EFFECT OF ARGUMENT-BASED INQUIRY APPROACH ON ACQUISITION OF WRITTEN COMMUNICATING SKILLS AND INTEREST IN BIOLOGY

Abstract: This study was designed to investigate the effect of Argument-Based Inquiry (ABI) approach on acquisition of written communicating skills and interest of Senior Secondary School Biology students. Four research questions and six null hypotheses tested at 0.05 level of significance guided the study. A quasi experimental (non-equivalent control group) design was adopted for the study. 138 (58 males, 80 females) Senior Secondary School year one (SSS1) students from four co-educational public secondary schools in Oshogbo Local Government Area of Osun State were involved in the study. Simple random sampling technique was used to select the four co-educational senior secondary schools from 13 of such senior secondary schools in the Local Government Area. The four randomly selected schools were randomly assigned, two schools each to the experimental and the control groups. The Experimental Group (EG) was taught nutrition in animals using ABI approach while the Control Group (CG) was taught the same topic with TI approach. Science Written Communicating Skills Acquisition Test (SWCSAT) and Biology Interest Inventory (BII) were used for the study. The SWCSAT had 0.84 using Pearson-Product Moment correlation while BII had 0.74 using Cronbach's Alpha. The findings among others showed that teaching biology with ABI approach enhanced the students' acquisition of written communicating skills and interest in biology better than the TI approach. The implications of the findings include that science teachers should use ABI approach so that the studer can acquire written communicating skills.

— — — — — — — — ◆ — — — — — — — — —

Introduction

Science has emerged as one of the most significant influencing field of study which has improved man's life. It has through technology transformed how man relates to his environment drastically. For example through the application of the knowledge of science, diseases can be controlled and in some cases totally eradicated; environmental awareness as a result of science has culminated in more rational use of resources to aid better living. Emphasizing the role of science in the modern world, Oyekan (1993) maintained that science provides the tools of industrialization and national development. It is for this reason that governments all over the world including Nigeria give priority to science education. Hence, Nigeria government has always placed emphasis on increasing the enrolment of students offering science over arts students in her higher institutions. In the Nigerian secondary schools, one of the sciences being taught is biology. With the knowledge of biology, students are in the position to understand the structures and functions of different parts of the body; the environment in which they live and how best to conduct themselves therein. Studying biology with other subjects provides several career paths and these include: Research, medical and pharmaceutical services, agriculture, environmental science and conservation just to mention a few (CESAC, 2004). Therefore for learners to become competent future biologists and scientists, the learners are expected to acquire

reasoning ability and scientific skills as contained in the National Policy of Education (Federal Republic of Nigeria, 2004).

Scientific skills are also referred to as the science process skills (America Association for Advancement of Science (AAAS, 1990). According to AAAS, one of the process skills includes the communicating skills. Communicating skills refer to using words or graphic symbols to describe an action or event and when appropriately acquired by the students, these skills facilitate learning in sciences; ensure active participation; help the students develop the sense of undertaking responsibility by themselves in their learning; increase permanence of learning and ensure students think and behave like scientists (AAAS, 1990). However, Chinn and Malhotra (2002) noted that communicating skills are poorly acquired by science students.

In this study communicating skills are considered under written communicating skills. Written communicating skills can have components as developed by Morreale and Michael (2003). These are: content, organization, support for explanation, observing and measuring. Content has to do with the ability to state the topic investigated clearly; state the procedure and report the results using correct science terminologies. Organization is the ability to use paragraphs appropriately focused around the central theme while Support for explanation is the ability to support claims with relevant evidences using drawings or graphs. Observing is the ability to use senses to gather information about an object/event and record appropriately in writing while measuring is the ability to use standard and non-standard estimates to describe the dimensions of an object/event accurately.

However, the Senior Secondary School Certificate Examination (SSSCE) results published by West African Examination Council WAEC, (2009-2012, 2013/2014) showed a decline in biology results. The decline in the students' performance was partially attributed to low communicating skills and poor use of English language among many science students. In addition the WAEC Chief examiners' report in biology (2007 – 2009 and 2013/2014) revealed among others that the students exhibited the following lapses: inability to properly interpret questions, inability to write or answer questions logically, systematically and convincingly; poor drawing skills; shallow understanding of most concepts in biology; poor power of expression using the language of communication; inability to spell many biological terms correctly; and inability to relate features to functions (WAEC, 2010; 2013/2014). There is therefore the need to ensure that science education helps students to acquire written communicating skills especially

since it is found to be an indispensable aspect of language while language plays a vital role in knowledge construction and interpretation (Ford, 2008).Hence there is the need to explore possible ways of enhancing the acquisition of communicating skills among students through effective instructional approaches. This could be achieved using various instructional methods/approaches such as field trip, demonstration, discovery, project method, inquiry based approaches. However, some of these methods are seldom used (Onyegegbu, 2008). Studies revealed that the teaching of science in general and biology in particular has been marked by didactic traditional approach. (Folaranmi, 2002; Nwagbo, 2006). This is dominated by lecture method which is teacher centered.

Lecture method sets the teacher as the only active participant in the class while the students are made complete observers or 'admirers' throughout the class. This method not only encourages laziness, rote memorization but also makes the students dependent and loses interest in science. It also leads to low scientific reasoning both in quality and quantity among the science students. Thus the students perform poorly in knowledge and communicating skills acquisition in biology. In this regard, some other innovative teaching strategies or approaches have been advocated for science classrooms. These include co-operative learning, analogy, field trips, problem solving, constructivist instructional model, and inquiry (Osisioma, 2005).

Inquiry can be seen as any process that has the aim of augmenting knowledge, resolving doubt, or solving problem. Inquiry is seeking knowledge, information or truth through questioning. Inquiry is an official process to find out the cause of something or to find information about something (Hornby, 2006). Inquiry involves the activities of students in which they are expected to develop knowledge and understanding of scientific ideas as well as an understanding of how scientists study the natural world.

 Research has shown that even young children develop conceptual understanding by wondering, asking question, and developing naïve theories about their environment (Kuhn, 2000). In this study inquiry is a teaching method/approach that combines the curiosity of students and the scientific method to enhance the development of science process skills while learning biology.

Through effective inquiry approach, students are expected to improve in science process skills acquisition and also exhibit more positive attitudes towards science. The students are expected to take responsibility for their learning and begin to think like scientists. Despite its

merits and the central role the inquiry is expected to play in science classrooms, inquiry has not been properly carried out to produce the desired outcome in science students (Sampson, Groom & Walker, 2011). The most emergent problem is the shortage of appropriate instructional systems for inquiry learning or teaching in schools. Besides, the science students are resistant to the extra work required to think through problems on their own (Loughran& Derry, 1997). Watters and Watters (2007) also found that the science students showed preference for memorization and regurgitation rather than deep understanding of the subject matter. Apart from these problems, Chinn and Malhotra (2002) discovered that the current high school inquiry tasks bore little resemblance to authentic scientific reasoning and were better described as simple inquiry tasks (including simple observations, simple illustrations or even simple experiments).

Apart from the differences in how inquiry- based instruction is implemented, Norris, Phillips &Corpan (2003) argued that at best, the use of inquiry as a method of instruction only contributed to acquisition of scientific literacy which is "fundamental". Norris, Phillips &Corpan (2003) therefore described such inquiry method as the traditional inquiry.

However, according to Lederman; Wade & Bell, (1998) simply engaging in traditional inquiry is not adequate to develop students' ideas about the nature of science. Students still continue to do laboratory verification activities closely following directions and memorizing what biology textbooks or teachers have indicated as truths about the natural world whereas the real inquiry-based scientific investigations are very different from simply doing verification experiments (National Research Council, 1996). Hence, the recent proposition for the use of the improved inquiry methods in teaching science.

The proponents of the inquiry-based reform are of the view that efforts must be made such that the processes scientists value for generating and validating knowledge emerge from epistemological commitments to what counts as scientific knowledge and that the problem observed about many science students' lack of effective use of the language of communication in participating in and reporting scientific activities be solved (Hand, 2008).Since communicating skills (both verbal and written) are among the top 21st century skills needed by employers for effective productivity and collaboration, there is need to integrate into traditional inquiry method the principles and requirement of good language usage. The students should therefore be provided with opportunities to integrate reading, writing, talking and reasoning with other forms of actions such as making observation, experimenting and measurement etc.

