INFLUENCE OF TWO CONSTRUCTIVE LEARNING APPROACHES AND GENDER ON THE COGNITIVE ACHIEVEMENT OF JUNIOR SECONDARY SCHOOL STUDENTS IN BASIC SCIENCE

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Abstract

This paper examined the influence of two constructivist learning approaches on the cognitive achievement of Junior Secondary School students in Basic Science in Afijio Local Government Area of Oyo State. The population comprises of 17 secondary schools in Afijio Local Government Area. Three schools were randomly selected and 120 JSS II students were used for the study using quasi-experimental designed. The schools were chosen on the premises that they offer Basic Science, their laboratories are adequately equipped with modern teaching and learning materials. Two instruments (i) Objective Tests on Basic Science (OTBS) and (ii) An Instructional Guide/Packages were used to generate the raw data. OTBS was a 30 items objectives test on Basic Science constructed by the researcher and validated by two experts in the department of Integrated Science, Oyo State College of Education, Lanlate, Oyo State. The result obtained showed the significance of the two experimental groups on students achievement in Basic Science when compared to the control group. Finding also revealed that gender had a significant influence on students' achievement in Basic Science. It was recommended that the need to use constructivist learning approaches and to integrate constructivist strategies in the curriculum for the teaching of Basic science in junior secondary schools is necessary.

Keywords: *Achievement, Basic Science, Cognitive learning, Constructivist*

Introduction

Science is what scientists do. It is what we can see, taste, feel, smell, perceive or reason within our environment. Science deals with the understanding of phenomenon or event in nature. It unravels the mystery of man's cosmic environment such as the source of rain water, the emergency of thunderstorms and lightening, the flying birds in the air, the living mackerel fish in the oceans, the occurrence of day and light, resemblance of offspring by the parents, transference of some lethal genes in generations, the motion of a body, the evolution of substances and many other events or phenomena in nature. Science strive to give order to array of disordered events in nature with the ultimate aim of defining, predicting, interpreting, explaining and controlling the nature for the benefits of man (Olagunju, Odutuyi, Bolaji & Adesina, 2015). Ige, Durowoju & Oke (2017) describe science as an attempt by human beings to organize their experiences about nature into meaningful systems of description, explanations and predictions. Such experiences about nature (scientific knowledge) are products of critical investigation in a logic-hypothetical-deductive reasoning spanning from empirical observations about phenomena in nature, prompting problem identification, formulation of workable hypotheses, reviewing related literature, conducting experiment, collating data, analyzing data with testing of hypotheses for logical inference about phenomena in nature. This critical scientific investigation produces scientific facts, concepts, hypotheses, theories, laws and principles that originate another rigorous scientific process in a continuous, cyclical pattern.

Science education in the 21st century is expected to be harnessed towards the production of citizens who are scientifically and technologically literate with high level of competence for rational thought and action. Thus, one of the aims and objectives as stated in the National Policy of Education (2013) is that Education is required to lay a sound basis and to train the mind in the understanding of the world. However, evidences abound in literature that poor performance of students in Basic Science is a manifestation of their attitude towards learning science. (Olosunde & Akinpelu, 2013).

Learning as a psychological construct entails the relatively permanent change in behavior as a result of experience or practice not due to drugs or any chemical manipulation. Atanda (2013) identified the three domains in which learning must take place as the cognitive learning, affective learning and the psychomotor learning. It is a process of acquiring knowledge and developing the ability to perform new behaviours. Learning is closely related to memory which is the storage of information in the brain. Some important keys to implementing more effective teaching and learning strategies are to be found in the question, "how do student learn". However, Resmick (1983) and Driver (1986) as cited by Durowoju (2013) agreed on some important issues in learning science. These are:

i. Students' learn science based on their prior knowledge, which may interfere with the understanding of the new information.
ii. Learners actively construct new understanding about natural phenomena
iii. Learning implies the reorganization of prior conceptual schemes based on establishing new meanings in the learners mind.

Results from researchers on students' understanding in science indicated that certain incorrect ideas about the physical world are common among the students of a wide variety of national background, educational levels and ages. This is because according to (Oludipe, 2012) a lot of emphasis has been placed on teaching rather than on learning science.

Conventional lesson plan focuses on what the teachers will do, and if learning is teacher-centered, the teacher does everything in the learning environment while students passively listen. Teachers base most conventional teaching models on verbal explanation or visual demonstration of a procedure or skill. That is why over the years students perform poorly in science because they memorize concepts they rarely understand and therefore they easily forget. Hence constructivist learning approach, which is the active process of constructing or putting together a conceptual framework by a process of interpretation is expected to be the solution to the quest for meaningful learning in science.

