



# EFFECTS OF ARGUMENTATION-BASED SCIENCE TEACHING APPROACH ON STUDENTS' LEARNING OUTCOMES IN SENIOR SECONDARY SCHOOL CHEMISTRY IN ONDO STATE

BY

**ODUTUYI Musili Olubu Ph.D**

Department of Curriculum and Instruction,  
Adeyemi Federal University of Education, Ondo,  
Ondo State, Nigeria  
odutuyimo@aceodo.edu.ng

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## **Abstract**

*The study investigated the effects of Argumentation-Based Teaching Approach (ABSTA) on students' learning outcomes in Senior Secondary School Chemistry. Specifically, the study determined the effects of Argumentation-Based Science Teaching Approach (ABSTA) on students' academic achievement in Senior Secondary School Chemistry. The study adopted the pre-test, post-test control group quasi-experimental research design. The sample comprised 80 Senior Secondary School three (SSSIII) Chemistry students in their intact classes from two schools purposively selected from two Local Government Areas (LGAs) of Ondo State. The research instruments used for collection of data were Chemistry Achievement Test (CAT), Scholastic Ability Test in Chemistry (SATC) and worksheets developed by the researcher about Argumentation-Based Science Teaching Approach (ABSTA). Data collected were analysed using Analysis of Variance (ANOVA). The results of the analysis showed that there was a significant difference in the academic achievement of Chemistry students exposed to Argumentation-Based Approach Science Teaching Approach (ABSTA) and Conventional Teacher Expository Method (CTEM). Argumentation-Based Science Teaching Approach (ABSTA) improved the academic achievement of the learners. It was found that both male and female Chemistry students achieved equally when taught using Argumentation-Based Science Teaching Approach (ABSTA). Based on the findings, it was recommended that Argumentation-Based Science Teaching Approach (ABSTA) should be encouraged for teaching and learning of Chemistry.*

**Keywords:** Argumentation-Based Science Teaching Approach, Conventional Teacher Expository Method, Achievement, Secondary School Chemistry

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## **Introduction**

Chemistry is a core science subject and as such a credit pass in it is required before a student can be admitted in any tertiary institution for most science-related

disciplines like Medicine, Pharmacy, Bio-Chemistry, Microbiology, Agriculture, Metallurgy and all the fields of Engineering. Learning Chemistry means

not only learning facts and concepts that describe the physical world at the atomic level, but also learning how to examine the physical evidence of chemical principles in a laboratory learning environment. Chemistry education does not just aim in chemical concepts. It also aims to develop student's scientific inquiry abilities. The study of Chemistry involves the learning of concepts, established principles, laws and theories and also substantial activity-oriented laboratory work. These laboratory experiments are to demonstrate practically some of the principles taught in theory, test the validity of certain empirical chemical laws and illustrate properties of substances taught theoretically in the classroom.

Argumentation is derived from the latin word "*argumentum*, meaning a "logical argument" or "proof," which is derived from the verb *arguere*, meaning "to make clear" or "to prove". This argument is the reasons for supporting a chain (Merald, Sahin and Akbas, 2021). The argumentation is described as a process that aims to express opinion by thinking or writing about a subject individually or as a group to support the idea with data, to reach a conclusion by criticizing and evaluating, and to persuade the other person. The adoption of the constructivist approach in science programmes aimed to develop learning environment centered on the students where the teacher acts as a counsellor (problem-solving, argumentation method, collaborative, cooperative and competitive learning strategies). Argumentation plays an important role in science education since with the heuristic approach, students can reach conceptual and epistemic goals, and the argumentation process can foster students scientific thinking and reason. There are some studied in the literature which focus on argumentation-based approach in science education (Ural and Gencoglan, 2020; Memis and Ergun, 2023; Isiker and Emre, 2021; Kocak an

Seven, 2021; Ates and Ozdemir, 2021, Milmaz Ozcan and Tabak, 2019)

According to Kuhn's (2010 cited in Costa, 2015), argumentation has both procedural and metalevel components that regulate its use. The procedural components involve the cognitive skills that support the execution of argumentation, whereas the metalevel components involve both metastrategic understanding of the goals of argumentation and more general epistemological understanding, that is, understanding of what is scientific knowledge and how one knows. Scientific argumentation enables the learners to understand how to assess scientific knowledge and generate new knowledge. Thus, argumentation reflects the nature of science as inquiry and discussion, guides students through activities, and functions as a metacognitive support that asks students to reason about their data (Kizkapan and Bektas, 2021).

Argumentation-based learning is important for individuals to gain a place in social life, to adapt themselves to social life, to solve the problems they encounter and to use critical and scientific approaches (Yilmaz-Ozcan and Tabak, 2019). The Argumentation-Based Science Teaching Approach (ABSTA) is a learning approach that aims to cultivate students as individuals who have strong social skills, develop collaboration and communication skills, are open-minded, can conduct research, ask questions, collect and share information, and critically evaluate arguments and justifications in discussions (Göler, 2016). With this approach, students can use different strategies including asking questions, creating claims, testing claims, creating new claims, and comparing their claims with existing scientific information (Isiker and Emre, 2021). The argumentation-based approach helps individuals express their ideas about a subject and see their missing points (Duran, Doruk and Kaplan, 2017).