In this regard, some research studies proposed the use of instructional approaches that can stimulate students' argumentation within inquiry investigations. For example, Model-Based Inquiry (Windschitt, Thompson &Braaten, 2008)/ Argument-Driven Inquiry (Sampson, Grooms & Walker, 2011)/ Argument-Based Inquiry (Hand &Prain, 2002) are all known as the Science Writing Heuristic (SWH) approach. These instructional approaches were designed to facilitate science learning from laboratory activities through writing-to-learn strategies. According to Hand &Prain (2002), Argument- Based Inquiry (ABI) instructional approach consists of the following steps:

- the identification of a task by the classroom teacher that creates a desire for the students to make sense of a phenomenon or to resolve a problem.

- a laboratory-based experience where small groups of students have an opportunity to generate or analyze data using appropriate tools.

- the production of a tentative argument that articulates and justifies an explanation on a medium that can be seen by others.

- an argumentation session where groups share their arguments and then critique and refine their explanations

- a written investigation report generated by individual or group of students that explains the goal of the investigation; the method used, and provides a well-reasoned argument.

- a double-blind peer review of these reports to ensure quality and to generate valuable feedback for the individual authors.

- the subsequent revision of the report based on the results of the peer-review

- an explicit and reflective discussion about the inquiry.

Argument-Based Inquiry (ABI) instructional approach is designed to provide opportunities for students to learn how to propose, support, evaluate, and revise ideas through discussion and writing in a more productive manner. Moreover, acquisitions of skills and achievement have been found to be positively related to interest.

Interest is the positive feelings towards an object or event. Webster (2006) conceptualized interest as the feeling of one whose attention, concern or curiosity is particularly engaged by something. It is that which concerns, involves, draws and arouses the curiosity of a person.Njoku (1997) opined that an activity or object can be sustained depending on what the individual whose interest is engaged stand to gain or lose by so doing. This means supporting students' open

mindedness towards biology as well as guiding the students to discover which areas and topics they are enthusiastic about which they would like to work on by themselves. Although there has been much research works on the contributive factors that affect Nigerian students' interest in science (biology inclusive) however, there is no consensus on whether the students' lack of interest in biology is due to the difficulty nature of biology or the method of instruction adopted The inconclusive research results relating to interest and science education underscores the need for finding strategies that could enhance students' interest in biology classrooms. This need becomes apt since advances in technological innovations and increasing globalization require all students of the 21st century regardless of their gender to handle vast and often complex sets of information from a variety of different sources. These students irrespective of subject specialization are expected to be able to evaluate information that requires them to engage in argumentation to arrive at evidence based decisions regardless of their gender (Jimenez and Erduran as cited by McDonald 2013).

Ensuring gender equality in education means girls and boys having equal opportunities to enter school, as well as to participate in and benefit from the range of subjects or other learning experiences offered in schools or classrooms. However, it is noted that Nigerian science classrooms are grossly gender biased in favour of males and decisively against the females (Erinosho, 1997). Some research studies in different science subjects have found that boys do better than the girls while others found that the girls do better than the boys. Since literature is inconclusive about gender performance in the science subjects and literature is also replete with the effect of ABI on students' acquisition of skills in developed nations, there is need to replicate and explore the effect of Argument-Based Inquiry approach on the acquisition of written communicating skills and interest among the Nigerian secondary school biology students irrespective of gender.

Statement of the Problem

Science is important to any nation. It provides the tools for technological and man power development. Science is therefore expected to be taught effectively. However, the results obtained by biology students both in the internal and external examinations such as West African Senior Secondary Certificate Examination (WASSCE) in Nigeria including the geographical area of this study are generally poor. This situation is blamed on the prominent use of lecture method in teaching biology by the science teachers. Though lecture method allows wide coverage of

topics and also caters for the overblown population in the classrooms, it does not allow for acquisition of relevant skills such as written communicating skills. The male and female students are still found doing laboratory verification activities by closely following the directions and memorizing what biology textbooks or teachers have indicated as truths about the natural world.Since these skills are very much needed in the 21st century jobs, educators see the need to try out the use of more efficacious methods such as inquiry method.Since literature is scarce with evidence on the use of ABI on acquisition of written communicating skills while the effect of gender in science education outcome is inconclusive and the acquisition of written communicating skills are very much needed for the 21st century jobs, it becomes apt to investigate the use of ABI approach for the acquisition of written communicating skills in biology. Hence the problem of this study is: what is the effect of Argument-Based Inquiry (ABI) approach on the acquisition of written communicating skills and interest of male and female biology students?

Purpose of the Study

The aim of this study was to determine the effect of Argument-Based Inquiry approach on acquisition of written communicating skills and interest of male and female biology students. Specifically, the study seeks to determine the:

1. effect of Argument-Based Inquiry approach and Traditional Inquiry approach on students' acquisition of written communicating skills in biology.

2. effect of Argument-Based Inquiry approach and Traditional Inquiry approach on students' interest in biology.

3. influence of gender on students' acquisition of written communicating skills in biology when taught using Argument-Based Inquiry approach.

4. influence of gender on students' interest in biology when taught using Argument-Based Inquiry approach.

5. interactive effect of teaching method and gender on students' acquisition of written communicating skills in biology.

6. interactive effect of teaching method and gender on students' interest in biology.

Research Questions

The following research questions guided the study:

1. What is the effect of Argument-Based Inquiry (ABI) approach and Traditional Inquiry (TI) approach on students' written communicating skills in biology?

2. What is the effect of Argument-Based Inquiry approach (ABI) and Traditional Inquiry (TI) approach on students' interest in biology?

3. What is the influence of gender on mean scores of written communicating skills when taught biology with ABI approach?

4. What is the influence of gender on mean interest scores of students when taught biology with ABI approach?

Research Hypotheses

The following null hypotheses were formulated to guide the study and were tested at 0.05 level of significance.

Ho_1. There is no significant difference between the mean written communicating skills scores of students taught with Argument- Based Inquiry (ABI) approach and those taught using Traditional Inquiry (TI) approach.

Ho_2. There is no significant difference between the mean interest scores of students taught with Argument- Based Inquiry approach and those taught using Traditional Inquiry approach.

Ho_3. There is no significant difference between the mean scores of male and female students on written communicating skills when taught biology with Argument-Based Inquiry approach.

H_{o4}. There is no significant difference between the mean interest scores of male and female students when taught biology with Argument-Based Inquiry approach.

H_{o5}. The interaction effect of teaching method and gender on students' mean scores on written communicating skills in biology is not significant.

H_{o6}. The interaction effect of teaching method and gender on the students' means interest scores in biology not significant.

Theoretical Framework of the Study

This study anchored on Dewey and Piaget's theories of learning.

Dewey argued that education and learning are social and interactive processes and that the school as a social institution provides an environment in which social reforms can and should take place. He sees the classroom as a social context where students can take part in

manipulating materials and thus form a community of learners who construct their knowledge together. Dewey believed in the permanent frame of references; namely the organic connection between education and personal experience. He maintained that every experience enacted modifies further experiences and results in positive attitude and growth of understanding. In his view, Piaget's theory focuses on the cognitive development of a person

Methodology

The method adopted in carrying out the study is discussed under the following sub-headings: Design of the study, Area of the study, Population for the study, Sample and Sampling techniques, Instrument for data collection, Validation of the instrument, Reliability of the instrument, Experimental procedure, Control of extraneous variables and Method of data analysis.

Design and Area of Study

A quasi-experimental design was adopted for the study. Specifically, a pretest-posttest non-equivalent control group design was used. In this study, non-randomized groups were used.This study was carried out in Oshogbo Local Government Area of Osun State, Nigeria. The local government has high population of secondary schools. In the area of study, all the students in the senior secondary schools offer biology as a subject but they perform poorly in biology due to lack of written communicating skills.