A constructivist learning approach entails the construction of new knowledge based on the students' previous ideas in which teaching and learning strategies that are capable of initiating restructuring, application and review of ideas are adopted. Constructivism is an advancement in the teaching and learning of science because it enables:

i. The learner actively participates in the teaching and learning process by interacting with peers, groups, teachers and laboratory materials.
ii. The learner to independently construct meanings to scientific concepts thereby retaining the facts much longer in his memory.
iii. The teacher to aptly consider the learner in the preparation and evaluation of science lessons.

There are many strategies used in constructivist approach, among them are Duchman (1966) strategy, Liem's (1987) strategy, the teacher demonstrates the discrepant event by an explanation of the event, he gives questions and draws

examples from the students' experiences, in the Friedl's (1986) strategy, the students conduct the discrepant events, discuss possible answers in small groups and the teacher encourages subsequent tests of variables or aspects of the events, focusing on process skills.

Generally, authors agree that a constructivism approach to teaching and learning is based on the premise that cognition (learning) is the result of students' "mental construction" Khalid & Azeem, 2012. In other words, students learn by fitting new information together with what the already know, which is "learned or previous experience" (Bimbola & Daniel, 2010). Previous experience of students, in turn, is shaped by their beliefs and attitude (Mishra & Bada, 2015). Thompson, (2015) further explains that a learning outcome from a constructive mode of learning has more impact on learner than a traditional receptive and passive mode where the teacher dominates the discourse. Thus, the conclusion, according to the proponents of constructivism, is that learning is constructed by the learners.

Constructed knowledge has two basic features (Bada & Mistra, 2015). First, learners from new understanding using what they already know, based on the fact that learners are no tabula-rasa-learners must possess some form of prior experience that will validate or corroborate and "construct" new learning. Second, learning is active. Learners apply current understanding, note relevant elements in new learning experiences, judges the consistency of prior and emerging knowledge and based on that judgment, modify their knowledge (Bada & Mistra, 2015).

Hence, the crux of this study is to determine which of the two strategies approaches effectively enhance cognitive achievement in Basic Science. In addition, findings of gender and students' achievement remain an unsolved puzzle. Literature established significant gender differences in attitude towards and interest in science, with girls losing interest faster than boys in senior secondary school (Adegoke, 2018) while Wonu & Anackwe (2014) found out no significant difference in the mathematics achievement of male and female students. Josiah and Etuk-Iren (2014) also observed a non-significant relationship between gender and achievement of college students but Bamidele, (2018) found that there was significant effect of gender on students' performance in practical chemistry. The controversy in the study leads to further investigation on gender as a moderator variable in this study.

Statement of the Problem

The issue of poor performance of students in Basic science has attracted attention for many researchers. This has been attributed to a number of reasons among which are teaching strategies. Unfortunately, efforts made in the past to solve the problem has not yielded significant improvement. Hence, this study examined the use of constructivist learning approach towards improving the performance of students in Basic Science.

Hypotheses

H_{01}: There is no significant main effect of treatment (Liem's and Friedl's constructivist-approaches) on students' achievements in Basic Science.

H_{02}: There is no significant main effect of gender on students' achievement in Basic Science when they are exposed to 2 constructivist learning approaches.

H_{03}: There is no significant interaction effect of treatment and gender on students' achievement in Basic Science.

Significance of the Study

The results of the study would lead to a better understanding of constructivist learning approach as against the conventional "chalk and talk" didactic method of teaching and learning Basic Science. It would provide a basis for improving the achievement of students

on Basic Science since constructivist learning approach is child-centered and practical oriented.

It would also provide a pre-knowledge for teachers about how students might arrive at solutions to science problems during lessons and potentially provides indications about appropriate teaching strategies. Moreover, the study aims at stimulating students' intelligence by making them learn how to learn meaningfully at their own rate. It would also provide the basis for conceptual learning rather than rote and memorization prevalent among science students.

Scope of the Study

The study is restricted to the effect of 2 constructivist-learning approaches on students' achievement in selected co-educational secondary schools in Afijio Local Government of Oyo State students from 3 randomly selected secondary schools were used for the study.

Methodology:

Research Design and Procedure

This study adopted a quasi-experimental pretest, posttest and control group design. It involved two experimental groups and one control group. All the 3 groups were given a pretest to generate baseline data for the finding.

Diagrammatic Representation of the Research Design

Groups	Pre-Test	Liem's Strategy	Friedl's Strategy	Gender		Post- Test
				M	F	
Experimental Group 1						
Experimental Group II						
Control						

Variables of the Study

The following variables were included in this study

Independent Variables

The independent variable for the study were (constructivist learning approaches) and gender at 2 levels.

i. Liem's constructivist learning approach.

ii. Friedl's constructivist learning approach.

