IMPACTS OF TWO INNOVATIVE INSTRUCTIONAL STRATEGIES ON JUNIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN BASIC SCIENCE

OYASOLA, Samuel Olalekan
Department of Integrated Science
School of Secondary Education (Science Programmes)
Emmanuel Alayande College of Education, Oyo

Dr. ADEGOKE, Adebare Idowu
Department of integrated science. School of science.
Oyo State College of Education, Lanlate

Abstract
This study investigated the impacts of two innovative instructional strategies on students' academic achievement in Basic Science in Oyo metropolis, Oyo State, Nigeria. A pretest-posttest control group quasi experimental design was employed in the study. The treatments were at three levels: Discovery learning, Guided Inquiry and Conventional strategies. The moderating effects of gender were also examined. 260 students obtained through intact classes of the three selected junior secondary schools participated in the study. Four research instruments were used. The data collected were analyzed using Analysis of covariance (ANCOVA) at alpha level of p<0.05. Estimated Marginal Mean (EMM) of different groups were also determined and Bonferroni Post-hoc was used to obtain significant main effects. The results of findings revealed that the treatment innovative teaching strategies was found to have significant effects on students' academic achievement ($F_{(2,249)}$ =21.373; p<0.05, partial η^2 = 0.160). Students exposed to treatment obtained a higher post-achievement mean score 24.50 for discovery learning group followed by guided enquiry strategy group 22.50, while the conventional strategy (CS) control group had the least adjusted post-achievement mean score in basic science with 13.62.Based on this finding, it is recommended that teacher should be discouraged from using teacher-center instructional strategy in teaching basic science but rather, innovative teaching strategy should be adopted by the teachers where students would be actively involved in the art teaching and learning. It was concluded that the innovative teaching strategy enhance students' achievement

Keywords: Innovative Teaching, Discovery Learning, Guided Inquiry Teaching, Achievement and Gender

Introduction

The 21st century introduced significant changes in didactics teaching methods. Pedagogy of the twentieth century differs from the pedagogy of the twenty-first century. Since the beginning of the twenty-first century, there have been many changes in the development of national and world education. As a result there are rapid changes taking place in education, industry, ICT, communication, agriculture, and medicine etc. Science as an instrument of development plays a dominant role in bringing about these changes by advancing technological development, promoting national wealth, improving health and industrialization.

According to Gbenga and Effiong (2015), integrated science, being the foundation for the sciences, deals basically with the fundamental unity of science. These sciences include subjects like mathematics, physics, Chemistry, Biology, Geography, Physical and Health Education. It also cuts across many other fields of human study. Today, based on recent development in science and technology, integrated science is taught as Basic science in junior secondary schools. This is why this work emphasizes

Basic Science. Basic Science is an enquiry-oriented discipline that helps in sharpening the learner's intellectual development and also building his attitudes.

Basic Science plays vital role in Nigeria's science education programme because it prepares pupils at the Junior Secondary School level for the study of core science subjects at the Senior Secondary School level which in turn brings about students' interest in science oriented courses at the tertiary institutions. Teaching and learning of science are two important activities in the field of science education. Akinsolu (2013) described teaching as being multidimensional with appropriate teaching contents, objectives (goal), methodology and robust teacher evaluation.

According to Bilesanmi-Awoderu (2012), learning is a change in behavior as a result of past experience. Learning is the aim of education activities, the intended outcomes of educational processes and practices. Despite government's efforts to encourage science teaching and learning among Nigerian students right from the junior secondary school level, the enrolment of students in core science subjects and science oriented courses at the Senior Secondary School level and tertiary institutions level respectively, is not encouraging. This is as a result of junior secondary school students' negative attitude towards Basic Science and belief that science subjects are difficult.

According to NERDC (2007), the overall objectives of the Basic Science and Technology curriculum (Revised: 2012) are to enable learners to: develop interest in science and technology, acquire basic knowledge and skills in science and technology, apply scientific knowledge and skills to meet societal needs, take advantage of the numerous career opportunities offered by science, become prepared for further studies, avoid drug abuse and related vices, be safety and security conscious. The enumerated objectives among other reasons, are supposed to prepare upper basic students for the study of science at the Senior Secondary School level. This could be one of the reasons why the contents of the Basic Science and Technology curriculum are sequenced in spiral form beginning with the simplest to the most complex.

