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EFFECT OF ANALOGY INSTRUCTIONAL STRATEGY ON STUDENTS' ACADEMIC PERFORMANCE AND CRITICAL THINKING IN BASIC SCIENCE IN TARABA STATE

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ABSTRACT

The study investigated the effect of analogy instructional strategy on students' academic performance and critical thinking in basic science in Taraba State. Two research questions and two hypotheses guided the study. The non-randomised, pre-test post-test control group type of quasi-experimental design was adopted for the study. The study area was Taraba State, Nigeria. The population of the study comprised all the 21, 672 Upper Basic II students in public upper basic

INTRODUCTION

The need for scientific and technological progress in Nigeria necessitates the inculcation of the spirit of enquiry and creativity in the Nigerian child. This could be achieved through the exploration of nature and local environment from the pre-primary level with a view to laying a solid foundation for scientific and critical thinking in the Nigerian child. The resultant effect of this is the teaching of Basic Science and Technology at the Basic Education level. This integrated approach to the teaching of science stresses the fundamental unity of science, de-emphasizes subject boundaries to make learners see the concepts and themes that embody science as a whole.

Basic Science and Technology is a subject that introduces students at the basic school level to the rudiments of science and technology. At the inception of the 6-3-3-4 system of education, it was called Integrated Science. However, in the current 9-3-4 system of education, it is called 'Basic Science and Technology' and comprises four sub-themes. These include Basic Science, Basic Technology, Information and Communication Technology (ICT) and Physical and Health Education (PHE) (Nigerian Educational Research and Development Council, 2009). The theme Basic Science is the focus of this study. The theme 'Basic Science' is a course of study which is devised and presented in such a way that

schools. The sample for the study was made up of 164 students drawn from four intact classes using multiple stage sampling technique. Two instruments were used for data collection in the study. The instruments were Basic Science Performance Test (BSPT) and Critical Thinking Test (CTT). The data collected were analysed using descriptive statistics of mean and standard deviation to answer the research questions. The hypotheses were tested using Analysis of Covariance (ANCOVA) at the significance level of 0.05. The findings revealed that there is a significant difference between the mean academic performance scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method in favour of those taught using analogy strategy ($F(1, 163) = 117.18$, $P = 0.00$). Also there is a significant difference between the mean critical thinking scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method in favour of those taught using analogy strategy ($F(1, 163) = 26.14$, $P = 0.00$). Based on the findings of this study, it was concluded that analogy strategy enhanced students' academic performance and critical thinking in Basic Science. It was recommended that Basic Science teachers should intensively employ the use of analogy teaching strategy in teaching science concepts to enhance students' academic performance and critical thinking and that Analogy teaching strategy should be included in the methodology content of teachers training institutions as this may ensure the pre-service science teachers knowledge of and use of analogy strategy.

Key Words: Basic Science, Analogy Strategy, Academic Performance and Critical Thinking

students gain the concept of the fundamental unity of science, the commonality of approach to problem of scientific nature

and helps students to gain an understanding of the roles and functions of science in everyday life and the world in which they live (Sambo, Kukwi, Eggari & Mahmuda, 2014). Basic Science is the foundation for the study of the core science subjects such as Biology, Chemistry and Physics at the senior secondary level of education. It provides students at the Basic Education level with the initial theoretical and practical frameworks which are inevitable prerequisites for their future study of science. Ekundayo (2012), Agogo and Ode (2017) maintained that Basic Science enables students to understand science concepts, principles, theories and laws which are further elaborated in the core sciences at the senior secondary level.

Despite the foundational role of Basic Science to the science education career of students, the performance of students in Basic Science is low. From 2017 to 2022, analysis of

students' yearly results released by the Taraba State Education Resource Centre has brought to limelight the poor performance of students in Basic Science in the Basic Education Certificate Examination (BECE). The poor performance in Basic Science at BECE becomes eminent when one considers the percentage credit passes which has been less than 55 % in most of the years under reviewed. This trend of poor performance does not augur well as Nigeria looks forward to be a dynamic, industrialized and knowledge-based economy that generates inclusive and sustainable development as specified in the Nigeria Agenda 2050. The implications of this poor performance in Basic Science are that there will be poor enrolments into science and technology subjects at the Senior Secondary School level. Also, there will be poor manpower development in science and technology based disciplines at the tertiary level. This factor could account for some of the reasons why there is lesser number of science students as compare to those in the social science at the senior secondary level.