Population of the Study

The population for the study consisted of all the senior secondary year one (SS1) biology studentsnumbering 3,505in all the coeducational schools in Oshogbo local government. The students are between 11-15 years of age.

Sample and Sampling Techniques

The sample size for this study comprised of 138 SS1 students from four senior secondary schools randomly drawn out of 13 senior secondary co-educational schools in Oshogbo Local Government Area of Osun State, Nigeria. Simple random sampling technique was used. The four

randomly selected schools were randomly assigned, two schools each to the experimental groups and the control groups. From each of the four selected schools, one intact class was randomly drawn from the SS1 classes. These students formed the sample for this study.

Instruments for Data Collection

The instruments for data Collection for this study consisted of the Science Written Communication Skills Acquisition Test (SWCSAT) and Biology Interest Inventory (BII). SWCSAT and BII were developed by the researcher. The SWCSAT was designed to measure the students' written communicating skills in biology. The SWCSAT has 3 practical questions of 17 items. All the test items were adapted from past WAEC practical biology questions. The distribution of the test items were according to the biology topics taught.The topics taught are food substances, classes of food, modes of heterotrophic nutrition and digestion of food. In marking the content, the communication skills assessment guides were used. This was to conform to their nature as skills-communicating and not as cognitive or achievement tests.

The BII has 30-items. The instrument was designed to assess students' interest in biology. It is scored on a 4-point scale: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). The points are weighted as 4, 3, 2, and 1 respectively. All the three instruments used for this study were administered for both pretest and posttest scores.

Validation of Instruments

All the instruments, SWCSAT, BII, and the table of specification as well as the lesson notes were subjected to face and content validation by experts.

Reliability of the Instruments

A trial testing of the SWCSAT and BII were conducted using 30 SS1 biology students of a public secondary school outside the selected schools from Oshogbo Local Government Area in order to obtain the reliability of the instruments. Estimate of temporal stability was used whereby the same instrument was applied to the same group of students after two weeks interval.The Pearson-Product Moment Correlation was used to determine the reliability coefficient of SWCSAT while Cronbach's alpha was used for the BII. 0.84 reliability coefficient was obtained for SWCSAT while 0.74 was obtained for the BII.

Experimental Procedures

The conduct of the study took place during the normal school lesson periods following the normal time-table for each of the four schools sampled. The regular biology teachers in each

of the schools were used in teaching the topics selected for the study. Each period lasted for 40 minutes.

The study lasted for eight weeks. On the first day, before the lesson commenced, during the first double periods, the two instruments BII and SWCSAT were administered as pre-tests to both the experimental and the control groups. Thereafter the proper teaching commenced by using the prepared lesson plans. During the treatment, the experimental groups and the control groups were taught nutrition in animals using Argument-based inquiry (ABI) and Traditional Inquiry (TI) approaches respectively.

Before the actual instruction, a training workshop was organized for the participating biology teachers who taught both the experimental and the control groups of the study using the training manual developed by the researcher. The training programme lasted for 2 weeks before the commencement of the instructional stage of the study. During the training, the participating biology teachers were instructed on the treatment specifications. The teachers were given detailed explanation on the use of the Traditional Inquiry and Argument-Based Inquiry approaches and other research expectations. The four biology teachers were given the validated lesson plans meant for each group. After one week training, a preliminary trial teaching was carried out by each of the participating teachers involved in the study. The researcher and one other expert supervised them. Their lesson presentations were analyzed and necessary corrections were made. Training continued for another one week, and was followed by second trial teaching. Again, discussions and necessary reviews were made on the teachers' presentation. At the end of this training, 2-man observer team (researcher and one expert) and the 4 biology teachers discussed and assessed each teacher's presentation on the level of compliance to the treatment specifications as contained in the training manual. All the teachers were above 80% in compliance to the training and the lesson note used as guide. To ensure strict compliance to the procedure of instruction during the actual instructional session, the researcher and the other expert supervised the actual instructional procedures.

Method of Data Analysis

Mean and standard deviation were used to analyze the data collected in order to answer the research questions while Analysis of Covariance (ANCOVA) at $P< 0.05$ was used to test the hypotheses formulated for the study. The standard deviation was adjudged on whether it is low

or high. When it is low, it implies that the scores clustered around the mean and when it is relatively high, it implies that scores are farther away from the mean (Nworgu, 2006).

Results

This chapter is concerned with the presentation of result from data analysis. The results are presented in tables according to the research questions and hypotheses that guided the study.

Research Question 1:

What is the effect of Argument-Based Inquiry (ABI) approach and Traditional Inquiry (TI) approach on students' written communicating skills in biology?

Table 1: Mean and Standard Deviation of Pre-test Post-test Scores of Students' Written Communicating Skills when taught Biology withArgument-Based Inquiry (ABI) approach and Traditional Inquiry (TI) approach

Written communicating skills	ABI GROUP				TI GROUP			
Components	Pre-test		Post-test		Pre-test		Post-test	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Content	19.94	1.78	37.03	5.97	19.20	0.53	27.89	3.95
Organization	2.47	0.73	4.52	1.18	2.17	0.41	3.44	0.96
Support for Explanation	18.29	2.65	34.50	4.99	17.03	1.69	27.68	3.88
Observing	4.11	0.36	8.33	1.42	4.00	0.41	6.63	1.60
Measuring	3.83	0.85	7.76	1.51	3.68	0.50	5.74	1.41
Overall/composite score	48.64	4.26	92.14	7.96	46.08	1.91	71.38	6.71
N	66				72			

SD= standard deviation, N = number of students in the group

Results presented in Table 1 showed the pre-test and post-test mean scores for the components of written communicating skills as well as the composite mean scores for the written communicating skills. Considering the components, Table 1 indicated that the pre-test, post-test

mean scores for the content component of written communicating skills for the students taught with ABI are 19.94 and 37.03 respectively (a mean difference of 17.09), while those of students taught using TI are 19.20 and 27.89 respectively(a mean difference of 8.69). This indicated that the students taught with ABI acquired the content component of written communicating skills more than the students taught using TI. For organization component of written communicating skills, results in Table 1 showed that the students taught using ABI had the pre-test, post-test mean scores of2.47 and 4.52 respectively(a mean difference of 2.05) while those of students taught using TI were 2.17 and 3.44 respectively (with a mean difference of 1.27). Thus the students of ABI group acquired the organization component of written communicating skills more than the students of TI group. For the explanation for support component of written communicating skills, the students taught using ABI had the pre-test, post-test scores of 18.29 and 34.50 respectively (a mean difference of 16.21) while those taught using TI had 17.03 and 27.68 respectively(a mean difference of 10.65). Hence the students of ABI group acquired this skill of support for explanation more than the students of TI group. For the observation component of written communicating skills, the pre-test, post-test scores of students taught using ABI are 4.11 and 8.33 respectively(a mean difference of 4.22) while those students taught using TI had 4.00 and 6.63 respectively(a mean difference of 2.63). This indicated that the students taught with ABI approach acquired the skill of observing more than those taught with TI. For the measuring component of written communicating skills, the pre-test, post-test scores of students taught using ABI are 3.83 and 7.76 respectively(a mean difference of 3.93) while those students taught using TI had 3.68 and 5.74 respectively(a mean difference of 2.06). This indicated that the students taught with ABI approach acquired the skill of measuring more than those taught with TI approach.

Also for composite mean scores, Table 1 showed that the students taught with ABI had pre-test post-test mean scores of 48.64 and 92.14 respectively (mean difference of 43.50) with SD of 4.26 and 7.96 respectively while the pre-test post-test mean scores of those taught using TI are 46.08 and 71.38 respectively (a mean difference of 25.30) with SD of 1.91and 6.71 respectively. Hence the results presented in Table 1 showed that the students taught using ABI approach acquired the written communicating skills better than the students taught using TI approach.

For the standard deviation (SD), the maximum score for written communicating skills was 176 and its 1/5 is 35.2 (Nworgu, 2006). Since the post SD for both groups (ABI: 7.96 and TI: 6.71) are below 35.2 for the written communicating skills, the relatively low SD therefore indicated homogeneity because the scores clustered around the mean (Nworgu, 2006). Nworgu also maintained that relatively high mean scores with low SD indicated overall mastery of the content. This may also be said to be true of the students taught with ABI. Same is noted in terms SD for written communicating skills components. The relatively high post-test mean scores and low standard deviation scores for each of the written communicating skill components indicated that mastery is achieved among the students but more in favour of the ABI students.