Dependable Variables

The dependent variable for this study was students' cognitive achievement.

Moderating Variables

The moderating variables are gender (Male and Female).

Participants

The target participants used in this study was Basic science students who were in the second year of junior secondary school. A random sampling was adopted to select the 3 coeducation secondary schools in Afijio Local Government Area. These schools were chosen on the premise that they offer Basic Science, their laboratories are adequately equipped with modern teaching and learning materials and they have qualified teachers who are willing to assist and co-operate with the teacher.

Simple random sampling by balloting was used to select the intact class in each of the 3 groups and to assign them into treatment (experimental) and control groups. The total number of students is 120 comprising of 70 boys and 50 girls. The intact classes were assigned to different treatment condition to avoid disrupting normal school programme which could have occurred when students were being selected and put into different groups for the experiment.

Choice of Course Content and Teaching Unit

The instructional package for this study was based on J.S.S. 2 Basic science curriculum. This justification for the selection of topics is based on the topics to be taught at this level as indicated by the scheme of work. The topics were:

1. Human Skeletal System
2. Digestion in Man
3. Blood Circulation in Man

Teachers' guides/lesson plans were prepared on the three topics based on the 2 constructivist learning strategies (Liem's and Friedl's strategies). Where the control group was exposed to their normal conventional lessons method in Basic Science.

Research Instruments

The 2 research instruments used for the study were as follows:

1. A 30 – item objectives tests on Basic science (OTBS)
2. An instructional guide/package

1. A 30 – item objective tests on basic science was constructed by the researcher with assistance from the Basic science teachers. A table of specification was prepared (Table 2) and the test items covered the first three domains of cognitive abilities namely: Knowledge, comprehension and analysis. Having considered the mental alertness of students and nature of the subject matter.

Table 2:

Table of Specification on the Test Items for Achievement

	CONTENT			
COGNITIVE ABILITIES	**SKELETAL SYSTEM**	**DIGESTION**	**CIRCULATORY SYSTEM**	
KNOWLEDGE	1, 14, 26, 30	2, 10, 15	3, 7, 19	10
COMPREHENSION	11, 12, 13	4, 16, 21, 28	6, 18, 19	10
ANALYSIS	5, 23, 24	9, 25, 27	8, 17, 20, 22	10
	10	**10**	**10**	**30**

The test items were submitted to experts in measurement and evaluation and corrections were made on its appropriateness and validity. Then, the test items were administered to a pilot group to ascertain its reliability. After about 2 weeks of trial testing, the internal consistency of the items was determined by using the Kuder Richardson (KR20) formula and the reliability coefficient of 0.71 was obtained.

Administration of Instruments

After identifying the school, the researcher visited the schools and selected 3 science teachers based on their teaching experience and their readiness to participate in the study. An arm of J.S.S. 2 in each of the 3 schools was randomly selected by ballot. The instructional package/guide was made available to each of the teachers to study. Then the teachers were trained on how to make use of the instructional packages. A microteaching involving students was done

to demonstrate the effectiveness of each of the instructional packages. The researcher administered the pretest item on the subjects which lasted for 5 weeks. This was immediately followed by a post test administered on the students to assess the effect of the treatments on the achievement of the subjects in Basic science.

Method of Data Analysis

The method used to determine the significance of the null hypotheses postulated in this study is the analysis of convenience (ANCOVA). Multiple classifications Analysis (MCA) was also used to find out the level of performance of each group. All hypothesis were tested at $p < 0.05$ level of significance.

in the selected schools before the commencement of the experiment proper

Results

Results were presented according to the research hypotheses tested.

Ho_1: States that there is no significance main effect of treatments (Liem's and Friel's constructivist approach) on the students' achievements in Basic science.

Table 1 shows the summary of (ANCOVA) on the effect of treatment and gender on the post-test achievement scores of subjects using the pretest scores as covariates.

As shown in table 3, the main effect of treatment was significant [$F(2, 119) = 79.351$; $P<0.5$]. Hence, hypothesis one which states that there is no significant main effect of treatment on students' achievement was rejected.