Some researchers such as Owolabi and Oginni (2013), Olasehinde and Olatoye (2014) have attributed the poor performance in science to poor foundation at the basic education level which is sometimes attributed to ineffective use of instructional strategy, inadequate instructional materials and weak teacher qualification. According to Ankeli, Eriba and Achor (2020) this disturbing trend of poor performance in science is largely attributed to the use of the conventional teaching strategies which have been in use as the method of instruction. This method is the traditional teaching strategy in most basic education schools across the study area of this research, which is not yielding improvement in students' academic performance in Basic science.

It is against this backdrop that science educators have advocated for the use of methods that can foster meaningful learning in the learner (Samba and Kyado, 2017). Such learning will not only equip learners with knowledge content, but will help to build up their psychomotor skills, foster the development of critical thinking abilities to such as extent that they can aptly apply the knowledge and skills so learned in their daily living. It is only when learners are able to make use of such knowledge and skills acquired that one can say they have actually benefited from their schooling activities. For such heights or feats to be attained teaching methods must be carefully selected. Priority and prominence should be given to the use of teaching methods that allow full participation of learners in the construction of knowledge. This can only come to play if teachers are familiar with a wide variety of teaching methods. Teachers therefore must acquaint themselves with a plethora of teaching strategies, the theoretical underpinnings of the strategies as well as the procedural knowledge of each strategy. One of such strategies that is rarely used in the study area but could be useful is the analogy instructional strategy.

Analogy involves the use of common happening or process to explain seemingly difficult concepts (Samba and Atume, 2014). Samba and Atume (2014) further define analogy as an instructional strategy that is found effective in motivating students by providing them

with familiar and tangible visual stimuli taken from the students' world to provide a basis for bridging and promoting associations between a known and unknown realm. In this way, a complex abstract concept could be made simple and interestingly by reducing or eliminating students misconceptions and alternative frameworks. Analogy teaching strategy is a comparison of an unfamiliar concept with a familiar material or construct in order to explain a shared principle. The familiar concept is called the analog and the unfamiliar science concept is called the target (Gokhan, Refik, Yasemin & Bahattin, 2012). Analogy strategy builds on the framework of the learners' existing knowledge so that they are not starting from the scratch. Analogy helps to relate the concepts to real life situations making the concepts more real and easy to understand in such a way that the student can explain it to others in his or her own words. Analogies help students remember new information by connecting it to frameworks or contexts they already know (Kuykendall, 2023). Just as we use bridges to travel from one place to another, we use analogies as "bridges" from known to unknown information. Imagine explaining the function of white blood cells as "the white blood cells are part of the immune system. When a disease causing micro-organism enters the body, the white blood cells are triggered to ingest these microorganisms through action of various enzymes." It is simpler to explain white blood cells as "soldiers defending our body from invading structures and instead of using bows and arrows or guns, they use enzymes." As we make use of analogies that are familiar to students, we increase retention and retrieval of information and thus improve and strengthen their critical thinking ability.

Critical thinking is the analysis of facts to form a judgment (Edward, 2017). It follows that critical thinking is based on arriving at a conclusion when facts are considered. *Mulnix* (2010) states that critical thinking is a type of thinking pattern that requires people to be reflective, and pay attention to decision-making which guides their beliefs and actions. Critical thinking allows people to deduce with more logic, to process sophisticated information and to look at various sides of issues so that they can produce more solid conclusions. Critical thinking has seven critical features. These are being inquisitive, curious, being open-minded to different sides, being able to think systematically, being analytical, being persistent to truth, being confident about critical thinking itself and being mature (*Facione & Facione, 2013*). Although critical thinking could be defined in several different ways, there is a general agreement in its key component which is the desire to reach for a satisfactory result. This could be achieved by rational thinking and result-driven manner.

Researchers have established that students' critical thinking ability has positive effect on learning and academic performance (Samba 2018; Agogo 2012). Critical thinking is considered important in the academic fields for enabling one to analyse, evaluate, explain and restructure thinking, thereby ensuring the act of thinking without false belief. However, even with knowledge of the methods of logical inquiry and reasoning, mistakes

occur due to a thinker's inability to apply the methodology consistently, and because of overruling character traits such as egocentrism. Critical thinking includes identification of prejudice, bias, propaganda, self-deception, distortion and misinformation. Given research in cognitive psychology, some educators believe that schools should focus on teaching their students critical thinking skills and cultivation of intellectual traits. Foong (2016) observes that critical thinking is one of several learning and innovative skills necessary to prepare students for post-secondary education and the professional field. It is therefore pertinent that teachers should emphasise higher order thinking skills, especially critical thinking skills. Samba and Eriba (2012) emphasised that thinking outside the box could enable learners cope with future challenges in all areas of human endeavour. The authors further stressed that science teachers' appropriate use of instructional strategies could provide an enabling environment for students to think well both in and outside the classroom. Students who acquire critical thinking ability stand a good chance to attain higher academic performance. This is because critical thinking enable students to arrive at correct conclusions based on rational reasoning. In an examination or test situation, such students employ their critical thinking skills in providing accurate answers. What is not clear is whether the use of analogy instructional strategy could enhance students' critical thinking ability and academic performance in Basic Science.