Hypothesis 1

There is no significant difference between the mean written communicating skills scores of students taught with Argument- Based Inquiry (ABI) approach and those taught using Traditional Inquiry (TI) approach.

Table 2a: Analysis of Covariance (ANCOVA) for testing the Students' Mean Scores of Written Communicating Skills when taught biology with ABI and TI approaches

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	15196.414	4	3799.103	72.631	.000
Intercept	2459.149	1	2459.149	47.014	.000
Pre cs total	239.170	1	239.170	4.572	.034
Groups	11002.423	1	11002.423	210.344	.000
Gender	88.749	1	88.749	1.697	.195
Groups * Gender	7.451	1	7.451	.142	.706
Error	6956.804	133	52.307		
Total	934388.000	138			
Corrected Total	22153.217	137			

The result on Table 2a showed that an F-ratio of 210.34 with associated probability value of 0.00 was obtained with regards to the mean written communicating skills when taught biology using ABI and TI approaches. Since the associated probability (0.00) is less than 0.05, the null hypothesis (H_{o1}) was rejected. Thus, there is a significant difference between the mean written

communicating skills scores of students taught with ABI and those taught using TI approach in favour of the ABI approach as shown by their mean gain values.

Research Question 2

What is the effect of Argument-Based Inquiry approach (ABI) and Traditional Inquiry (TI) approach on students' interest in biology?

Table 3: **Pre-test Post-test Means Interest Scores of Students when taught Biology with ABI and TI approaches**

Groups		Pre test		Posttest		Mean gain
	N	$\overline{X}$	SD	$\overline{X}$	SD	
Argument-Based Inquiry(ABI)	66	78.49	25.16	82.61	23.49	4.12
Traditional Inquiry(TI)	72	70.88	24.09	71.88	27.00	1.00

Table 3 showed that the posttest mean scores of students' interest when taught biology using ABI approach was 82.61 with a mean gain of 4.12 (82.61-78.49) while those taught using Traditional Inquiry had 71.88 with a mean gain of 1.00 (71.88-70.88). The higher mean difference of the students taught with ABI approach indicated that ABI approach enhanced the students' interest in biology more than the TI approach. Considering the standard deviation, Nwana cited by Nworgu (2006), the Standard Deviation (SD) is set as the 1/5 of maximum possible score. The maximum possible score from the interest scale was 120 and its 1/5 was 24. Since the posttest SD for ABI (23.39 < 24), it means that the SD was low. Hence the mean interest scores of ABI group are homogenous because the majority of the scores tightly clustered around the mean score for the post-test. Conversely, the post SD for TI group (27.00 > 24) indicated that the students' individual mean interest scores of the TI group diverge from the mean interest score. The relatively high mean scores with low standard deviation scores of the ABI group according to Nworgu (2006) also indicated that the students in the ABI group have achieved some mastery.

Hypothesis 2

There is no significant difference between the mean interest scores of students taught with Argument- Based Inquiry approach and those taught using Traditional Inquiry approach.

Table 4: **Analysis of Covariance ANCOVA for testingthe Difference in the students'**

Mean Interest Scores when taught Biology with ABI and TI approaches

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	89143.810	4	22285.952	1.205	.000
Intercept	14.777	1	14.777	.799	.373
Pretest Int	85123.972	1	85123.972	4.604	.000
Group	351.689	1	351.689	19.020	.000
Gender	41.555	1	41.555	2.247	.136
Group * Gender	66.228	1	66.228	3.582	.061
Error	2459.183	133	18.490		
Total	909959.000	138			
Corrected Total	91602.993	137			

Table 4 showed the ANCOVA for testing the difference in the students' mean interest scores of in biology. From the table, the calculated F against group is 19.020; this value of F is significant at 0.00. The F calculated is equally significant at 0.05 that is 0.00 is less than 0.05 (p = 0.00: p< 0.05). The null hypothesis (H_{O2}) is therefore rejected. Hence there is a significant difference between the mean interest scores of students taught with Argument- Based Inquiry approach and those taught using Traditional Inquiry approach. This further confirmed that using ABI approach in teaching biology enhanced students' interest more than using TI approach.

Research Question 3

What is the influence of gender on mean scores of written communicating skills when taught biology with ABI approach?

Table 5a: Influence of Gender on the Pre-test Post-test Means Scores of Written Communicating Skills when taught Biology with ABI approach.

Groups	Gender	Pre-test			Post-test		Mean gain
		N	$\overline{X}$	SD	$\overline{X}$	SD	
ABI	Male	30	49.20	4.81	93.00	9.01	43.80
	Female	36	48.17	3.75	91.42	7.01	43.25

The data presented on Table 5a showed that the overall pre-test post-test means scores for male students taught biology with ABI approach were 49.20 and 93.00 respectively with standard deviation scores of 4.81 and 9.01 respectively. There was a mean difference of 43.80(93.00-49.20) of written communicating skills for the males. Similarly, the pre-test post-test mean scores for the female students taught with ABI approach were 48.17 and 91.42 respectively with standard deviation scores of 3.75 and 7.01 respectively. There was a mean difference of 43.25(91.42-48.17) of written communicating skills for the females. This indicated that exposure of students to ABI approach influenced both the male and female students to acquire written communicating skills but the males acquired a little more than the female students (43.80 > 43.25).

Table 5b: **Influence of Gender on the Pretest Posttest Mean Scores of Written Communicating Skills Components When Taught Biology with ABI Approach.**

Written communicating skills components	ABI GROUP							
	Pre-test				Post-test			
	Male		Female		Male		Female	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Content	19.93	1.87	19.94	1.72	35.93	6.55	37.94	5.37
Organization	2.73	0.91	2.25	0.44	4.73	1.29	4.33	1.07
Support for Explanation	18.53	2.93	18.08	2.42	35.97	4.70	33.28	4.96
Observing	4.17	0.46	4.06	0.23	8.67	0.99	8.06	1.66
Measuring	3.83	0.91	3.83	0.81	7.70	1.58	7.81	1.47
Overall/composite score	49.20	4.81	48.17	3.75	93.00	9.01	91.42	7.01

From Table 5b the male pre-test post-test mean scores for content are 19.93and 35.93 with a mean difference of 16.00 (35.93-19.93) and standard deviation scores of 1.87 and 6.55 respectively while the females had the pretest posttest mean scores of 19.94 and 37.94 with a mean difference of 18.00 (37.94-19.94) and standard deviation scores of 1.72 and 5.37 respectively. This suggests that the teaching of biology using ABI approach influenced both boys and girls in acquisition of content component of written communicating skills in biology. It is however noticed that the females had a higher mean difference of 18.00 compared to the males

who had a mean difference of 16.00. The low standard deviation scores amongst the males and the females indicated a small difference in their inter-individual scores.

For organization, the males had pre-test post-test mean scores of 2.73 and 4.73 with a mean difference of 2.00 (4.73-2.73) and standard deviation scores of .91 and 1.29 respectively while the females had the pre-test post-test mean scores of 2.25 and 4.33 with a mean difference of 2.08(4.33-2.25) and standard deviation scores of .44 and 1.07 respectively. This suggests that the teaching of biology using ABI approach influenced both boys and girls in acquisition of organization-a component of written communicating skills in biology. Though the females had a higher mean difference of 2.08 compared to the males who had a mean difference of 2.00. The low standard deviation scores amongst the males and females also indicated a small difference in their inter-individual scores.

For support for explanation, the males had pre-test post-test mean scores of 18.53 and 35.97 with a mean difference of 17.44 (35.97-18.53) and standard deviation scores of 2.93 and 4.70 respectively while the females had the pre-test post-test mean scores of 18.08 and 33.28 with a mean difference of 15.20(33.28-18.08) and standard deviation scores of 2.42 and 4.96 respectively. The males had a higher mean difference of 17.44 compared to the females who had a lower mean difference of 15.20. This suggests that the teaching of biology using ABI approach influenced the males more than the females in acquisition of support for explanation-a component of written communicating skills in biology. The relatively low standard deviation scores amongst the males and females indicated a small difference in their inter-individual scores.