In the past, research efforts had been focused on identifying factors that militate against student's learning outcomes in Basic Science. Arisi (2002) has pointed out that despite the thirty (30) years existence of learning styles/ theories (detailing how people learn), most teachers still dispense information using traditional lecture methods without regard to student's learning abilities in Science, and factors such as inadequate instructional materials, teachers' poor improvisation skills, specialty and competency, among others, as some of the causative factors of low achievement in science. They have also proffered recommendations such as the use of inquiry, cooperative, Jigsaw instructional strategies, among others, as the way forward. However, despite these efforts, students' achievement and interest in science have not shown appreciable improvement. This could probably be related to the inability of the instructional strategy employed in the teaching of Basic Science to guide learners unto developing and adopting the appropriate learning strategy for learning Science.

The question then is what is the way out? Identification of a problem they say, is a step towards its solution. There is need to search for a strategy where students must be given sufficient opportunity for creative activity so that each can bring out his/her own measure of talent and thereby display his/her personality.

Adesina (2019) indicated that in a bid to make the science package knowledge tantalizing to the buyer (the learners), the science teachers should be innovative in congruence to the learners' styles, learning habits, mental ability, self-efficacy, intellectual capability and even the learners' emotional intelligence, so that when the learner tastes the package he/she will yearn for more.

Olagunju and Ige (2013) pin-pointed nine heuristic instructional strategies towards innovative science teaching and learning; viz: laboratory/investigative method, project, field trips, demonstration, individualized instruction, problem solving, case-studies and assignment or Dalton

method. The duo recommended that to firmly impress in the mind of the learners the scientific concepts, facts, laws, theories, and principle should be critically selected along with the relevant instructional materials with appropriate stated objectives, map out different activities for students to learn either as individual or groups, plan the instructions with skills and techniques, organize discussion, debates, quizzes, assignments and projects to stir learners' inquisitiveness and explorativeness. Inquiry learning occurs when students are doing things and thinking about what they are doing, and meaningful learning happens when students integrate new information into what they already know (Adodo, 2013). Through active learning, students are engaged in series of activities such as reading, discussing and writing, which also increases students' motivation to learn. Students can receive immediate feedback from their instructors and are involved in higher order thinking (analysis, synthesis and evaluation).

Empirical evidence has shown that studies on effects of using the learning method in Basic Science teaching (Qarareh, 2012), demonstration strategy (Giridharan and Raju, 2016), jigsaw method (Abdulkadir, 2016), concept mapping (Ahmed andOyasola, 2019), experiential and generative learning strategies (Adeyemi and Awolere, 2016), on academic achievement of students in Basic Science and other science subjects have been successfully carried out. Although most of these innovative instructional strategies proved to be significant when compared with conventional strategies used by the regular science teachers, the results of these studies are such that there are significant effect of the different teaching strategies on students' achievement in science subjects.

Nwagbo (1999) carried out a study on the effects of guided inquiry and expository teaching methods on the attitude and achievement of students in Biology at different levels of scientific literacy. A pre-test, post-test non-equivalent control group design was used for the study. The findings of the study indicated, among others, that the guided inquiry approach favoured the students in the high level group better than the medium and low level groups respectively in enhancing achievement in biology more than the expository method. The researcher found out that guided inquiry approach was significantly better than expository method of teaching in enhancing cognitive achievement in biology for all levels of scientific literacy students. The study also, found out that gender was a significant factor in students' achievement in biology.