Argumentative interaction in its epistemological dimension according to Smyrnalou, Petropoulou and Sotiriou, (2015) involves three aspects of knowledge: (1) the intrinsic properties of knowledge which involve alternative solutions or conceptual points of view due to its inherent ambiguity, (2) the knowledge domain which reflects and addresses the knowledge possessed by domain experts and (3) the source of the knowledge which involves the learner's attained current knowledge and the social-institutional status of the person from whom knowledge is acquired (e.g, teacher, scientist, etc.).

### Statement of the Problem

In Nigeria, some researches have been carried out through the use of carefully planned instructional strategies and models to improve the status of Chemistry teaching and learning. Despite all these efforts, students' performance in Chemistry has remained consistently poor at the Senior Secondary Certificate Examination. (SSCE). All these strategies gave a little improvement over the conventional lecture method, which is being used in our secondary schools.

The students require learning environments where they could actively participate in teaching-learning processes at an early age, participate in activities as a researcher and questioner in educational activities, explain their ideas with scientific reasons, and support.

### Purpose of the Study

The study investigated the effects of argumentation-based science teaching approach on senior secondary school students' learning outcomes in Chemistry. Specifically, this study examined:

- i. determine the effects of argumentation-based science teaching approach on students' academic achievement in Chemistry.
- ii. determine the influence of gender on the relative effectiveness of

argumentation-based teaching approach and conventional teacher expository method on students' academic achievement in Chemistry.

### Research Hypotheses

The following research hypotheses were formulated for the study:

- i. There is no significant difference in the academic achievement of students exposed to Argumentation-Based Science Teaching Approach and those taught using conventional Teacher Expository method in Chemistry.
- ii. There is no significant difference in the academic achievement of male and female students exposed to Argumentation Based Science Teaching approach and those taught using conventional Teacher expository method in Chemistry
- iii. There is no significant difference in the academic achievement of male and female students exposed to Argumentation-Based Science Teaching Approach.

### Method

The study adopted a quasi-experimental design. The population consisted of all senior secondary school three (SSIII) Chemistry students in Ondo State. Purposive sampling technique was used to select two (2) senior secondary schools from the State used for the study. The choice of the schools used for the study was based on the following criteria, schools with;

- i. a standard and functional Chemistry laboratory and
- ii. qualified and experienced Chemistry teachers.

In each school selected for the study, intact class of Chemistry students was involved. The schools were randomly

assigned to experimental and control groups. One instrument was developed by the researcher tagged “Chemistry Achievement Test (CAT)” was used to assess students’ academic achievement in Chemistry. The face and content validity were done by experts in Chemistry department while the reliability was determined by using test-re-test method. The data obtained from trial testing was analysed using Cronbach Alpha and a coefficient of internal consistency of 0.87 for CAT. The research hypotheses were analyzed using t-test.

**Table 1: Results of t-test analysis of pre-test scores of experimental and control groups**

Variables	N	X	SD	df	t	Sig	Decision
Experimental Group (pre-test)	40	32.90	12.61	78	.942	.349	NS
Control Group (Pre-test)	40	30.50	10.03				

NS= Not Significant at 0.05 alpha level  
To test this hypothesis, t-test analysis was conducted. The result showed that, there was no statistically significant difference in the pre-test scores between the experimental and control group students in terms of dependent variables at the beginning of the implementation.

## Results

**Hypothesis One;** There is no significant difference in the academic achievement of students exposed to Aargumentation-Based Science Teaching Approach (ABSTA) and those taught using Conventional Teacher Expository Method (CTEM) before treatment

The result of the analysis is shown in Table 2

**Hypothesis Two;** There is no significant difference in the academic achievement of students exposed to Aargumentation-Based Science Teaching Approach (ABSTA) and those taught using Conventional Teacher Expository Method (CTEM) after treatment.

**Table 2: t-test analysis of post -test scores of chemistry students taught with Argumentation-Based Science Teaching Approach (ABSTA) and Conventional Teacher Expository Method (CTEM)**

Variables	N	X	SD	df	t	Sig	Decision
Experimental Group	40	57.75	18.39	78	2.380	0.02	*
Control Group	40	49.15	13.57				

\* = Significant at 0.05 alpha level

The result in Table 3 showed that, the main effect of treatment (Argumentation Based Science Teaching Approach) on students’ academic achievement was significant ( $t=2.380$ ,  $P=0.02$ ). Therefore, the null hypothesis stating a non-significant difference in the mean academic achievement of chemistry students taught using Argumentation-based science teaching approach was rejected.

This indicates that, the Argumentation-Based Science Teaching Approach (ABSTA) was more effective when compared to the conventional approach in terms of enhancing academic achievement in chemistry and argumentativeness.