For observing, the males had pre-test post-test mean scores of 4.17 and 8.67 with a mean difference of 4.50 (8.67-4.17) and standard deviation scores of .46 and .99 respectively while the females had the pre-test post-test mean scores of 4.06 and 8.06 with a mean difference of 4.00(8.06-4.06) and standard deviation scores of .23 and 1.66 respectively. This suggests that the teaching of biology using ABI approach influenced both males and females but the males are influenced more than the females in acquisition of observing skill-a component of written communicating skills in biology. The low standard deviation scores amongst the males and females also indicated a small difference in their inter-individual scores.

For measuring, the males had pre-test post-test mean scores of 3.83 and 7.70 with a mean difference of 3.87 (7.70-3.83) and standard deviation scores of .91 and 1.58 respectively while

the females had the pretest posttest mean scores of 3.83 and 7.81 with a mean difference of 3.98(7.81-3.83) and standard deviation scores of .81 and 1.47 respectively. This suggests that the teaching of biology using ABI approach influenced the females (with a mean difference of 3.98) more than the males (with a mean difference of 3.87) in acquisition of measuring skill-a component of written communicating skills in biology. The low standard deviation scores amongst the males and females also indicated a small difference in their inter-individual scores.

Hypothesis 3

There is no significant difference between the mean scores of male and female students on written communicating skills when taught biology with ABI approach

Table 5c: **Analysis of Covariance (ANCOVA) for testing the male and female Mean Scores of written Communicating Skills when taught biology with ABI approach**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	.355	2	.177	48.265	.000
Intercept	1.686	1	1.686	458.865	.000
Pre written	.231	1	.231	62.858	.000
Group	.000	0	.000	.000	.000
Gender	.100	1	.100	27.186	.120
group * gender	.000	0	.000	.000	.000
Error	.232	63	.004		
Total	225.788	66			
Corrected Total	.586	65			

From Table 5c, the value of F against gender is 27.19. This value of F is not significant at 0.12. The F calculated is equally not significant at 0.05. That is 0.12 is greater than 0.05 (p = 0.12: p >.05). The null hypothesis (H_{o3}) is therefore accepted. Hence there is no significant difference between the mean scores of male and female students on written communicating skills when taught biology with ABI approach. Further analysis of the data on the students taught biology with ABI approach and those taught using TI approach, Table 2a also shows that the F value against gender is 1.70. This value is also not significant at 0.20. The F value is equally not significant at 0.05. That is 0.20 is greater than 0.05 (p = 0.20: p > 0.05). This implies that the use

of ABI and TI approaches did not bring about significant difference in the mean scores of both male and female students on written communicating skills in biology.

Research Question 4

What is the influence of gender on the mean interest scores of students taught biology using ABI approach?

Table 6a: **Pretest Posttest Mean Interest Scores of Male and Female Students Taught Biology using ABI approach**

Group	Gender	N	Pre-test		Post-test		Mean gain
			$\overline{X}$	SD	$\overline{X}$	SD	
ABI	Male	30	77.67	25.93	81.93	23.85	4.26
	Female	36	79.17	24.85	83.17	23.52	4.00

Table 6a revealed that the gender (male and female) post-test mean scores of interest in biology were 81.93 and 83.17 with standard deviation scores of 23.85 and 23.52 respectively. The male had a mean difference of 4.26 (81.93-77.67) while the female had a mean difference of 4.00 (83.17-79.17). This suggests that teaching the students biology using ABI approach aroused both boys' and girls' interest in biology. It is however noticed that the males had a higher mean difference of 4.26 than the females with a lower mean gain of 4.00. This suggests that the males had more interest in biology than the females. Since the standard deviation scores of both males and females are less than the expected 24, this indicated that the treatment given using (ABI) approach influenced both male and females' interest in biology more in favour of the males.

Hypothesis 4

There is no significant difference between the mean interest scores of male and female students when taught biology with Argument-Based Inquiry approach.

Table 6b: **Analysis of Covariance (ANCOVA) for testing the male and female Mean interest Scores when taught Biology with ABI approach**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	35140.114	2	17570.057	1512.914	.000
Intercept	616.044	1	616.044	53.046	.000
Pre interest	35115.223	1	35115.223	3023.685	.000
Group	.000	0	.000	.000	.000
Gender	.383	1	.383	.033	.857
Group * gender	.000	0	.000	.000	.000
Error	731.643	63	11.613		
Total	486240.000	66			
Corrected Total	35871.758	65			

From Table 6b the value of F for gender is 0.03, this value of F is not significant at 0.86. The value of F is equally not significant at 0.05 that is 0.86 is greater than 0.05 (p = 0.86: p > 0.05). The null hypothesis (H_{o4}) is therefore accepted. Hence there is no significant difference in the male and female students' mean interest scores when taught biology with ABI. Moreover the analysis of the mean interest scores of male and female students taught biology with ABI approach and those taught using TI approach, Table 4 showed that the value of F against gender is 2.25, this value of F was not significant at 0.14. The F calculated is equally not significant at 0.05 that is 0.14 is greater than 0.05 (p = 0.14: p > 0.05). This means that the use of ABI and TI

approaches has no significant difference on the mean interest scores of male and female students in the two groups.

Hypothesis 5

The interaction effect of method and the students' gender on the means scores of written communicating skills in biology is not significant.

Interaction effect is the situation in which the independent variable has different effects, depending on the value of some other variable (Carlsmith, Ellsworth & Aronson, 1976). From Table 2a, the calculated F for group gender is 0.14; this value of F is not significant at 0.71. The F calculated is equally not significant at 0.05 that is 0.71 is greater than 0.05 (p=0.71: p> 0.05). This indicate that the method did not have different effects depending on gender rather the method has constant effects independent of the students' gender. The null hypothesis (H_{o5}) was therefore accepted. Hence there is no significant interaction effect of method and students' gender on the means scores of written communicating skills in biology. This then suggests that the high post-test means score by the ABI students in written communicating skills was caused mainly by the method and not due to students' gender.

Hypothesis 6

The interaction effect of methods and gender on the students' means interest scores in biology is not significant.

Interaction effect is the situation in which the independent variable has different effects, depending on the value of some other variable (Carlsmith, Ellsworth & Aronson, 1976).From Table 4, the calculated F against group gender is 3.58; this value of F is not significant at 0.06. The F calculated is equally not significant at 0.05 that is 0.06 is greater than 0.05 (p = 0.06: p > 0.05). This indicated that the method did not have different effects; depending on gender rather the method has constant effects independent of the students' gender. The null hypothesis (H_{o6}) was therefore accepted. Hence there is no significant interaction effect of method and gender on students' means interest scores in biology. This then suggests that the high post-test mean interest scores by the ABI students was caused mainly by the method and not due to students' gender.

Summary of the Major Findings

The major findings of this study are presented as follows:

1. The students taught biology with ABI approach scored significantly better than those taught with TI in written communicating skills. That is ABI significantly favours the acquisition of written communicating skills in biology than the TI approach.

2. There is a significant difference between the mean interests' scores of students taught biology with ABI approach compared to those taught using Traditional Inquiry approach.

3.   Gender has no significant effect on the students' mean scores of written communicating skills in biology using ABI approach.

4. Gender has no significant effect on the students' mean interest scores in biology using ABI approach.

5. The interaction effect of method and gender on the students' mean scores of written communicating skills in biology is not significant.

6. The interaction effect of method and gender on the students' means interest s biology is not significant.

Discussions

The discussions are presented under the following sub-headings: discussion of findings, conclusion reached from the findings of the study, summary of the study, educational implications of the findings, recommendations, limitations of the study and suggestions for further studies.

Discussion of the Findings

The findings of this study were discussed under the relevant sub-headings below in line with the research questions and hypotheses.

- Effect of ABI Approach and Traditional Inquiry approach on Students' Acquisition of Written Communicating Skills in Biology.

- Effect of ABI Approach and Traditional Inquiry approach on Students' Interest in Biology.

