Heffernan (2011) stated that as the techniques of AI become widely known and appreciated in the field of educational computing, AI with interests in education has also undergone changes in direction. He also stressed that the overall aim of developing AI is to enable the computer to be effective and act as a knowledgeable agent in the teaching and learning process. A major strand of research has been the design of the so-called Intelligent Tutoring Systems (ITS) which require knowledge representations to provide models of the subject domain, the learner capabilities, and the tutorial pedagogy (Heffernan, 2011). Canfield (2011) defined ITS as a system that is able to diagnose and adapt to students' knowledge and skills. According to Canfield (2011), an ITS is able to provide

precise feedback when mistakes are made and able to present new topics when the student is ready to learn. Intelligent tutoring systems are part of a new breed of instructional computer programs.

Lecture teaching method is concerned with the teacher being the controller of the learning environment. Power and responsibilities are held by the teacher and they play the role of instructor (in the form of lectures) and decision makers (in regards to curriculum content and specific outcome). They regard students as having knowledge holes that need to be filled with information. The traditional teacher's view is that the teacher causes learning to occur, (Novec, 2008). According to Awodi, (2001), the lecture method is mainly teacher- centered, with students being constantly passive and contents are constantly taught as absolute knowledge irrespective of the above comments on lecture method of teaching. Lecture method is mostly employed by most science teachers because of some of its advantages which include the fact that it can be used to cover a large content area at a time and students are given the same content at the same time. Another major advantage is that it can be used to teach a large class which is a prominent feature in most Nigerian secondary schools. It has been observed that effective teaching may facilitate learning and make it more meaningful. In line with this, Sandra (2013) stated that effective teaching helps the learner to learn better, while poor teaching would naturally lead to poor learning and consequently poor achievement.

Achievement according to Adeyemi (2008) is the scholastic standing of a student at a given moment. It has to do with the successful accomplishment of goal(s). The purpose of testing an achievement is to help the teacher and the students evaluate and estimate the degree of success attained in learning a given concept. Interest is an important variable in learning because when one is interested in an activity, one is likely to perform positively. Chukwu (2016) stated that interest can be expressed through simple statement made by individuals of their likes and dislikes. Lack of interest according to chukwu may be caused by uninteresting teaching methods. Also, Obodo (2012) described interest as the attraction which forces or compels a child to respond to a particular stimulus..This points that a child develops interest if a particular stimulus is attractive and arousing or stimulating This shows that interest comes as a result of eagerness to learn not by force (Harbor Peters,2014). The development of interest in basic science and technology as an objective of the basic science and technology teaching, may likely promote achievement in the course.

An issue of contention in Nigeria today is the issue of gender in our society including the educational system. In recent times educators have expressed diverse views about gender and achievement especially in science and technology. While some are of the view that males do better than females, others disagree with this view, arguing that achievement is a factor dependent on several factors such as socio –economic background, teaching method among others. In view of the issues on the use of intelligent tutoring and lecture teaching method on students achievement and interest in sciences in senior secondary schools, the researchers wishes to investigate

the above teaching methods on student's achievement and interest in junior secondary school basic science and technology irrespective of gender.

Purpose of the Study

The main purpose of this study is to find out the effect of intelligent tutoring and lecture methods of teaching on students' achievement and interest in basic science and technology. Specifically, the study will determine:

1. the effects of intelligent tutoring and lecture teaching methods on students' mean achievement scores in basic science and technology
2. the effects of intelligent tutoring and lecture teaching methods on students' mean interest scores in basic science and technology
3. the influence of gender on mean achievement scores of students in basic science and technology

Research Questions

The following research questions were posed to guide the study:

1. what is the relative effect of intelligent tutoring and lecture methods on students' mean achievement scores in basic science and technology?
2. what is the relative effect of intelligent tutoring and lecture methods on students' mean interest scores in basic science and technology?
3. what is the influence of gender on mean achievement scores of students taught basic science and technology using intelligent tutoring and lecture method?

Hypotheses

The following null hypotheses (Ho) were formulated and will be tested at 0.05 level of significance:

HO_1: There is no significant difference in the mean achievement scores of students taught basic science and technology using intelligent tutoring and lecture methods.

HO_2: There is no significant difference in the mean achievement scores of male and female students taught basic science and technology using the two methods.

