

## Employing Argument Mapping in Enhancing Students' Learning outcome, Bridging Ability Gaps and Enhancing Retention in Secondary School Physics in Delta State

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### Abstract

*The study examined the effects of argument mapping on the students' learning outcome, ability level and rate of retention in physics. It adapted a quasi-experimental design pretest, posttest and delayed design. The study sampled eight-three (83) students from two intact classes and from two schools across Delta North senatorial district. The two schools were drawn through random sampling by balloting. In answering the research questions raised, mean and standard deviation were used, while analyzing of covariance (ANCOVA) were used in testing the hypotheses formulated. The instrument for the study was physics learning outcome test (PLOT) which was validated in face and content. In establishing the reliability of PLOT, kuder- Richardson formula 21 was employed which yielded a reliability coefficient of 0.86. The result showed a significant difference in learning outcome between group taught using Argument mapping and those taught using lecture method. Also the result showed a bridge in the ability gap when argument mapping was used to teach. Furthermore, the result showed a significant difference in the rate of retention in favor of argument mapping. Based on the results, it was concluded that argument mapping increases learning outcome, bridges ability gap and improves students' retention. It was recommended that among others that curriculum planners and faculties of education of higher institution should include Argument mapping as a method of instruction.*

**Keywords:** 1.Argument Mapping, 2.Retention, 3.Ability-gap and Physics.

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### Introduction

The importance of Physics in the development of any nation translate from the technological sector science mathematics and physiology (Abamba 2021). As a science subject, it the foundation for developing technological and scientific advancement (Ogunleye & Babaijde, 2011). Physics is prerequisite to the study of almost all science, technical, technological and mechanical science in Nigerian Universities. Therefore the place of physics the development of the science cannot be over emphasized.

In spite of the importance of Physics, reports and research has established that students performance in physics is poor and on the decline (Abamba, 20022, 2021, Oguntaye & Babajide and the chief examiner report). A problem that has been attributed to mostly the method used in teaching of physics which is predominantly lecture method. Improving instructions has been a global effort by science teachers and curriculum expert to improve achievement and facilitate connections between the teacher, student and the curriculum. (Bybee, Taylor, Gardner, Scaffer, Powell,

Wesibrook and Landies ,2006). Therefore, from the aforementioned, it is imperative to seek for a shift in the instructional method that is predominantly employed to a method that is interactive and integrating.

The use of mappings has gained prominence in enhancing achievement, improving retention, improving interaction of students in educational practices all over the world(Abamba, 2021). The use of argument visualization as a teaching pedagogy can be traced to the nineteenth-century logic pedagogy (Cullen, Fan, Brugge & Elga; 2018). According to them, understanding the logical structure of argument is a foundation for higher level thinking. Argument mapping as one of mapping techniques, is concerned with the visual representation of an argument. Probably originated from Richard Whately in 1826,it involve students either agreeing or disagreeing with a contentious issue or issues. The reason for agreeing is stated by the group, evidence(s) of arriving at the agreement provided and discoursed, and the source(s) stated, usually drawn in boxes with arrows, each box contains a claim arranged so that claims are reasons for believing other claims. Also, each branch represent a separate reason supporting a conclusion. The major difference between other mapping techniques and argument mapping resides in the fact that while mind and concept mappings purpose is to establish the relationship between concepts and association between ideas, topics or things, argument mapping is concerned with inference between claims (conclusion) and support argument (Gargaouri and Naatus, 2017). The arrows are used to highlight the inferential relationship that links the preposition together. According to (Dwyer, Hogan, & Stewart, 2012) an arrow between two propositions is used to indicate that one is evidence against the other. According to him colors can be used to distinguish evidence for a claim or evidence against a claim.

Argument mapping tools are design to help a user visualize the premises and conclusion of arguments in a graph structure and display a sequence of connected arguments chained together to support an ultimate conclusion (Rapanta and Walton 2015). According to them, argument mapping has been useful as a teaching method in that, it makes reasoning explicit in different learning situations.