- Influence of Gender on the Students' Written Communicating Skills in biology.

- Influence of Gender on Student's Interest in Biology.

- Interaction Effect of Method and Students' Gender on Written Communicating Skills in Biology.

- Interaction Effect of Method and Students' Gender on Interest in Biology.

Effect of ABI Approach and Traditional Inquiry approach on Students' Acquisition of Written Communicating Skills in Biology.

The findings of this study revealed that the students taught biology with ABI approach improved significantly in acquisition of written communicating skills compared to the students taught biology using Traditional Inquiry (TI) approach. Communication in science is the ability to apply the process skills such as measuring, observing, interpreting, asking questions, experimenting etc. and report the findings using good English either verbally or in writing or graphically. From the results, it was observed that the ABI group had a posttest means scores of 92.14 while the TI group had a lower post-test mean scores of 71.38. This indicated that the students taught using ABI approach acquired written communicating skills better than the students taught with TI approach (92.14 > 71.38) (See Table 1). The result of the null hypothesis showed that both the composite and the component mean scores of all the written communicating skills acquired by the ABI students differ significantly from those of the TI students due to the higher mean scores obtained by the ABI students (see Table 2a and 2b).

Since the content component of written communicating skills has to do with stating the topic of the given problem clearly; stating the aim of the experiment in detail and appropriately and indicating the apparatus used properly among others. The higher mean scores of the students using ABI approach indicated that the students acquired these indicators of content component of written communicating skills more than those students taught using TI approach. For example, the ABI students indicated the aim of the experiments performed while testing for the presence of glucose-a reducing sugar in specimen A given better than TI students.

Organization has to do with the ability to use paragraphs more focused around the central themes appropriately. The higher mean scores of ABI group indicated that the students acquired the organization component of written communicating skills better than those taught with TI approach. Hence the ABI students were able to use paragraphs more focused around the central themes than the students of TI group. For the support for explanation component of written communicating skills, the higher mean scores of the ABI group indicated that the students acquired organization component skill of written communicating skills better than the TI group. Hence the students taught using ABI approach were able to explain actions taken in their experiments with strong introductory statements in clearer and more logical manner than those taught with TI approach. For the observation component of written communicating skills, the higher mean scores of ABI group indicated that this component of written communicating skills was more acquired than those in the TI group. The relatively high mean scores and low standard

deviation scores for each of the components and the overall written communicating skills also confirmed the acquisition of written communicating skills more among the ABI group than the TI group. Hence the ABI students were able to record what they observed more accurately and appropriately in writing than those taught with TI approach. For measuring component of written communicating skills, the higher mean scores of ABI group indicated that the measuring component of written communicating skills was acquired more than those in the TI group. Hence the ABI students were able to measure their specimens more accurately using correct and appropriate instrument compared to those in TI group.

The findings of this study concerning the effect of ABI approach on the students' acquisition of written communicating skills are consistent with the findings of earlier study conducted by National Research Council NRC (2005, 2007) who found that integrated approaches where reading and writing is incorporated with laboratory method are more effective than ordinary laboratory experiences at enhancing students' learning to read and write and cultivating interest in science. The significant acquisition of the written communicating skills by the ABI students more than those of the TI students may be explained by the difference between the ABI and TI stages. Though both approaches are inquiry oriented, the ABI approach is one of such integrated approaches through which the students go beyond their textbooks to obtain facts about a concept through reading, writing and asking questions particularly during tentative argument, argumentation session and double- blind peer review stages. During the tentative argument and argumentation sessions, the students were able to work in group, reason and share with each other by supporting their claims with evidences. Also during the double-blind review, the students were able to obtain feedback about their reports indicating areas that need improvement. All these activities thus produced better acquisition of the written communicating skills especially in measuring and observing than those taught using TI approach. The ABI approach also encouraged the students to construct or critique arguments (i.e. an explanation supported by one or more reasons). According to Osborne (2011), this approach gives confidence to the students because they are equipped with scientific facts. With ABI approach, the students are also able to collaborate with each other while working and reporting their findings either verbally or through writing during the argumentation session. When the students succeed in acquiring these skills as enumerated, they enjoy the opportunity of functioning effectively in a science heuristic environment provided by the ABI approach as earlier observed

by Osborne 2011. With these, learners come to understand that learning is their own responsibility particularly in this 21st century where communicating skills have become a predominant factor even while recruiting employees.

The findings of this study is similar to that of Chukwemeka (2005) whose study revealed that science process skills were better acquired through learners' active participation in the use of resources than the conventional method. The findings of this study is also similar to that of Nwokolo (2013) who found that the use of games approach consistently enhanced acquisition of science process skills irrespective of gender and school locations.

Dewey (1910) sees school as a social institution where social reforms can take place. For example, the students through the phases of ABI, were able to exchange views and opinions while debating on the reasons to back their claims, thus socializing. Also according to Piaget (1980) acquisition of written communicating skills are made possible through the students' interaction with the materials, the teacher and other students as provided by the ABI approach. Hence the possibility for the changes as observed amongst the students.

Effect of ABI Approachand Traditional Inquiry approach on Students' Interest in Biology.

The result in Table 3 showed that the students taught with ABI approach had a posttest mean score of 82.61 with a mean difference of 4.12 while the students taught with Traditional Inquiry (TI) approach obtained a posttest mean score of 71.88 with a mean difference of 1.00. The null hypothesis analyzed also revealed that there is a significant difference between the students' means interest scores in biology when taught with ABI compared to those taught using Traditional Inquiry approach. This study revealed that the two groups indicated interest in biology but the students taught biology with ABI indicated more interest in the lessons than those taught biology using Traditional Inquiry approach. The relative high mean scores and low standard deviation scores of students' interest scores also confirmed the development of more interest among the ABI group than the TI group. This may likely be due to the double-blind peer review and revision of the report stages of ABI approach. The ABI students were more interested and enthusiastic in their activities. Interest is an intent state that influences an individual's action. The interest built up in the ABI students could also be attributed to the method of instruction which was student-centered, activity-based and problem-solving oriented. Dewey's theory sees learning as a process, so students must be engaged in meaningful activities that induce them to apply the concept they are trying to learn, and the teacher's role should be to provide the

enabling environment for active learning to take place. Such an environment is provided more by the ABI approach than the Traditional Inquiry (TI) approach, particularly during the tentative and argumentation phases as well as the double-blind peer review and the revision of reports. Thus ABI approach build up more interest in the students compared to the traditional inquiry classroom as noted in the results. For example from the class observation most students were eager to watch the reactions during the experiments they performed on their own in the class and the students readily exchange reports for review. All these practices might have led to the enhanced interest in students by ABI approach compared to TI approach.

Though there has been many research works conducted on the contributory factors that affect Nigerian students' interest in science however there was no consensus as to this. For example, Balogun (1985), Okebukola and Jegede (1986) found that the Nigeria students found science difficult not only because the discipline seems to be masculine but the discipline was perceived as uninteresting and leads to unattractive careers. In this 21st century, it is noted that biology in particular offer prospective career opportunities to students and as such arousing students' interest in biology could promote vocational interest in biology and biology related careers. However, for the students to be relevant in the chosen careers they must be able to communicate effectively using simple and correct English in order to relate well with the target audience. The ABI approach therefore appears to be more effective in offering such opportunities to students compared to TI.

The findings of this study are however similar to Okoro (2011) whose study revealed that co-operative patterns enhanced students' achievement and interest in biology. Agwagah (2003) also revealed that mathematics reading instruction enhances the students' interest. This study involved the use of co-operative learning approach in both groups. However reading was involved more with the ABI group than with the TI group.

Contrary to the findings of this study, Soyibo (1991) noted that students' interest in biology has continued to dwindle and this affects the level of biology achievement and science related courses. In the study, the interest of students in biology was enhanced by inquiry for both ABI and TI. However, the ABI approach used had a more significant effect on students' interest in biology than the TI group. The positive effect on the student's interest in biology as revealed by this study could be attributed to the fact that the use of ABI and TI approaches in teaching biology allowed all the students to carry out activities in groups during which they are able to

share their views and ideas. However, the tentative argument and argumentation stages of ABI stage offered more opportunities for enhancement of interest in biology. The development of more interest by the ABI group is also supported by Dewey's and Piaget's theories of learning. The students were more actively involved in all the activities. For example the students were privileged to communicate their ideas both in written and verbally with each other and at the same time ask questions from their colleagues. The greater success in these activities must have motivated the ABI group to develop more interest in biology than those in the TI group.