HO_3: There is no significant interaction effect of teaching methods and genders on students' mean achievement scores in basic science and technology

Methodology

The design for the study is quasi-experimental design. Specifically the study applied the non equivalent control group design. Quasi-experimental design is considered appropriate for the study because intact classes was used to avoid disruption of

normal class lessons and to control extraneous variables.The area of the study is Bida Education Zone of Niger State. The choice of the zone is borne out of the fact that researches have shown that students in the zone have a lot of problems in basic science and technology. All the Junior Secondary Two (JSS2) students in all the government owned coeducational secondary schools in Bida Education Zone formed the population of the study. There are 58 governments owned junior secondary schools in Bida Education zone. The total population of JSS2 students in all the government owned coeducational secondary schools in Bida Education Zone is 4592.Eighty (80) JSII students formed the sample for this study. Multi-Stage sampling technique was used in composing the sample. Multi-staged sampling technique was chosen because it will enable the researchers sample the students along the three local government areas in the zone. Finally, in each school, two intact classes were randomly selected for the study. One intact class was assigned to experimental group and the other, control group.

Two instruments: Basic science and Technology Achievement Test (BSTAT) and Basic science and technology Interest Inventory Scale (BSTIIS) were developed by the researchers to collect data for the study. The BSTAT consists of 30 multiple choice items with four options, A, B, C, and D. Each of the items in the BSTAT carries one mark. The Second Instrument is Basic Science and Technology Interest Inventory Scale (BSTIIS) which was designed to assess students' interest in basic science and technology on four- point likert type rating scale thus: strongly agree (SA) = 4, Agree (A) = 3 Disagree (D) = 2 and Strongly disagree (SD) = 1. The responses are: strongly agree, agree, disagree and strongly disagree is respectively assigned value point of 4, 3, 2, 1. For positive statement and the reverse for negative statements. The research instruments (Basic Science and Technology Achievement Test and Basic Science and Technology Interest Inventory Scale) were face-validated by three experts from the Department Industrial and Technology Education School of Science and Technology Education, Federal University of Technology Minna. The experts were requested to validate the instrument and vet the lesson notes. These experts validated the items in terms of clarity of language, appropriateness and adequacy of the items in measuring what they are supposed to measure.Content validation were done using table of specification. The advice of the experts helped to delete, modify and select the set of test items for the study.The reliability of the BSTAT was determined using Kuderd Richard formula. The internal consistency of Basic Science and Technology Interest Inventory Scale was determined from the response of 20 students. A reliability coefficient of 0.95 was determined for the instrument using crombach's alpha formula. The test was administered to 20 secondary school students by their class teacher. An internal consistency of 0.091 was obtained one week Training programme was organised for the Basic Science and Technology teachers in the sampled schools to assist in the study. These basic science and technology teachers were trained on how to teach using intelligent tutoring approach

Basic science and technology teachers in the sampled schools helped the research in collection of data. The teachers collected the data before and after the experiment, after which the researchers collected and organize the data accordingly for data analysis. The scores obtained from the pre and post test were analyzed using mean and standard deviation for research questions and Analysis of Covariance (ANCOVA) for testing the hypotheses at 0.05% level of significance. ANCOVA was used to test the hypotheses because the experiment involved pretesting of the subjects. ANCOVA was used to remove the effect of the covariate or pretest.

Results

Research Question 1: What is the relative effect of intelligent tutoring and lecture method on students' mean achievement scores in Basic science and technology?

Table 1: Mean (X_i) and Standard Deviation (SD_i) Scores of Students' Mean Achievement Scores in Basic Science and Technology

Group Gain Score		Pre-test		Post-test		
	N	X_1	SD_1	X_2	SD_2	Mean
Intelligent Tutoring	47	38.96	11.63	65.72	16.63	26.76
Lecture Method	33	41.79	10.96	57.89	10.51	16.1

The data on students' achievement in table I revealed that students taught Basic science and technology using intelligent tutoring method had mean score of 65.72 with standard deviation of 16.63 while the mean achievement score of students taught with conventional lecture method was 57.89 with standard deviation of 10.51, the intelligent tutoring group had a gain score of 27.51 over the lecture group who had a gain score 16.1, of Students taught Basic science and technology using intelligent tutoring method therefore, performed better than students taught using the conventional lecture method.

