

USING EXPLICIT ARGUMENTATIVE INSTRUCTION TO FACILITATE CONCEPTUAL UNDERSTANDING AND ARGUMENTATION SKILLS IN SECONDARY SCHOOL CHEMISTRY STUDENTS

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The study investigated effects of Argumentative instructional strategy on Chemistry students' conceptual understanding of chemistry concepts in Senior Secondary Schools in Lagos state, Nigeria. 120 SS2 chemistry students from two randomly selected senior secondary schools in Lagos state formed the sample and quasi-experimental pre-test-post-test research design was used for the study. Chemistry Achievement Test and Questionnaire were used to collect data. The formulated hypotheses were tested using t-test statistical tool at 0.05 level while the raised research questions were answered using descriptive statistics. It was found out that students taught using Argumentative strategy achieved significantly higher than those taught using conventional method. Based on the findings, it was recommended among others that Chemistry teachers should adopt the use of Argumentative strategy in teaching chemistry. .

INTRODUCTION

Chemistry is one of the important science subjects taught at the Senior Secondary School (SSS) level of education in Nigeria. It is one of the core science subjects that students are required to pass at credit level in order to qualify for admission into tertiary institutions to pursue science-based programmes. In spite of this central and important position of chemistry among others science and related disciplines, studies revealed that, academic performance of students in chemistry at Senior Secondary School Certificate Examination (SSSCE) has consistently been very poor and unimpressive (Njoku, 2009). Statistics from the West African Examinations Council (WAEC) for many years consistently reveal a persistent poor achievement of Chemistry students in public examinations (WAEC Chief Examiner's report for 2003, 2004, 2006, 2007, 2008, 2010, 2011, 2012, 2013 & 2014)

Many factors have been suggested as contributing to this poor performance of students in science in general and chemistry in particular. Some of these factors include: inadequate laboratory equipment in chemistry (Eniayeju, 2010); poor teaching methods (Ogunwuyi, 2000); mathematical nature of chemistry among others.

A number of activity-oriented instructional strategies have been advocated for by curriculum designers and science educators to help improving students' performance in science. Examples of these strategies include guided discovery approach, demonstration method, discussion method and problem-solving for teaching senior secondary school chemistry as stipulated in National Policy on Education (FRN, 2008). Research findings had however, revealed that to date, a large proportion of science teachers, chemistry inclusive, still resort to the use of traditional/lecture method rather than the activity-oriented or student centered

strategies advocated basically due to inadequate/unavailable instructional resources these strategies require for their effective application (Ogunwuyi, 2000; Kola, 2007).

Recently, with advance of teaching and learning science as inquiry, numerous studies have focussed on argumentation in science education (Osborne, Erduran & Simon, 2004; Eskin & Ogan-Bekiroglu, 2012) Argumentation as a teaching strategy has been considered relevant and fruitful in developed countries but no study is available on its effectiveness in Nigeria, especially in chemistry education. Argumentation is the process of making claims and providing justification for the claims using evidence (Toulmin, 1958). According to Osborne (2013), teaching students how to argue based on available evidence engages them in the scientific process and provides a better idea of how science actually works. When Argumentation is used, students encourage and support each other, assume responsibility for their own and each other's learning, employ group related social skills.

Another issue of contention in Nigeria today is the issue of gender both in our educational system and the society at large. In recent times researchers have expressed different views about gender and achievement especially in sciences hence, the issue has remain inconclusive.

The present study therefore, investigates the effectiveness of argumentative teaching strategy in facilitating conceptual understanding of chemistry concepts and helping students to develop argumentation skill in Nigerian chemistry classroom. Students' gender was built in as a moderating variable in the study.

STATEMENT OF THE PROBLEM

The problem of effective teaching and learning of Chemistry in Nigerian Senior Secondary Schools have become a sensitive issue that needs urgent attention. It has been observed that the issue is affecting the performance of students in both internal and external examinations adversely. It has also been discovered that the poor academic performance of students is related to the conventional method used to teach them by the teachers. Argumentation is a new approach of teaching which has been identified as a possible tool for promoting conceptual change in the developed world (Tippet, 2009). This study therefore, aims at investigating the effectiveness of argumentative instructional strategy on students' conceptual understanding of chemistry concepts in Nigerian classrooms.