Discovery Learning is where the teacher's role is more in the line of being a facilitator helping the students to discover information by deduction and construction (Kaufman, 1971).The main initiators of this approach to learning are Bruner (Denbo, 1994), John Dewy, Jean Piaget, and LevVygotsky based on their constructivist learning theories (Castronova, 2002) as well as Hilda Taba's curriculum-based projects on Discovery Learning in the 1960's (Kaufman, 1971. Many researchers have worked extensively on discovery learning. Nwagbo (2006) revealed that it showed good performance in pupils than expository one. Similarly, Abubakar and Dodboo (2011) explained it assisted learner to understand problem solving as they learn by experiment. The findings of Ibe (2006) on Guided discovery showed highest mean scores compared to demonstration and the least mean score in conventional. In terms of gender difference in achievement male shows higher mean score than female. The guided discovery approach has effects on student performance and attitude (Mohammed 2012). In the study of Nwachukwu and Nwosu (2007), it was observed that the success of some known innovative and effective methods may be predicated on the level of exposure students have had in basic day-today method of discovery.

Today is the era of science and technology with a great need to improve quality of education, specifically of science education. This could be possible by bring fundamental changes through innovative techniques through which teachers could provide student-centered learning environment that could make learning process interesting and understandable to the young learners.

Hypotheses

This study tested the following hypotheses at 0.05 level of significance.

HO_1: There is no significant main effect of treatment on students' achievement in Basic Science

HO_2: There is no significant main effect of treatment on gender in Basic Science

Methodology

Research Design

This study adopted the quasi – experimental pre-test and post-test three group design (two experimental groups and one control group), the three groups were administered a pretest before treatment and post-test after treatment. The experimental groups were subjected to treatment using innovative teaching strategies (i.e. guided inquiry and discovery teaching strategies) and the control group was taught using conventional teaching strategy.

Sample Selection and Sampling Techniques

Three local government areas were randomly selected from the thirty-three local government area within Oyo state. A total of six (6) randomly selected school were used for the study. Two schools were randomly selected from each local government area understudied, two schools each for the experimental groups and two schools for the control group. The intact class of the selected schools were used for this study. The total number of Basic Science students from the six junior secondary schools was two hundred and sixty (260) male and female students. The research assistants used for this study were the Basic Science teachers in the selected schools.

The following criteria were used in selecting two (2) schools used for this study:

12. The schools should be a co-educational school.
13. Accessibility of the school.
14. Evidence of presenting students for Basic Education Certificate Examination (BECE) in Basic Science for at least ten (10) years.

Research Instruments

The following instruments were used in this study:

15. Basic Science Achievement Test (BSAT)
16. Teacher's Instructional Guide on Guided Inquiry Instructional Strategy (TIGGIIS)
17. Teacher's Instructional Guide on Discovery Instructional Strategy (TIGDIS)
18. Teacher's Instructional Guide on Conventional Instructional Strategy (TIGCIS)

Basic Science Achievement Test (BSAT):

The Basic science achievement test was designed by the researcher to measure acquisition of knowledge, comprehension and application. The test has two sections. Section A consists of students' personal profile such as name of school, sex, age of students. Section B is a 20-item multiple choice test chosen out of initial draft containing 30 items with four options lettered A-D. The test items were constructed with reference to the lesson objectives specified for thecontent.The content of the test covered all the topics taught during the experiment. The number of items picked for each topic was proportional to the number of sub concepts and ideas covered within the topic.

The table below shows specification and distribution of the questions as used for the selection of items.

Topic	Knowledge	Comprehension	Application	Total
Skeletal system	3	3	4	10
Simple machine	2	3	5	10
Total	**5**	**6**	**9**	**20**

The instrument was subject to face and content validity by giving its copies to experts in educational evaluation, and science education with bias in Integrated Science. These experts determined its suitability for the target population in terms of clarity, breath and language of presentation. After this was done, out of the 30 items, only 20

survived scrutiny. The reliability coefficient of 0.77 was obtained using kuder-Richardson scale (KR20).

Validation and Reliability of BSAT

The BSAT was given to three experienced science education lecturers for scrutiny and their suggestions were effected and resulted in the final version of the instrument. The reliability coefficient of the instrument was determined using Kuder-Richardson 20 and the reliability coefficient of 0.77 was obtained.

Research Procedure

BSAT was administered to participants as pre-test on the first day of the study. Treatment condition for each group took place for Six weeks. The two groups of students were taught the same topics, different instructional strategies by the research assistants. The experimental group was taught Basic Science using guided inquiry and discovery while the control group was taught Basic Science using conventional method. At the end of the research exercise, students in the experimental and control groups were all subjected to BSAT.