**Hypothesis Three;** There is no significant difference in the academic achievement of male and female students exposed to

Argumentation-Based Science Teaching Approach.

**Table 3: t-test analysis of post-test scores of male and female chemistry students taught with Argumentation-Based Science Teaching Approach (ABSTA)**

Variables	N	X	SD	Df	t	Sig	Decision
Male	22	57.22	16.92	38	0.19	.472	NS
Female	18	58.32	18.86				

NS= Not significant at 0.05 alpha level  
The result in Table 3 showed that, the main effect of gender on students' academic achievement was not significant ( $t= 0.19$ ,  $p = .472$ ). Therefore, the null hypothesis stating a non-significant difference in the mean achievement scores of male and female chemistry students taught using argumentation-based teaching approach was retained. Hence, there is no difference in the achievement of male and female students in Chemistry when taught using Argumentation-Based Science Teaching Approach (ABSTA).

## Discussion

The result showed that, there was no statistically significant difference in the pre-test scores between the experimental and control group students in terms of dependent variables at the beginning of the implementation. The comparison of the pre-test scores showed that the groups displayed similar characteristics. The level of prior knowledge of a subject is an important factor in student's ability to engage in effective argumentation. Therefore, when engaging students in argumentation, their prior knowledge should be considered.

The findings of this study also indicated that significant difference existed between the academic achievement of students exposed to Argumentation-Based Science Teaching Approach (ABSTA) and their counterparts that were taught with Conventional Teacher Expository Method

(CTEM). Students exposed to Argumentation-Based Science Teaching Approach (ABSTA) performed significantly better than those taught with Conventional Teacher Expository Method (CTEM). This was supported by the findings of Farrokhlagha (2019), Yilmaz-Ozcan and Tabak (2019), Ural and Gencoglan (2020), Isiker and Emre (2021), which found that, argumentation-based instruction had a positive impact on students' academic achievements. The findings from these researchers also indicated that argumentation-based instruction had a positive impact on academic achievements and scientific process skills. The superior performance of students in the experimental group may be attributed to the input from the teacher who exposed them to activity-oriented method and also aroused their interest in the scientific argument. The activities the learners engaged in when exposed to argumentation-based teaching approach allowed them to participate in the teaching-learning process through discussions. In this process, students make claims about the given topic, justify their claims and try to refute the counter-claims (Asian, 2019). Besides, students are also provided to develop socially by creating effective scientific discussion environments with small group activities (Asian, 2019). This teaching approach facilitated students understanding which seems to translate into improvement in their academic achievement. The findings revealed that the academic achievement

of the students was significantly influenced by the activities related to Argumentation-Based Science Teaching Approach (ABSTA) was concluded that the application of argumentation-based science learning (ABSL) approach in the 'Structure and Properties of the Matter' unit contributed to the academic achievement of the students.

The results of this study also revealed that there was no significant difference in the academic achievement of male and female students exposed to Argumentation-Based Science Teaching Approach (ABSTA). This suggest that both male and female students benefitted from this teaching strategy. The results showed that argumentation-based science teaching approach had a similar effect on the academic achievement of both male and female students. This could be explained by the fact that each gender had equal opportunity to participate effectively during teaching and learning process. The implication of this is that the argumentation-based instruction is gender friendly. This finding is in line with the outcomes of the research conducted by Asian (2019) who found that there was no significant difference between the post-test scores of students in the experimental group 1, experimental group 2 and control group in terms of gender.

### Conclusion

Based on the findings of this study, that student's exposed to Argumentation-Based Science Teaching Approach (ABSTA) performed significantly better than those taught with Conventional Teacher Expository Method (CTEM), it could be concluded that argumentation-based instruction had a positive impact on students' academic achievements and it is thus a more effective method of teaching Chemistry than the didactic teaching.

### Recommendations

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

1. Chemistry teachers should be exposed to Argumentation-Based Science Teaching Approach (ABSTA) in order to promote active students' participation, discovery learning, motivation, learning by doing and learning by experience among students.
2. Textbooks writers and publishers should shift emphasis from teachers to students' activities in line with constructivist epistemology which invariably incorporate argumentation-based teaching strategy. Teachers' guides and related activities should also be developed and produced along such strategies.
3. Federal and state ministries of education, relevant educational agencies and other stakeholders should organize workshops on the use of Argumentation-Based Science Teaching Approach (ABSTA) to enhance better performance of students in Chemistry. In addition, for wider application of this approach, some policy guidelines should be formulated to guide the implementation process. In particular, the teachers would require training and retraining on relevant curriculum materials and reference materials on how to implement Argumentation-Based Science Teaching Approach (ABSTA) which will make students effective problem solvers.

### Suggestion for Further Studies

Since in this study, the effects of the method on academic achievements was investigated, it is therefore suggested that the effects of the argumentation-based teaching strategy on other areas (such as attitudes towards science, critical



thinking skills, scientific process skills and course social skills) could be investigated in future studies.

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