Statement of the Problem

Students find it difficult to understand science concepts as reflected in the poor performance of candidates in the Basic Education Certificate Examination in Taraba State. This students' dwindling performance in Basic Science in the BECE in Taraba State has had serious implication on the advancement of science and technology education in the State. This usually affect enrolment of students in science at the senior secondary school level since a credit pass is required in Basic Science and Technology for placement of students in science at that level. This situation is worrisome to both teachers and parents.

This failure may be trace to the instructional strategies used by teachers which are mostly conventional method, (lecturing), questioning and answering, explanation of procedures and note giving (Dajal & Ejezie, 2020). The methods being used are not practically oriented and teachers in general make little efforts to relate the science concepts taught and examples and illustrations used to real life especially within the context of the students' own lives experience and environment. It is now thought that complementing classroom lessons with other teaching strategies such as analogy instructional strategy that is rarely use may improve learning and performance in Basic Science since it is capable of linking the new science concept to students' real life experiences. Therefore, the problem of this study put in question form is, what the effect of analogy instructional strategy on students' academic performance and critical thinking in basic science.

Research Questions

Two research questions guided the study:

1. What is the difference in the mean academic performance scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method?
2. What is the difference in the mean critical thinking scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method?

Hypotheses

Two hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference between the mean academic performance scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method.
2. There is no significant difference between the mean critical thinking scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method.

Research Design

The non-randomised, pre-test post-test control group type of quasi-experimental design was adopted for the study. This design was adopted because it was not possible to have complete randomization of the respondents without disruption of school organisation. The study area was Taraba State, Nigeria. The population of the study comprised all the 21, 672 Upper Basic II students in public upper basic schools. The sample for the study was made up of 164 students in upper basic schools in Jalingo education zone, Taraba State. Four schools were randomly selected and one intact class was selected from each of the school. The number of students in the four intact classes form the sample for the study. Two intact classes each were assigned to the analogy group (experimental group) and the control group (conventional method).

Instruments for Data Collection

Two instruments were used for data collection in the study. The instruments were Basic Science Performance Test (BSPT) and Critical Thinking Test (CTT). The BSPT was adapted by the researchers using some of the items from Basic Education Certificate Examination 2015-2020 that were relevant to the content covered in the study. The BSPT has 25 multiple choice questions from the Basic Science Upper Basic II curriculum.

The Critical Thinking Test was develop by the researcher. It comprises twenty five objective test items made up of short statements and conclusions. Students were

required to read through the statements carefully and come out with definite conclusions by choosing the option with the correct answer.

Experimental Procedure

The researchers organized two day training session for the research assistants for the experimental group and control group separately. The training session focused on Basic Science content taught, the use of the lesson plans, the procedures for administration of the instruments for data collection. The study lasted for six weeks, one week for preparation and administration of pretest, four weeks teaching the content and one week for administration of post-test.

Method of Data Analysis

The data collected were analysed using descriptive statistics of mean and standard deviation to answer the research questions. The hypotheses were tested using Analysis of Covariance (ANCOVA) at the significance level of 0.05.

Results

Research Question 1

What is the difference in the mean academic performance scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method?

Table 1: Mean and Standard Deviation of Academic Performance of Analogy and Conventional Groups

Group	N	Pre BSPT Mean	SD	Post BSPT mean	SD	Mean Gain
Analogy strategy	85	24.30	3.04	44.25	9.16	**19.95**
Conventional method	79	22.62	5.30	31.68	7.41	**9.06**
Mean difference		1.68		12.57		**10.89**

Table 1 shows the students mean scores performance in Basic Science between those who were taught using analogy strategy and those were taught using conventional method. The table revealed that the mean gain of students taught using analogy was 19.95 and the mean gain of those taught using the conventional method was 9.06. The difference in the mean performance scores between those taught using analogy and those taught using the conventional method was 10.89 in favour of students who were exposed to analogy strategy. The implication is that students who were taught using analogy strategy

had higher grades in their performance in Basic Science than those who were taught using the conventional strategy.

Research Question 2

What is the difference in the mean critical thinking scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method?