RESEARCH HYPOTHESES

The following hypotheses were generated and tested in the study:

1. There is no significant difference in the students' conceptual understanding of chemistry concepts between students taught with argumentative instructional strategy and those taught with conventional method.
2. There is no significant difference in students' conceptual understanding of chemistry concepts using argumentative instructional strategy due to gender.

RESEARCH QUESTIONS

The study also provides answers to the following research questions;

1. What are the students' views about the effectiveness of argumentation as a teaching strategy for conceptual understanding of chemistry concepts?

2. Does students' gender influence their views about the effectiveness of argumentation as a teaching strategy for conceptual understanding of chemistry concepts?

RESEARCH METHODOLOGY

The study used pre-test, post-test Quasi-experimental design which involves experimental and control groups consisting of both male and female respondents. The population of the study comprised all the SS2 chemistry students in district IV area, Lagos State.

Two schools were randomly selected from Yaba Local Government Area from District IV of Lagos State. Each of the two schools was randomly assigned to experimental and control groups respectively and in each school intact class was used with total number of 120 students forming the sample size for the study. Chemistry Achievement Test (CAT) and Questionnaires on Students' Views of Effectiveness of Argumentative Instructional Strategy (QSVEAIS) were developed by the researchers and used to collect the necessary data on the subjects. The CAT consists of two sections; Section A sought bio-data information of the students while section B contained 30 multiple choice questions on kinetic theory of matter. The (QSVEAIS) also contained 10 items soliciting information on the views of the experimental group about the effectiveness of the instructional strategy used. Both instruments were validated by experts in item construction, CAT was tested for reliability (0.64) using Kuder Richardson formula 20 while the reliability (0.75) of the QSVEAIS was established using Croubach Alpha.

Procedure for Data Collection

The CAT was administered to the two groups before treatment which serves as the pre-test, after which the experimental group was taught the concept of Kinetic theory of matter using Argumentative instructional strategy and the control group was taught the same concept using conventional method for a period of two weeks.

After the treatment the CAT was administered again to both the experimental and control groups which form the post-test data and in addition, the questionnaire was also administered on the experimental group to obtain information on their views of the teaching strategy. In scoring the achievement test on kinetic theory of matter, correct response to the each question in the instrument was scored 1 point, while each wrong one was scored zero point and the maximum score on the test was 100 points. T-test statistical tool was used to test the hypotheses formulated and frequency counts and simple percentages were used to answered the research questions raised in the study

RESULTS AND DISCUSSION

Research Hypothesis 1: There is no significant difference in the students' conceptual understanding of chemistry concepts between students taught with argumentative instructional strategy and those taught with conventional method.

Group	N	Mean	Std. Deviation
Experimental group	60	52.1432	13.45345
Control group	60	51.4000	10.71068

Table 1: Descriptive statistics of pre-test score for the experimental and control groups

The result in table 1 shows that there is no significant difference between the mean score of the experimental group and the mean score of the control group, which implies that they have the same level of initial knowledge of the concepts under study.

Group	N	MEAN	SD	SE	Df	t-val	P	Remark
Experimental	60	60.67	10.97	3.90	118	3.5	0.02	Significant
Control	60	49.45	6.78	1.89				

Table 2: T-test analysis of post-tests of the experimental and control group

Table 2 shows there is significant difference between the experimental and control group ($t=3.5$, $df: 118$, $p<0.05$). Therefore, the null hypothesis is rejected.

Research Hypothesis 2: There is no significant difference in students' conceptual understanding of chemistry concepts using argumentative instructional strategy due to gender.

Gender	N	MEAN	SD	SE	Df	t-val	P	Remark
Male	37	61.49	10.83	6.64	58	6.4	0.03	Significant
Female	23	64.78	16.15	7.99				

Table 3: T-test analysis of students' conceptual understanding using argumentative instructional strategy based on gender

Table 3 show that there is significant difference in the conceptual understanding of the students in experimental group based on gender ($t=6.4$, $df: 118$, $p<0.05$). Therefore, the null hypothesis is rejected.

Research Question 1: What are the students' views about the effectiveness of argumentation as a teaching strategy for conceptual understanding of chemistry concepts?

Reference was made to Table 5 in answering this question.