Data Analysis

The data collected were analyzed using Analysis of covariance (ANCOVA) to determine the significant main effects, Estimated Marginal Mean (EMM) to different groups was used to detect the magnitude and the direction of difference and Bonferroni Post-hoc was used where significant main effects were obtained.

Results

HO_1: There is no significant main effect of treatment (Guided inquiry and discovery strategies) on students' achievement in Basic science.

Table 1. Analysis of Covariance (ANCOVA) of Post-Achievement by Treatment and Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	500.379[a]	6	100.063	8.186	.000	.160
Intercept	1235.679	1	2347.669	192.059	.000	.546
Pre Achievement	3.272	1	3.272	.260	.605	.021
Treatment	476.309	2	238.155	20.383	.000*	.150
Gender	29.573	1	29.573	2.419	.121	.010
Treatment Gender	54.109	2	28.054	2.213	.112	.018
Error	2921.462	239	13.224			
Total	31277.000	260				
Corrected Total	3521.841	259				

R Squared = .160 (Adjusted R Squared = .150)

Table 1 shows that there is a significant main effect of treatment on students' achievement in Basic Science ($F_{(2,249)}$ =20.383; p<0.05, partial η^2 = 0.150). The effect is 15.0%. This implies that 15.0% variation in students' achievement in Basic Science is accounted for by the treatment. Thus, hypothesis 1 was rejected. In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was carried out and the result is presented in Table 2.

Table 2: Estimated Marginal Means for Post-Achievement by Treatment, Gender and Control group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Guided Inquiry Strategy (GIS)	22.50	.359	18.897	21.311
Discovery Strategy (DS)	23.16	.494	19.182	22.127
Conventional Strategy (CS)	12.72	.367	11.098	12.544

Table 2 reveals that students in Discovery Strategy (DS) treatment Group 2 had the highest adjusted post-achievement mean score in Basic Science (23.16) followed by Guided Inquiry Strategy (GIS) treatment Group 1 (22.50), while the Conventional Strategy (CS) control Group had the least adjusted post-achievement mean scores in Basic Science (12.72). This order can be represented as DS > GIS> CS.

Table 3: Bonferroni Post-hoc Analysis of Post-Achievement by Treatment and Control Group

Treatment	Mean	CMS	MMS	CS
Guided Inquiry Strategy (GIS)	22.50			*
Discovery Strategy (DS)	23.16			*
Conventional Strategy (CS)	12.72	*	*	

Table 3 reveals that students exposed to Discovery Strategy (DS) were not significantly different from their counterparts exposed to Guided Inquiry Strategy (GIS) but significantly difference from those exposed to the Conventional Strategy (CS) in their post-achievement scores in Basic Science. Furthermore, students exposed to discovery strategy were significantly different from those taught using conventional strategy. This implies that the significant difference is as a result of difference between the treatment (guided inquiry and discovery strategies) and the control group but not between the two treatment groups as far as post-achievement is concerned.

HO_2: There is no significant main effect of treatment on gender in Basic science. Table 1 shows that there is no significant main effect of gender on students' achievement in Basic science ($F_{(1,239)} = 2.419$ $p>.05$, partial $\eta^2 = 0.010$). Hence, hypothesis 2 was not rejected. This indicates that gender has no effect on students' achievement in Basic science.

Discussion of Findings

The findings of the study revealed significant difference in the achievement score of the students' in selected Basic science concepts across the two level of experimental groups. Students' exposed to the innovative strategy (Guided inquiry and Discovery strategies) had higher achievement scores than their counterparts in the control group. The students exposed to Discovery strategy had the highest adjusted mean score followed by guided inquiry strategy and lastly followed by the students' in the control group.

The findings showed that the experimental strategies (Guided inquiry and Discovery strategies) are more viable than conventional method in improving students' achievement in Basic Science in junior secondary school.

The result is in support of the findings by Ariyo and Monogbe (2018) that revealed that there were significant difference between the mean pre-test and post-test score of the experimental groups and control group in which the experimental groups performed better; it also indicated no gender in the use of innovative teaching strategy (i.e.

Kolawole's Problem Solving strategy and lab-less) and students' performance.