Influence of Gender on the Students' Written Communicating Skills in biology

The findings of this study as shown on Table 5a revealed that male biology students obtained a posttest mean score of 93.00 with a mean gain of 43.80 while the female biology students obtained a post-test mean score of 91.42 with a mean gain of 43.25. This result showed that male biology students differed from the female biology students in the written communicating skills by having a higher mean difference of 43.80. However, this difference was not significant. The slight difference here due to gender may also point to the influence of past experiences and practices on learning.

The findings of this study is similar to Ibe (2004) who found that gender of the subjects did not significantly affect their performance while investigating the effect of guided inquiry and demonstration on science process skills acquisition among senior secondary one biology students. The findings of this study is also similar to Nwokolo (2013) who found that the use of games approach consistently enhanced acquisition of science process skills irrespective of gender and school locations. The findings of the study however differs from Isabelle, Jamshid, Beheshti, Cole, Dhary and Mohammed (2013) who found that there were gender differences in the frustration and optimism level of boys and girls in inquiry-based learning. The authors also found that during the inquiry-based learning project, boys were more confident than the girls. However in this study, judging from the low and negligible mean score difference between boys and girls the result revealed that ABI approach helped both the females and the males students in acquisition of written communicating skills in biology equally.

The findings of this study could be explained by the fact that ABI approach allowed both girls and boys within the classroom during the tentative argument and the argumentation session of ABI approach to focus very much on their activities. The ABI students were able to open up while sharing their views and asking questions on the claims given by other groups/students.

This might have improved the students' (both males and females) written and verbal communicating skills. Further still, the collaborative learning environment provided by ABI approach where reports are reviewed was more attractive to both girls and boys in the classroom.

Influence of Gender on Student's Interest in Biology

The findings of the study on Table 6a revealed that the male biology students obtained a post-test mean interest score of 81.93 while the female had 83.17 with standard deviation scores of 23.85 and 23.52 respectively. Though the males had a higher mean difference of 4.26 while the females had a lower mean difference of 4.00, this mean difference was not significant. This indicated that gender influence on students' interest in biology was not significant. The result of this study showed that males are more interested in biology when taught using ABI approach. This finding is similar to Abonyi (1998) who found that ethno science based package had no differential impact on concept formation among males and females students used for the study. The finding of this study is however dissimilar to that of Njoku (1997) who found that the female group had significantly higher mean scores in chemistry practical skills than the male group. The author reported that sex groupings and school location had significant interaction effect on students' acquisition of chemistry practical skills. The absence of gender influence on students' mean interest score in this study is in line with Dewey's emphasis that all students should have the opportunity to take part in their own learning. Hence ABI provided the environment where all students irrespective of their gender actively participated in the learning process. For example, the sharing of views during the tentative argument would have stimulated both the males' and females' interest in biology. Further replication of this study appears to be a meaningful option in order to explicate gender effect of ABI on students' interest in Biology.

Interaction Effect of Method and Students' Gender on Written Communicating Skills in Biology.

The data on Table 2a revealed that there is no significant interactive effect between method and students' gender on written communicating skills in biology. This means that the method did not have different effects on students' acquisition of written communicating skills depending on gender. Rather the method has constant effects on written communicating skills independent of the students' gender. Hence the effect is mainly due to the method. In this study, all students (boys and girls) benefitted equally from ABI approach in terms of acquisition of written communicating skills.

In like manner the finding of this study is similar to Nwagbo and Uzoamaka (2011) who found that there was no significant interaction effect of method and gender on student's process skill acquisition. The finding is similar to Ismail- Ipek (2011) who found that there was no significant difference among FDI (Field Dependent Instruction) groups on achievement in CBI (Computer Based Instruction) geology, tutorial, reading and time spent to complete lessons in CBI tutorial. The findings also differ from Adegoke (2011) who showed that the interaction effect of treatment and cognitive style was statistically significant. The absence of interactive effect of method and gender on the students' written communicating skills in this study could be attributed to the fact that ABI approach provided the opportunity for all the students irrespective of gender to be actively involved in learning situations, hence all the students benefitted equally irrespective of their gender and thus operate at the same level in the acquisition of written communicating skills in biology.

Interaction Effect of Method and Students' Gender on Interest in Biology

The findings of this study showed that there was no significant interaction effect of method and gender on the students' mean interests scores in biology. This means that the method did not have different effects on students' interest in biology; depending on gender rather the method has constant effects on students' interest independent of the students' gender. Hence the effect (increase in students' interest was mainly due to the method. This finding is dissimilar to Njoku who found that the school location had significant interaction effect on students' acquisition of chemistry practical skills. However, the findings of this study is similar to Ismail Ipek (2011) who revealed that there was no significant interaction between the cognitive style of field dependence and text density levels on reading comprehension scores. The finding of this study is also supported by Oludipe (2012) who found that there was no significant difference in the academic achievement of male and female students in basic science using cooperative teaching strategy. The absence of interaction effect of method and gender on the students' interest in biology indicated that ABI approach benefitted both male and female students equally in enhancing their interest in biology. This could be explained by the fact that the interactive nature of ABI especially during the tentative argument, argumentation session, double-blind peer review and revision of the report stages caused both boys and girls to benefit equally and so were found to be all interested in biology.

Conclusions Reached from the Findings of the Study

Based on the discussions of the findings, the following conclusions were made:

The use of ABI approach significantly increased the students' means scores of written communicating skills in biology compared to the TI approach. The students taught with ABI approach also gained more interest in biology compared to the TI approach.

Gender has no significant effect on the students' mean scores of written communicating skills when taught biology with ABI compared to the TI approach. Gender also has no significant effect on the students' means interest scores in biology using ABI approach.

The interaction effects of method and gender on the students' means scores of written communicating skills in biology are not significant. Finally, the interaction effect of method and gender on the students' means interest scores in biology is not significant. These indicated that the method had the constant effect on students' acquisition of written communicating skills and interest, irrespective of the students' gender.

Summary of the Study

The main purpose of this study was to investigate the effect of Argument-Based Inquiry (ABI) and Traditional Inquiry approaches of teaching on students' acquisition of written communicating skills and interest in biology. This desire was motivated by the need for the students to acquire the necessary scientific skills and be able to use language to communicate their ideas and information effectively among peers and with the teacher. Studies found that most of the methods adopted in teaching failed to encourage students' acquisition of written communicating skills in science. There was emphasis on the students knowing only the products of scientific inquiry rather than being involved in the process of doing science. Consequently the performance of the students in biology steadily declined. Hence this study was conducted in attempt to find out if the use of an integrative approach such as ABI could redeem the current situation by allowing the students to integrate reading, talking and writing into inquiry approach. This is to induce the students' acquisition of written communicating skills and interest in biology irrespective of gender. Four research questions and six null hypotheses guided the study. The hypotheses were tested at 0.05 level of significance.

The theoretical framework hinges on Dewey and Piagets' cognitive theories of learning. The theorists believed that leaning is enhanced in activity-based environments.

This study adopted a non-equivalent control group (quasi experimental) design. A sample of 138 senior secondary school one (SS1) students drawn from Oshogbo education zone of Osun

state was used for the study. Simple random sampling was employed to draw four senior secondary schools for the study. One intact class of SSI was randomly drawn from each of the four schools. Out the four intact classes, simple random technique was used to assign them to two experimental and two control groups. Each intact class consisted of male and female students. The experimental groups were taught nutrition in animals using argument-based inquiry approach while the control groups were taught the same topic using traditional inquiry approach. The intact classes were taught by the regular biology teachers in each of the schools.

All the students were pretested before and protested after the treatment. Data collected with the help of the research instruments was descriptively and inferentially analyzed using means, standard deviation and ANCOVA. Based on these results, discussion, educational implications were highlighted.