Research Question 2: What is the relative effect of intelligent tutoring and lecture methods on students' mean interest scores in basic science and technology?

Table 2: Mean (X_i) and Standard Deviation (SD_i) Scores of Students' Mean Interest Scores in Basic Science and Technology

Group		Pre-test		Post-test		
	N	X_1	SD_1	X_2	SD_2	Mean
Intelligent Tutoring	47	1.55	0.65	2.56	0.66	1.01
Lecture Method	33	1.51	0.63	2.24	0.94	0.73

The data on students' interest in table 2 revealed that students taught Basic science and technology using intelligent tutoring method had mean interest score of 2.54 with standard deviation of 0.66 while the students taught with conventional lecture method had mean interest scores of 2.23 with standard deviation of 0.94. The

students taught basic science and technology had gain score of 1.01 while their counterpart taught using conventional method had mean gain score of 0.73. This revealed that students taught basic science and technology using intelligent tutoring method therefore, had higher interest in Basic science and technology than students taught using the conventional lecture method. Therefore, intelligent tutoring method is superior to conventional method.

Research Question 3

What is the influence of gender on mean achievement scores of students taught basic science and technology using intelligent tutoring and lecture method?

Table 3: Mean (X_i) and Standard Deviation (SD_i) of Influence of gender on students' mean achievement score in Basic Science and Technology

Gender Gain score	N	Pre-test		Post-test		Mean
		X_1	SD_1	X_2	SD_2	
Male	42	41.08	11.23	65.11	11.58	24.03
Female	38	39.26	11.57	60.11	13.95	20.85

Data in Table 3 revealed mean achievement score of 65.11 with standard deviation of 15.58 for male students, while the female students had mean achievement score of 60.11 with standard deviation of 13.95. Male students had mean gain score of 24.03 in basic science and technology while their female counterparts had mean gain score of 20.85. Male students therefore, performed better than their female counterparts in basic science and technology.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught basic science and technology using intelligent tutoring and lecture methods.

Table 4: Analysis of Covariance of Students' Mean Achievement Scores in Basic science and Technology

Sources of Variance	Sum of squares	Df	Mean Square	F	Sig.
Corrected model	11613.487	4	2903.372	37.258	.000
Intercept	2623.714	1	2623.714	33.669	.000
Pretest		1			
Gender	146.749	1	146.749	1.883	.174
Method x Gender	1.156	1	1.156	.015	.903
Error	5844.501	75	77.927		
Total	329833.000	80			
Corrected Total	17457.987	79			

Data in table 4 showed that there is a significant mean effect for mode of instruction on students achievement in basic science and technology f(1, 80) p<.0.05. The null hypothesis therefore was rejected, indicating that there was significant difference in

235

the mean achievement score of students taught basic science and technology using intelligent tutoring method and those taught using conventional instructional method.

HO₂: There is no significant difference in the mean achievement scores of male and female students taught basic science and technology using the intelligent tutoring method and conventional method.

Table 4 revealed no significant mean effect of gender on students' achievement in basic science and technology $f(1, 80)$, $p> .174$. The null hypothesis was not rejected, indicating that there was no significant difference in the mean achievement scores of male and female students taught basic science and technology using intelligent tutoring method.

HO₃: There is no significant interaction effect of teaching methods and gender on student's mean achievement scores in basic science and technology

Data in table 4 indicated non-significant interaction effect of method and gender on students achievement in basic science and technology $f(1, 80)$, $p>.903$. The null hypothesis was not rejected. The interaction effect of method and gender on students mean achievement scores in basic science and technology was, therefore, not statistically significant.

Discussion of Findings

The intelligent tutoring method of instruction was superior to the conventional method in facilitating students' achievement in basic science and technology. The intelligent tutoring method may have been more effective because the instructions were characterized by active student's involvement. thereby capturing the interest of the students and maximizing comprehension of the subject matter. This is in line with the observations of Nwagbo (2009) and Ibe (2014) who indicated that intelligent tutoring approaches prove to improve students' achievement in sciences more than the traditional instructional methods like lecture, demonstration. Also, Timothy and Awodi (2001) revealed a significant difference between intelligent tutoring and lecture method in improving student's performance in biology achievement test in favour of the intelligent tutoring approach.