The finding is also in line with the study outcomes of Anyafulude (2014) which showed that discovery-based learning method has helped to a great extent in effective teaching and learning of Physics. Also, discovery-based learning method has promoted research in Physics. The respondents classified by gender did not differ on the extent to which discovery-based learning method helped in effective teaching and learning, improved students' knowledge and promoted research in Physics.

This result is in agreement with the findings of Mastropieri (2006) who found out that discovery-based pedagogy works best in promoting meaningful learning when the learner strives to make sense of the presented materials by selecting relevant incoming information, organizing it into a coherent structure, and integrating it with other organized knowledge.This is in line with the observations of Nwagbo (1999) and Ibe (2004) who indicated that inquiry approaches prove to improve student's achievement in sciences more than the traditional instructional methods like lecture, demonstration. Also, Timothy and Awodi (1997) revealed a significant difference between inquiry and lecture method in improving student's performance in biology achievement test in favour of the inquiry approach.This result is in agreement with Akinbobola (2008) who opined that new approach of communicating science and mathematics is by involving students and making sure that they participate fully rather than listening to talks and taking notes. Science teaching has been shifted from the teacher centered approaches to student centered approaches of learning such as inquiring and problem – solving methods (Akinbobola, 2008).

Conclusion

The results of the study have shown that guided inquiry and discovery teaching strategies are more effective in enhancing students' level of achievement in Basic Science than the conventional strategy. The aim of teaching is not only to transmit information but also to transform passive students into active receptors of knowledge and constructor of their own knowledge. The use of innovative teaching and learning strategies in educational institutions has the potential to improve achievement, empower students and galvanize the effort to achieve the human development goals for the country. There are no gender and location disparity in the students' responses to Discovery and Guided Inquiry strategies of teaching Basic science.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Teacher should be discouraged from using teacher-centered instructional strategy in Basic science but rather, innovative teaching strategy where students' would be actively involved in the art teaching and learning.
2. Students should be encouraged to cooperate with their teachers when these strategies are being used in the course of teaching of Basic Science
3. Education stakeholders should put in place seminars and workshops for secondary school Basic Science teachers as yearly training programmes to introduce and demonstrate diverse innovative strategies.

References

Abdulkadir, Y. (2016). Effect of jigsaw method on students' chemistry laboratory achievement. *International Journal Education. Science, 15,* 377-381.

Abubakar, R. B. &Dodboo, O. (2011). Age and gender as predictors of academic achievement of college mathematics and science students.*Proceedings of the 2011 international conference on teaching, learning and change international association for teaching and learning.*

Adesina, A. E (2019). Innovating science teaching and learning with technology. Innovation in STEM Education, proceedings of STAN Conference (Oyo State) 151- 166

Adeyemi B.S. &Awolere M. A. (2016). Effects of experiential and generative learning strategies on students' academic achievement in environmental concepts. *J. Human Ecology, 56,* 251-262.

Adodo, S. O. (2013). Effect of mind mapping as a self-regulated learning strategy on students'achievement in basic science and technology. *Mediterranean Journal of Social Sciences,4(6),163 – 172.*

Agommuoh, P. C. &Ifeanacho, A. O. (2013).Secondary School Students' Assessment of Innovative Teaching Strategies in Enhancing Achievement in Physics and Mathematics. *IOSR Journal of Research & Method in Education (IOSR-JRME) Volume 3, Issue 5, PP 06-11.*

Ahmed, A. A &Oyasola, S. O(2019). Effects of concept mapping instructional strategy on junior secondary school students' Achievement in Basic science in Oyo Metropolis. *Lanlate Journal of Pure and Applied Science.*

Akinbobola, A. O. &Ado, I. B. (2008). Hands-on and minds – on strategies for teaching of force: Guided discovery approach In: Udo, E.; Uyoata, U.; Inyang, N. E. U.; Yero, H.; & Bello, G. (eds). Hands- on and minds – on in the teaching of force. UyoAfahaide& Bros Printing 2007.