Table 2: Mean and Standard Deviation of Critical Thinking Scores of Analogy and Conventional Groups

Group	N	Pre CTT Mean	SD	Post CTT mean	SD	Mean Gain
Analogy strategy	85	24.30	3.04	40.84	7.60	**16.54**
Conventional method	79	22.62	5.30	28.80	6.20	**6.18**
Mean difference		1.68		12.04		**10.36**

Table 2 shows the students mean critical thinking scores in Basic Science between those who were taught using analogy strategy and those were taught using conventional method. The table revealed that the mean gain of students taught using analogy was 16.54 and the mean gain of those taught using the conventional method was 6.18. The difference in the mean critical thinking scores between those taught using analogy and those taught using the conventional method was 10.36 in favour of students who were exposed to analogy strategy. The implication is that students who were taught using analogy strategy had higher grades in their critical thinking in Basic Science than those who were taught using the conventional strategy.

Hypothesis 1

There is no significant difference between the mean academic performance scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method.

Table 3: ANCOVA of Academic Performance Scores of Students taught Basic Science using Analogy strategy and those taught using Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9876.10	2	4938.05	69.80	.00	.60
Intercept	7807.50	1	7807.50	110.37	.00	.57

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Pretest	4.22	1	4.22	.06	.81	.00
Strategy	8289.50	1	8289.50	117.18	.00	.58
Error	5800.91	161	70.74			
Total	143950.00	164				
Corrected Total	15677.01	163				

Table 3 is an ANCOVA table for students' performance in Basic Science for those taught using Analogy strategy and those taught using the conventional method. The table revealed that F(1, 163) = 117.18, P =0.00. Since p = 0.00 is less than 0.05 (p = 0.00 < 0.05) the null hypothesis is rejected. There is a significant difference between the mean academic performance scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method in favour of those taught using analogy strategy.

Hypothesis 2

There is no significant difference between the mean critical thinking scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method.

Table 4: ANCOVA of Critical Thinking Scores of Students taught Basic Science using Analogy strategy and those taught using Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	16038.92	2	8019.46	450.67	.00	.91
Intercept	64.68	1	64.68	3.64	.06	.04
Pretest	3848.03	1	3848.03	216.25	.10	.72
Strategy	3428.55	1	3428.55	26.14	.00	.26
Error	1459.12	161	17.79			
Total	127011.00	164				
Corrected Total	17498.04	163				

Table 4 is an ANCOVA table for students' critical thinking in Basic Science for those taught using Analogy strategy and those taught using the conventional method. Table 4 revealed that F(1, 163) = 26.14, P =0.00. Since p = 0.00 is less than 0.05 (p = 0.00 < 0.05) the null hypothesis 2 is therefore, rejected. It is concluded based on evidence from data analysis

that there is a significant difference between the mean critical thinking scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method in favour of those taught using analogy strategy.

Discussion of Findings

Result of the study showed that students who were taught Basic Science using analogy strategy have higher mean academic performance scores than those taught using the conventional method. This was further confirmed by the finding which revealed that there is a significant difference between the mean academic performance scores of students taught Basic Science using analogy strategy and those taught using the conventional method in favour of the analogy strategy group (experimental group). The finding is possible because analogy strategy provides the students with familiar and tangible visual stimuli taken from the students' world thus providing a basis for bridging and promoting association between the known and unknown thereby aiding understanding of the science concepts taught. Another reason for this finding is that students are captivated, more focused, attentive and interested in the analogy presented to them. This finding is in agreement with the finding of Samba and Atume (2014) that there is a significant difference between the mean academic performance of students taught Basic Science using analogy and those taught using the conventional method. This means that Basic Science could be better taught using analogy strategy.

Another finding of the study was that there is a significant difference between the mean critical thinking scores of students taught Basic Science using analogy instructional strategy and those taught using the conventional method in favour of those taught using analogy strategy. In other words, students who were taught Basic Science using analogy strategy have higher mean critical thinking scores than those who were taught using the conventional method. This could be because students who participated in the analogy process enjoyed the activities, had great fun and they became more aware of the scientific concepts under study. This means that the analogy strategy was more effective in the positive development of the students' critical thinking and their environmental awareness knowledge levels. This finding aligns with Samba and Eriba (2012) who found that engaging students in related activities enable understanding of scientific concepts. As it is the case with analogy, a new scientific concept is related to a familiar experience or happening within the learners' environment.

Conclusion

Based on the findings of this study, it was concluded that analogy strategy enhanced students' academic performance and critical thinking in Basic Science.

Recommendations

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

1. Basic Science teachers should intensively employ the use of analogy teaching strategy in teaching science concepts to enhance students' academic performance and critical thinking.
2. Analogy teaching strategy should be included in the methodology content of teachers training institutions as this may ensure the pre-service science teachers knowledge of and use of analogy strategy.

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