The findings of this study are in line with that of similar studies by Ibe and Nwosu (2015) who carried out a study on the effects of intelligent tutoring and demonstration methods of teaching on science process skills acquisition among secondary school biology students. Their finding revealed that the student taught through intelligent tutoring method performed significantly better than those taught through demonstration and conventional (lecture) methods. Results obtained from the study showed that students taught with intelligent tutoring method had higher interest in basic science and technology than their counterparts that were taught with conventional method. The finding is in agreement with that of Ezeudu (2015) who

236

found out that student centered instructional approach enhances student's interest in science. Okoro (2011) found out that students' interaction pattern promotes student's interest in biology than the conventional instructional approach. Students perform better when they work in groups, they share ideas. This increase their interest especially when taught basic science and technology using intelligent tutoring method

The results of the study showed that male students performed better than their female counterparts in basic science and technology (Akusoba and Ezike in Mandore (2013). This could be as a result of the different socialization processes of male and female students in which the male persons are expected to explore their environment while the female ones are to conform or maintain their existing environment notwithstanding, male students performed significantly better than female students in basic science and technology. The finding supports the finding of Nwagbo (2009) who found out that male students performed better than their female counterparts in biology. The finding did not support that of Ibe and Nwosu (2015) and others who found that girls achieved more than boys in science subjects, and that female learners show some superiority over male learners. Okoro (2011) also found that male students achieve higher than their female counterparts in science, Okeke (2007) and Nzewi (2010). are of the view that females achieve as high as their male counterparts when given equal opportunities. Ibe (2014) reported that there was no significant difference in the achievement of male and female students used to determine the effect of intelligent tutoring and demonstration methods on science process skill acquisition among secondary school Biology students. Males perform better than their female counterparts when taught with intelligent tutoring method probably because males tend to explore their environment more than the females who tend to conform to the environment they found themselves.

Conclusion

From the results obtained in the study on the effects of intelligent tutoring method on students' achievement in basic science and technology, it was found that

- Students taught basic science and technology using intelligent tutoring method performed better than their counterparts taught basic science and technology using the lecture method

- Students taught basic science and technology using intelligent tutoring method had higher mean interest score in basic science and technology than their counterparts taught basic science and technology using the lecture method

- Gender did not significantly influence students' achievement in basic science and technology, even though the posttest mean scores of male students was slightly higher than that of their female counterparts.

Educational Implications of the findings

The findings of this study have implications for education particularly in teaching basic science and technology in secondary schools. The implications of this study border on development of more virile instructional approach for teaching basic science and technology. The study revealed that intelligent tutoring method was superior to lecture method. These results imply that the current instructional approach used in teaching basic science and technology might have been partly responsible for students' poor performance and poor interest of students in basic science and technology.

The findings of this study equally implicated the science teachers; science teachers should endeavour to use innovative student-centered instructional strategies like the intelligent tutoring pedagogy other than traditional teaching methods since the latter is not students centred and cannot enhance student's achievement. In addition, science and technology teachers should ensure that students' cognition are activated during teaching and learning, this will make them to focus on the learning task.

Also, the finding of the study shows that male and female students exist in separate conceptual world. Hence, science and technology teachers should consider the gender of their students when teaching.

The authors and publishers of science books should ensure that they incorporate intelligent tutoring-inducing practicals in their books for this will trigger and sustain students' achievement and interest in basic science and technology

The findings of this study implied that planners of curriculum should include intelligent tutoring basic instructions in future curriculum development..

Recommendations

Based on the findings of this study, and their implications, the following recommendations are made.

1. In view of the fact that the intelligent tutoring method was more effective in teaching basic science and technology and enhancing students' achievement and interest in basic science and technology, the Ministries of Education should ensure that textbook authors incorporate intelligent tutoring methods in the instructional methods for secondary schools.
2. Mode of instruction had no differential effects on male and female students' achievement in basic science and technology. Hence, teachers should make teaching and learning of science gender unbias
3. Ministry of Education should ensure that their teachers are trained regularly on the use of innovative instructional approaches eg. intelligent tutoring method

4. The curriculum planners should ensure that they incorporate intelligent tutoring methods in basic science and technology curriculum, as it will help to promote students' achievement and interest in the subject.

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