References

Abonyi, O.S. (1998). *Effect of an ethno-science based instructional package on students' conception of scientific phenomena and interest in science*. (Unpublished doctoral dissertation), University of Nigeria, Nsukka.

Adegoke, B.A. (2011). Effects of indirect teacher influence on dependent-prone students' learning outcome in secondary school mathematics. *Journal of Education Psychology, 9* (1), 283-308.

Agwagah, U.N.V. (2003). A postgraduate research in mathematics education. *Journal of Nigeria Education Association. 15*(1), 148-159.

American Association for the Advancement of Science (AAAS) (1990). *Science for all Americans, project 2061*. New York: Oxford University Press.

Balogun, T.A. (1985). Interest in science & teaching education in Nigeria. *Journal of the STAN,23*(1&2), 92-99.

Carlsmith,J.M; Ellsworth, P.C. and Aronson, E. (1976). *Methods of research in social psychology.*Califonia: Addison-Wesley Publishing Company.

Chinn, C.A., &Malhotra, B.A. (2002) Epistemologically authentic inquiry in schools. A theoretical framework for evaluating inquiry tasks.*Science Education,56*,175-218.

Chukwuemeka, P.C. (2005). *Effects of mode of presentation of material resources on the acquisition of science process skills among primary school pupils.* (Unpublished M.Ed. thesis), University of Nigeria Nsukka .

Colburn, A. (2000). *Inquiry and the national science education standards*. Washington: National Academy Press.

Comparative Educational Studies and Adaptation Centre (CESAC) (2004). *National curriculum for secondary schools Biology.* Abuja: Federal Government Press.

Dewey, J. (1910). Science as subject matter and as method.*Science, 31*, 121-127.

Erinosho, S.Y. (1997). *Female participation in science: An analysis of secondary science curriculum materials in Nigeria.* Abridged report no 29. Nairobi academy of science publishers.

Federal Republic of Nigeria.(2004). *National Policy on Education.* Abuja: Federal Government Press.

Folaranmi, B. A. (2002). The teaching of sciences in our Schools: What hope do we have for the future, bright or bleak? *Journal of Science and Movement Education, 4*, 132-142.

Ford, M. (2008). 'Grasp of practice' as a reasoning resource for inquiry and nature of science understanding.*Science and Education,17*, 147 – 177.

Hand, B, and Prain, V. (2002). Teachers implementing writing-to-learn strategies in junior secondary science: A case study. *Science Education 86*(6), 737-755.

Hand, B.(2008). *Science inquiry, argument and language: A case for the science writing heuristic*. Rotterdam, the Netherlands: Sense Puublishers.

Hornby, *A.S. (2006). Oxford advanced learners dictionary of current English 7th edition*. London: Oxford University Press.

Ibe, E. (2004). *Effects of guided inquiry, demonstration and conventional methods of teaching science on acquisition of science process skills among senior secondary school students*. (Unpublished M.Ed. Thesis).University of Nigeria, Nsukka.

Isabelle, J., Beheshti, C., Cole, D and Mohammed (2013).Gender differences in inquiry-based learning at the middle school level. *Association for information Science and Technology (ASSIST) 2013*.1,12-15.

Ismail- Ipek, E.D. (2011). The effects of text density and the cognitive style of field dependence on learning from computer Based Instruction tutorial.*The Turkish online Journal of Education Technology. 10* (1), 167-182.

Kuhn, D. (2000). Development origins of scientific thinking.*Journal of cognition & Development, 1,* 113-129.

Lederman, N.G., Wade, P.D.; & Bell R.L. (1998). Assessing the nature of science: What is the nature of our assessments? *Science & Education, 7*, 595-615.

Loughran, J. & Derry, N. (1997). Researching teaching for understanding: the students' perspective. *International Journal of Science Education, 19*(8), 925-938.

McDonald, C.V. (2013). *Nature of science and argumentation.A review of empirical research.*In Akpan, B. *Science Education. A global perspective*; Abuja, Nigeria: Next Generation Education Ltd.

Morreale, S.P; & Michael, Z.H.(2003). "A communication competency approach to public speaking instruction". *Journal of Instructional Psychology 21*(3),1-8.

National Research Council (1996).*National science education standards*. Washington, D.C: National Academy Press.

National Research Council (2005a).*America's Laboratory: Investigations in High school science. Committee on high school laboratories: Role and vision.* Washington, DC: National Academy Press.

National Research Council (2005b).*How students learn science in the classroom*. Washington DC: National Academies Press.

National Research Council (NRC) (2007).*Taking science to school: Learning and teaching science in grades k-8.* Washington, D.C. National Academy Press.

Njoku, Z.C. (1997). *Effects of practical work under different sex groupings on students' skill acquisition & Interest in chemistry practical activities*.(Unpublished Ph.D Thesis).University of Nigeria, Nsukka.

Norris, S. Phillips, L.M., &Corpan, C. (2003). University students' interpretation of media reports of science and its relationship to background knowledge, interest and reading difficulty. *Public understanding of science, 12*, 1-23.

Nwagbo, C. &Uzoamaka, C.C. (2011). Effects of Biology Practical Activities on students process skill Acquisition. *Journal of Science Teachers Association of Nigeria, 46*(1), 58 – 70.

Nwagbo, C.R. (2006). Effects of two teaching methods on the achievement in and attitude to biology of students of different levels of scientific literacy.*International Journal of Education Research. 45*, (2006), 216 – 229.

Nwokolo, O.C. (2013). *Effects of games on the acquisition of science process skills among Junior Secondary School (JSS) students in Enugu State*. (Unpublished M.Ed thesis) University of Nigeria, Nsukka.

Nworgu B.G. (2006).*Educational   research, basic issues and methodology (2nd ed).*Nsukka: University Trust Publishers.

Okebukola, P.A.O. &Jegede, O. (1986). The under-achieving students in science: Opinions on the etiology of the ailment: *Proceedings of the 27th the Annual STAN Conference. 96-103.*

Okoro, A.U. (2011). *Effects of interaction patterns on achievement and interest in biology among secondary school students in Enugu state, Nigeria.* (Unpublished M.Ed thesis) University of Nigeria, Nsukka.

Oludipe, O.I. (2012). Gender difference in Nigeria junior secondary students' academic achievement in Basic Science.*Journal of Education and social research*, *2* (1), 93-99.

Onyegegbu,N. (2008).*Using new technologies in creating excitement in biology laboratory activities*. Retrieved12/12/2011 from http://www.academicjournals.org/ err/pdf%202008.

Osborne, J. (2011). *The role of argument in science education.*Retrieved on 02/08/2013 from http://link.springer.com/chapter/10.1007%2FI-4020-3673-629#_page-2.

Osisioma, I (2005).*Active learning strategies for science classrooms*. Paper presented at the 46th Annual Conference of Science Teachers Association of Nigeria,Jos.

Oyekan, J.F. (1993). The acquisition of science concepts among physics students*. Journal of Research in Science Education 1* (1), 256-261.

Piaget, J.(1980). *Learning theory and practice: Psychology and teacher.*New York: Rinehart Winston Ltd.

Sampson, V., Groom, J., & Walker, J. (2011). Argument-Driven inquiry as a way to help students learn how to participate in scientific argumentation and craft written argument: An exploratory study. *Science education, 95*, 217-257.

Soyibo, K. (1991). A review of empirical research on Nigerian students' achievement.*Journal of Science Teachers Association of Nigeria*, *27*(1),181-186.

Watters, D. J. & Watters, J.J. (2007). Approaches to learning by students in the biological sciences: Implications for teaching. *International Journal of Science Education, 29*(1), 19-43.

Webster, M.(2006). *English dictionary (6ᵗʰ ed)* New York: Williams Collins Publishers.

West African Senior School Certificate Examination WASSCE (2007-2009,2012). *Chief examiner's report on student performance in Biology 1 & 2b*.Lagos: WAEC Publications.

Windschitl, M., Thompson, J., &Braaten M. (2008). Beyond the Scientific method: Inquiry as a new paradigm of preference for school science investigations. *Science education,12*,1-27.