Studies on argument mapping has been quite revealing. For instance, Nonik, Purwanto, Abdur and cholis (2020) found an improved argumentation skills when argument mapping was employed. Pantea and Parvis (2015) shows that computer in assisted mapping in a writing class improve learner self-reputation. Budi et al (2021) showed that the use of problem-based learning with argumentation scaffolding improved effecting in improving critical thinking of prospective teachers from the less critical to critical enough. Grand (2020) showed the use of computed assisted argument mapping (CAAM) as a means of fostering the CT skills necessary for the comprehension and composition of argument prove beneficial with the results of the study showing both significance and appreciable effects of size. Pantea and Parviz (2015) revealed that using CAAM in writing classes improved learners' self-regulation. Moreover, the Post-Hoc statistical procedure between two experimental groups showed that collaborative learning in a computer hands-on learning environment led to higher writing self-regulation. Yildizh and Simsek (2020) showed that the use of soft-ware argument mapping in learning and teaching process had positive effects on students' academic achievement.

Students do not assimilate at the same level. This disparity in students in science is something to worry about. This disparity is more evident between the high ability students is far increasing compared with low ability students. Saidu (2014) found a significant difference between the ability levels of students. Saidu opined that learner differ quantitatively in ability. In affirmation, Adesoji (2006) noted that the understanding of concept and principles differ in students. This is more evidence in the sciences, a domain that characterized by problem solving. Adesoji (2008) revealed researches suggesting that the method of instruction drastically reduces the ability gap of students. In affirmation, Aaro et. al.(2006) stated that good teaching can circumvent the problem of ability level grouping. Students cognitive abilities is simply concerned with brain skills as well as their mental process that are needed to solve task (Achor and Ejeh 2019). Noted that some students can solve problems faster, understanding new concept quicker and establish new relationship more than others.

How much students retain concepts taught is always a function of the effectiveness of instruction and method applied. According to Abamba, Efe and Esiekpe (2021), retention of learning is a major issue in the teaching and learning process. This is important considering that most external examinations like WAEC and JAMB takes into cognizance workload of three years. Therefore, the problem of this study is: will the use of argument mapping in

teaching Physics improve students learning outcome, bridge the ability gap of students and lead to retention of learned concepts?

### Research questions

1. What is the difference between the achievement of students taught Physics using argument mapping and those taught using lecture method?
2. What is the difference between the achievement of low and high ability students taught Physics using argument mapping?
3. What is the difference in the rate of retention between students taught Physics using argument mapping and those taught using lecture method?

### Research Hypotheses

Ho1 There is no significant difference between the achievement of students taught Physics using argument mapping and those taught using lecture method.

Ho2 There is no significant difference between the achievement of low and high ability students taught Physics using argument mapping.

Ho3 There is no significant difference in the rate of retention between students taught Physics using argument mapping and those taught using lecture method.

Ho4 There is no significant interaction between methods and ability level on students' achievement.

### Methodology

The design employed is a pretest, posttest and delayed test quasi experiment design. Two intact classes comprising of eight- three students (forty- four (44) for the experimental and thirty- nine (39) for the control) were used for the study. The research assistant were engaged in carrying out the research in Ika north and ukwuani Local Government Areas of Delta State. The instrument for the study includes:

- A three week learning plan based on the concept of heat energy for both argument mapping and lecture method
- Physic Learning Outcome Test (PLOT). This consist of forty (40) multiple choice test the selected concept. In the validity by PLOT, three expert in physics, science education and measurement and evaluation were consulted to determine it content and face validity. All necessary corrections were taking into account in the production of the final instrument. To establish the reliability of PLOT, the instrument were trial tested in a school outside the research sample. Kuder-Richardson (KR21) was used and reliability coefficient of 0.82 was obtained .Therefore, the instrument validity and reliability was established

### Treatment Procedure

The first of the research was to obtain formal permission from the school authority to allow the researcher carryout the study for three weeks.