Akinsolu, A. O (2013). Planning for creative and effective teaching through school management: school managers' roles In M. AAraromi; O. A. Morankola and J. A. Ademokoya(Eds.), Teaching and Evaluation in Regular and Special Secondary School; (pp. 61- 82). Ibadan: Royal People (Nig) Ltd.

Anyafulude, J(2014).Impact of Discovery-Based Learning Method on Senior Secondary School Physics. *IOSR Journal of Research &Method in Education (IOSR-JRME) Volume 4, Issue 3, PP 32-36*

Ariyo, B. O. &Monogbe T. G (2018). Two Innovative Teaching Strategies and Academic Performance of Senior Secondary School Student in Biology: Ekiti State Experience. *American Journal of Educational Science Vol. 4, No. 4, 2018, pp. 127-135*

Bilesanmi – Awoderu, J. B. (2012). Science education in Nigeria: Drowning but Waving, A 61st Inaugural Lecture of OlabisiOnabanjo University, Ago-Iwoye.

Castronova, J. (2002). Discovery learning for the 21st Century: What is it and how does it compare to traditional learning in effectiveness in the 21st Century? Literature Reviews, Action Research Exchange (ARE), 1(2). Retrieved on August 15, 2020 from: http://chiron.valdosta.edu/are/Litreviews/vol1no1/castronova_litr.pdf

Denbo, M. H. (1994). Applying Educational Psychology (5th ed.), Kıbgnab/Addison Wesley Longman, New York, NY, US.

Gbenga A and Effiong O. E (2015). Effects of two methods on student's achievement in junior secondary schools in yakurr, cross river state. *International Letters of Social and Humanistic Sciences Online: Vol. 61, pp 70-81*

Giridharan, K. &Raju, R. (2016). Impact of teaching strategies: demonstration and lecture strategies and impact of teacher effect on academic achievement in engineering education. *Int. J. Educ. Sci., 14,* 174-186.

Mastropieri M.A (2006). Differentiated curriculum enhancement in inclusive middle school science: Effects on classroom and high-stakes tests 2006, 130-137.

Ibe, S.O (2006). Equipping Physics Laboratories in Nigeria Secondary School with improvised Apparatus in the Absence of Standard Apparatus: HARE‟s Apparatus, *Nigeria Journals of Science and Educational Research. 1(1), 101-104.*

Ibe, E. (2004). Effect of Guided Inquiry and Demonstration on Sciences Process Skillsacquisition among biology secondary school student. *Unpublished M.ED Thesis.*Faculty of Education. University of Nigeria Nsukka

Kaufman, B. A. (1971). Psychological implications of discovery learning in science. Science Education, 55, 73-81. Doi:10.10012/sce.3730550114

Timothy, B.T. and Awodi, S (1997). Effect of inquiry and lecture method on Secondary School, Science Instrument, *Zaria Journal of Studies in Education*, 1 (1), 29-33.

Mohammed I. (2012). Effects of Improvised Instructional Materials on Pupils Academic Achievement and Attitude to Basic Science. M.ED Thesis A.B.U Zaria.

NERDC (2012). Basic science curriculum Federal Ministry of Education Nigeria.

Nwachukwu, J.N.&Nwosu,A. A. (2007). Effect of Demonstration Method on Different Levels of Students‟ Cognitive Achievement in Senior Secondary School Biology. *Journal of Science Teachers Association of Nigeria, 42 (1 and 2), 50-59.*

Nwagbo, C. R. (1999). Effect of guided-discovery expository teaching methods on the attitude towards biology students of different levels of scientific literacy, *Journal of science teachers association of Nigeria.* p34 (1and 2); 66-73

Olagunj, A. M. &Ige, T. A. (2013). Effective and creative methods of teaching Biology In M. A. Moronkola and J. A. Ademokoya (Eds.), Teaching and Evaluation in Regular and Special Secondary School (pp. 433 – 456). Ibadan: Royal People (Nig.) Ltd.

Qarareh, A.O. (2010). The effect of using concept mapping in teaching on the achievement of fifth graders in science. *Studies Home & Community Sci., 4*(3), 155-160.

Qarareh, A.O. (2012). The effect of using the learning cycle method in teaching science on the educational achievement of the sixth graders.*International Journal Education Science, 4,* 123-132.