S/ N	Items	Agreed (A)	%	Disagreed (D)	%
1	I prefer the use of Argumentative strategy during class group work	33	55	27	45
2	I prefer contributing rather than listening during chemistry lesson	30	50	30	50
3	I like saying my views about what I know about the topic	37	62	23	38
4	Students should be allowed to show their creativity	45	75	15	25
5	I dislike memorization	57	95	03	05
6	I like to be actively involved in any hand-on activities	36	60	24	40

7	I like an interactive class, than the teacher explaining all through the course of the lesson	60	100	00	00
8	Lessons with argumentation give me opportunity to learn different ideas from my colleagues.	57	95	03	05
9	I get bored if the teacher does the talking through the lesson	47	78.33	13	21.67
10	The class would be lively if the teacher raise an argument for students to come to a claim or conclusion	31	51.67	29	48.83

Table 4: Views of experimental group on the effectiveness of the treatment

Research Question 2: Does students' gender influence their views about the effectiveness of argumentation as a teaching strategy for conceptual understanding of chemistry concepts?

Reference was made to Table 5 in answering this question.

DISCUSSION

From Table 2, the experimental group performed better than the control group which is due to the teaching method used to teach the experimental group. This finding is in agreement with that of Eskin and Ogan-Bekiroglu (2012) who found out that, the students taught with a strategy where argumentation was embedded in the instruction developed more correct and detailed reasoning of physics than those taught with conventional method. It is also in line with the submission of Sampson, Grooms and Walker (2011) who reported that engaging in argumentation and production of oral written arguments improve scientific knowledge and abilities. The study supports earlier findings that argumentative skills develop and that engagement in an argumentative discourse activity enhances that development (Kuhn & Udell, 2003; Felton & Kuhn, 2001; Kuhn et al., 1997).

s/n	Items	Male				Female			
		A	%	D	%	A	%	D	%
1	I prefer the use of Argumentative strategy during class group work	19	51.35	14	48.65	18	66.67	09	33.33
2	I prefer contributing rather than listening during chemistry lesson	13	39.39	20	60.61	17	62.96	10	37.04
3	I like saying my views about what I know about the topic	10	30.30	23	69.70	14	51.85	13	48.15
4	Students should be allowed to show their creativity	28	84.85	05	15.15	17	62.96	10	37.04
5	I dislike memorization	33	100	00	00	24	88.89	03	11.11

6	I like to be actively involved in any hand-on activities	26	78.79	07	21.21	10	37.04	17	62.96
7	I like an interactive class, than the teacher explaining all through the course of the lesson	33	100	00	00	27	100	00	00
8	Lessons with argumentation give me opportunity to learn different ideas from my colleagues.	33	100	00	00	17	62.96	10	37.04
9	I get bored if the teacher does the talking throughout the lesson	22	66.67	11	33.33	25	92.59	02	7.41
10	The class would be lively if the teacher raise an argument for students to come to a claim or conclusion	26	78.79	07	21.21	16	59.26	11	40.74

Table 5: Comparison of responses across genders

Table 3 revealed that female students achieved significantly higher than the male students when both were taught using argumentative instructional strategy. This shows that female students tend to argue better than male students. This finding is corroborated by Wilson, (1991) who has also reported similar findings in his research study.

From Table 4 also shows that all the students are of the opinion that argumentative teaching strategy will facilitate conceptual understanding of chemistry concepts. Although only 38.33% prefer to say their views about what they know on the topic, this is in line with the findings of Roberts and Kay (1997), who reported that traditionally, students' opinions and views have been under-represented and overlooked when it comes to discussing what students want and need in terms of learning and school experiences. Again, 100% say they would like an interactive class (item7), yet 50% prefer contributing (item2) while 50% prefer to listen. This is not surprising because in African culture, a child is not expected to exchange words or argue especially when an elderly person is involved or present in any gathering, in this sense 'argument' connotes rudeness or uncooperative attitude. This finding further lends credence to assertion by Okebukola (2005) who observed that most science teachers in Nigeria use predominantly the lecture method to portray the teacher as a fountain of knowledge and the students as passive listeners and note-takers. 60% likes being actively involved in any hand-on activities and 95% of the respondents also pointed out that chemistry lessons with argumentation provide them opportunity to learn different ideas about the chemistry concepts from colleagues.