The second stage was training of the research assistant on how to use argument mapping in teaching the selected concepts. This involved going through the lesson plan prepared, the stage of groping on how to support argument on the claim presented. On the lecture method group, the researcher handed over the prepared note based on the lecture method.

Prior to instruction, PAT was administered to account for the pretest for three weeks. After the instruction, the research assistant administered the posttest and handed over to the researcher. The research visited the school after a month to issue a reshuffled PAT, this accounted for the delayed (retention) test.

### Results

The data obtained were computed using SPSS version 21 and the results obtained are presented below.

**Research question 1**

What is the difference between the achievement of students taught using argument mapping and those taught using lecture method?

In answering research question 1, mean and standard deviation was employed and the answer is presented in table 1.

**Table 1: mean and standard deviation between groups taught using lecture method and Argument mapping**

Source of Variation	Mean	Std. Deviation	N
Lecture method	50.41	5.90	39
Argument mapping	75.43	11.93	44
Total	63.68	15.77	83

The table showed a mean score of 50.41 and SD of 5.90 for students taught with lecture method while a mean score of 75.43 and SD of 11.93 was obtained for argument mapping group. Therefore, there is a difference in the mean scores of students between both groups in favour of argument mapping. In determining whether the difference was significant, ANCOVA was employed and the result is presented in table 2.

Ho1 There is no significant difference between the achievement of students taught using argument mapping and those taught using lecture method.

**Table 2: ANCOVA result for Lecture and Argument groups**

Dependent Variable: Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12945.400 <sup>a</sup>	2	6472.700	69.554	.000	.635
Intercept	15110.898	1	15110.898	162.378	.000	.670
Pretest	1.415	1	1.415	.015	.902	.000
Groups	12806.403	1	12806.403	137.614	.000	.000
Error	7444.817	80				
Total	356911.000	83				
Corrected Total	20390.217	82				

a. R Squared = .635 (Adjusted R Squared = .626)

The result showed  $F(1, 80) = 137.614, p = 0.000$  which is significant at 0.05. Hence, the null hypothesis is rejected. Therefore, there is a significant difference between groups taught using lecture method and those taught using argument mapping in favour of argument mapping. In establishing the effect, the value of Adjusted R Squared of 0.626 showed that argument mapping contributed 62.6% to students' achievement.

**Research Question 2**

What is the difference between the achievement of low and high ability students taught Physics using argument mapping?

**Table 3: The mean and Standard Deviation of Low and High Ability students taught using Argument Mapping**

Source of Variation	Mean	Std. Deviation	N
Low Ability	62.0286	16.01743	35
High Ability	64.8750	15.64449	48
Total	63.6747	15.76899	83

The table showed a mean score of 62.02 and SD of 16.02 for low ability students while a mean score of 64.88 and SD of 15.64 was obtained for High ability students taught using argument mapping. Therefore, there is a difference in the mean scores of low and high ability students taught using argument mapping in favour of high ability students. In determining whether the difference was significant, ANCOVA was employed and the result is presented in table 3.

Ho2 There is no significant difference between the achievement of low and high ability students taught Physics using argument mapping.

**Table 3: ANCOVA result for High and Low ability students taught using Argument Mapping.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	209.902 <sup>a</sup>	2	104.951	.416	.661	.010
Intercept	11202.248	1	11202.248	44.409	.000	.357
Pretest	45.906	1	45.906	.182	.671	.002
Abilities	70.904	1	70.904	.281	.597	.004
Error	20180.315	80	252.254			
Total	356911.000	83				
Corrected Total	20390.217	82				

R Squared = .010 (Adjusted R Squared = -.014)

The result showed  $F(1, 80) = 0.281, P = 0.597$  which is not significant at 0.05. Hence, the null hypothesis is retained. Therefore, there is no significant difference between low and high ability students taught using argument mapping.

**Research Question3**

What is the difference in the rate of retention between students taught using argument mapping and those taught using lecture method?

The result is presented in table 4

**Table 4: mean and standard deviation for the mean loss between students taught using argument mapping and lecture method.**

Source of Variation	N	Mean	SD	Std. Error Mean
Argument mapping	44	2.05	0.78	0.12
Lecture method	39	4.59	0.94	0.15

The table showed a mean loss of 2.05 and SD of 0.78 for argument mapping group and mean of 4.59 and SD of 0.94 for the lecture method. Based on this result, mind mapping group retained higher than lecture method. Therefore, there is a difference in the rate of retention between groups taught using argument mapping and lecture method. In determining whether this difference is significant, the independent t-test was employed and the result is presented in hypothesis 3.

**Hypothesis 3**

There is no significant difference in the rate of retention between students taught using argument mapping and those taught using lecture method. The result is presented in table 5 below.

**Table 5: Independent t-test for retention between groups taught using argument mapping and lecture method**

Source of Variation	N	Mean loss	SD	t-value	P-value
Argument mapping	44	2.05	0.78	13.52	0.000
Lecture method	39	4.59	0.94		

The result showed  $t(13.52) > p(0.000)$  which is significant. Therefore, there is a significant difference in the rate of retention between groups taught using argument mapping and those taught using lecture method.

Hypothesis 4

There is no significant interaction between methods and ability level on students' achievement. In determining the interaction between methods and ability levels, ANCOVA interaction was employed and the result is presented in table 6.

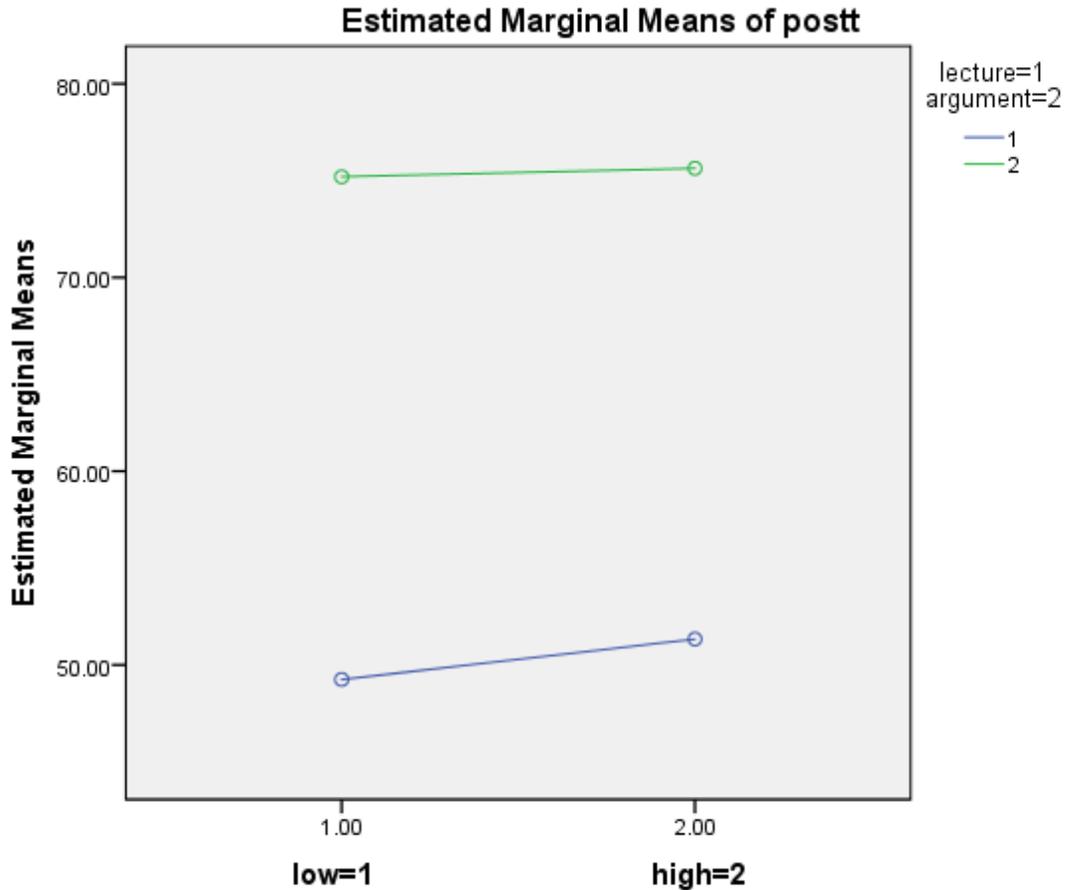
**Table 6: ANCOVA interaction for methods and ability levels**