But Table 5 shows that 60.61% of male students prefer to listen rather than contributing to the lesson being taught. This is in line with the findings of Goldin, Katz and Kuziemko (2006) who reported that high school female students now outperform male students in most subjects and in particular on verbal tests. Surprisingly, 62.96% of the female students dislike being actively involved in hand-on activities. This is finding is supported by that of Sampson and

Clark, (2008) who found out that female do not perform well in science because of their low level of confidence in hand-on activities and not their ability level. Taken together, these results imply that argumentation-based instruction used in this study, enhances students' conceptual understanding of chemistry concepts.

CONCLUSION AND RECOMMENDATIONS

Based on the findings from the study it is concluded that argumentative strategy can be used to enhance students' conceptual understanding of chemistry. The study also provides further evidence that the student-centered approaches are more effective in facilitating conceptual change and improving students' understanding than teacher- centered method. It is therefore, recommended that policy makers and curriculum planners should review senior secondary school chemistry curriculum in view to accommodate argumentation based science program for the students. Teachers are also encouraged to adopt argumentative instructional strategy to teach chemistry concepts especially where it is applicable for effective conceptualization and understanding of such concepts in chemistry. Both male and female students should be adequately encouraged and engaged through active participation during learning process when argumentative instructional strategy is used. Nigerian Government should put relevant and appropriate capacity building programs in place for the in-service teachers while such programs should be incorporated into the teacher education curriculum for pre-service teachers.

References

- Eniayeju, A. A. (2010). Effects of cooperative learning strategy on the achievement of primary sixboys and girls in mathematics. *ABACUS: The Journal of Mathematical Association of Nigeria*, 35(1), 1-9.
- Eskin, H., & Ogan-Bekiroglu, F. (2012). Argumentation as a strategy for conceptual learning of Dynamics. *Research in Science Education*, 43, 1939-1956.
- Federal Republic of Nigeria. (2008). *National Policy on Education*. Abuja: Federal Ministry of Education.
- Felton, M., & Kuhn, D. (2001). The development of argumentative discourse skills. *Discourse Process*, 32, 135-153.
- Goldin, C., Katz, L., & Kuziemko I. (2006). The homecoming of American college women: The reversal of the college gender gap. *Journal of Economic Perspectives* 20, 133-156.
- Kola, A. J. (2007). Uses of instructional material for teaching and learning physics. *International Journal of Research in Education*, 4(1), 74-78.
- Kuhn, D., Shaw, V., & Felton, M. (1997). Effects of dyadic interaction on argumentative reasoning. *Cognition and Instruction*, 15, 287-315.
- Kuhn D., & Udell, W. (2003). The development of argument skills. *Child Development*, 74(5), 1245-1260.
- Njoku, Z. C. (2009). Enhancing the relevance of chemistry curriculum delivery using science-technology-society (S.T.S) approach. *International Council of Associations for Science Education (ICASE)*, 48-54.
- Ogunwuyi, A. O. (2000). *A causal model of teachers and students factors as determinants of achievement in secondary school integrated science*. Unpublished doctoral dissertation, University of Ibadan, Ibadan.

- Okebukola, P. A. O. (2005). The race against Obsolescence: Enhancing the relevance of STAN to national development. Memorial lecture series 17. Science Teachers Association of Nigeria.
- Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching*, 41(10), 994-1020.
- Osborne, J. (2013). *Teach science through argument*. Stanford Report, April 9, 2013.
- Roberts, R., & Kay, S. (1997). Students speak: How Kentucky middle and high school students view school. Retrieved March 12, 2009 from http://www_robberandsandkay.com/clients/students_speak.html
- Sampson, V., & Clark, D. (2008). Assessment of the ways students generate arguments in science education: Current perspectives and recommendations for future directions. *Science Education*, 92(3), 447- 472.
- Sampson, V., Grooms, J., & Walker, J. P. (2011). Argument-driven inquiry as a way to help students learn how to participate in scientific argumentation and craft written arguments: An exploratory study. *Science Education*, 95(2), 217-257.
- Tippett, C. (2009). Argumentation: The language of science. *Journal of Elementary Science Education*, 21(1), 17-25.
- Toulmin, S. E. (1958). *The uses of argument*. London: Cambridge University Press.
- Wilson, M. (1991). (Ed.). *Girls and young women in education. A European perspective*. Oxford: Pergamon Press.
- WAEC (2003-04, 2006-08, 2010-2014). Chief Examiner Reports. Retrieved from <http://www.waecnigeria.org/>