Dependent Variable: postt

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	12986.113 <sup>a</sup>	4	3246.528	34.201	.000
Intercept	12617.867	1	12617.867	132.925	.000
Pretest	7.244	1	7.244	.076	.783
Abilities	25.706	1	25.706	.271	.604
Groups	12639.382	1	12639.382	133.152	.000
abilities * groups	13.217	1	13.217	.139	.710
Error	7404.104	78	94.924		
Total	356911.000	83			
Corrected Total	20390.217	82			

a. R Squared = .637 (Adjusted R Squared = .618)

Figure 1: ANCOVA interaction graph between methods and ability levels



Covariates appearing in the model are evaluated at the following values: prett = 11.3253

The result showed  $F(1, 78) = 94.924, p = 0.139$  which is significant. Therefore, there is a significant interaction between method and the ability level of students.

**Discussion of Result**

The instructional method employed by a teacher should be able to above all things improve learning outcome and improve the rate of retention of students since this external examination takes into cognizance years of study (Abamba 2002). This study looked into argument mapping in enhancing learning outcome and bridging ability gaps of students as well as increase retention level of students.

The result from table 1 showed a difference in the mean score of students taught using argument mapping and lecture method in favour of argument mapping. In determining whether the difference was significant, ANVCOA was employed and  $F(1, 80) = 137.614, P = 0.000$  showed the difference was significant. Therefore it was established that there is a significant difference between group taught using argument mapping and those taught using lecture

method. This result is consonance with Yildizh and Simsek (2020) which showed that argument mapping significantly improved students learning outcome.

Also, this result also showed that there is no significant level between the ability level of students with the ANCOVA result of which is significant at 0.05 level of significance. Therefore, there is no significant difference between low and high ability students taught using argument mapping. This result is in argument with (Adesoji (2008), Aaro et al (2006) and noted that the application of good method of teaching can circumvent ability gap of students.

Furthermore, hypothesis three (3) showed that there is a significant differences in the rate of retention between group taught using argument mapping and those taught using lecture in favor of argument mapping. The result showed  $t(13.52) > P(0.0000)$ . Which is significant.

The result of hypothesis 4 showed a significant interaction between method and ability level of students. The interaction graph a disordered graph because the lines did not cross each other.

### Conclusion

The results of the study shows an improved learning outcome when argument mapping is employed using in teaching physics compared with lecture method. Also, the result showed that Argument mapping will bridge ability gap of learners when effectively applied compared to lecture method. Furthermore, Argument mapping improved the retention rate of students when compared to lecture method. That is the mean loss an achievement of students was significant reduced compared with that of lecture method: Finally, the result showed a significant interaction between method and the ability level of students and achievement.

### Recommendation

Based on the result of the of study, the following recommendation were made;

- Science teacher are encourage to used argument mapping in teaching physics to improve learning outcome bridge ability gap and improve the rate of retention.
- There is the need for faculties of education and curriculum planners to include Argument mapping as a method of instruction across all level of education.

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