Table 3: Summary of ANCOVA on the effect of treatment and gender on the posttest achievement of subjects

Sources of Variation	Sum of Squares	Df	Mean Square	F	Sig.
Covariates	1397.557	1	1397.557	40.185	0.000
Pretest main effects (combines)	5721.735	4	1430.434	41.775	0.000
Treatment	5434.142	2	2717.071	79.351	0.000
Gender	229.767	1	229.797	6.710	.019
2-way interactions	116.482	5	23.296	0.680	0.644
Treatment & Gender	3.622	2	1.811	0.053	0.949
Model	7256.439	6	604.703	17.660	0.000
Residual	582.103	113	34.241	-------	------
Total	7838.542	119	270.225	-------	------

Significant at $P<0.05$

Table 4: Multiple classification analysis (MCA) for the effect of treatment and gender on the post-test achievement scores of subjects

Variable Category	N	Unadjusted Deviation	ETA	Adjusted Deviation for factors & covariates	BETA
Post Test Treatment					
1. Liem's	40	15.6667		15.7059	
2. Friel's	40	4.6667	0.932	3.7079	0.902
3. Control	40	-20.333		-19.4138	
Gender					
1. Male	70	30.0729	0.203	2.6338	0.174
2. Female	50	-3.5119		-3.0101	

Grand Mean = 74.58

However, to further indicate the magnitude and direction of significance among the treatment and control groups the multiple classification analysis (MCA) was used. In table 4, which shows that students exposed to Liem's constructivist strategy obtained a higher mean score of 90.2 followed by students exposed to Friel's strategy performed better than students exposed to conventional method (control). They obtained an average mean score of 55.17.

Table 5:

Treatment	Mean Scores	Liem's	Friel's	Control	% contribution
LIEM'S	90.25		*	*	90.25
FRIEL'S	79.25	*		*	79.25
CONTROL	54.25	*	*		54.25

Moreover, to see what group contributes to the significance, the Duncan Multiple Range Comparison was used. As illustrated in table 3 the pair that contribute to the significance are asterisked as follows:

- Liem's strategy and Friel's strategy
- Liem's strategy and control
- Friel's strategy and control

The Duncan multiple range comparison of treatment and control is indicated in table 5.

Duncan Multiple Range Comparison

Pairs significantly different at $p<0.05$

Hypothesis 2: states that there is no significant main effect of gender on students' achievement on Basic science when they were exposed to 2 constructivist learning approaches.

Result obtained in table 3 showed that there was a significant main effect of gender on students' achievement [f,(1,119) = 6.710; p, .05] therefore hypothesis 2 was rejected.

Furthermore, the multiple classification analysis (MCA) in table 4 indicates that the achievement mean scores of male students was 7.15.

Hypothesis 3 states that there is no significant interaction effect of treatment (Liem's and Friel's constructivist approaches) and gender on students' achievements in Basic science. Result obtained in table three showed that the interaction effect of treatment agenda on students' achievement is not significant [$F(1, 119) = 0.053$; $P<0.5$].

Discussion of Findings

Result obtained shall be discussed under the following headings:

1. Instructional strategies and students

performances
2. Effect of gender on students performances
3. Interaction effect of instructional strategies and gender on students' achievement

Instructional Strategies and Students' Achievement

The result obtained in this study shows that there was a significant effect of treatment (Liem's and Friedl's Approaches) on students achievement in Basic science. This agrees with the work of Olosunde and Akinpelu (2013) who believe that students perform better when they are motivated and helped to analyze and discuss their ideas, promote opportunities to construct new knowledge and apply their new ideas in meaningful learning. Moreover, the Multiple classification analysis MCA shows that students exposed to Liem's constructivist approach performed better than those exposed to Friedl's approach and conventional method respectively. The reason could have being because of the child centered nature of constructivist learning approach on like conventional teaching strategy that is teacher centered. This trend is consistent with the studies of Thompson (2015) who asserted that students did undergo qualitative changes in their knowledge, but some do so more than others. Thus, it could be deduced that the observed differences in students' posttest scores was sue to the type of teaching strategy adopted.

Effect of Gender on Students' Performances

The result also indicates that male achievement was relatively higher than female achievement in Basic science. As shown in result obtained in this study, the mean score for male is 77 while the mean score for female is 71.5. This result is in line with the general notion that girls perceive science as a male domain. Also the study lends credence to the claims of Efuk-Iren (2014) but inconsistent with Mishra & Yadaf (2012) who posited that girls outperform boys in Basic science. In addition, Oludipe (2012) and Durowoju (2012) observed gender parity in science achievement.

Interaction Effect of Instructional Strategies and Gender on Students' Achievement

As observed in this study the two-way interaction effect of instructional strategies and gender was not significant. This implies that boys and girls can be taught Basic science using this strategy irrespective of their gender which in line with Wonu & Anackwe (2014).

Conclusion

Based on the data presented and analyzed, the following conclusion was reached:

1. There was a significant main effect of the treatment (Liem's and Friedl's strategies) on students achievement in integrated science [f, (2, 119) = 79.361; p; .05].
2. The students exposed to Liem's strategy performed better with an average post-test mean score of 90.2 followed by students exposed to Friedl's strategy 78.2 while students exposed to the conventional/lecture method recorded the least performance of 55.17.
3. There was a significant main effect of gender on students achievement [f, (1, 119), = 6.710; p, < .05] with the boys having a higher achievement mean score 77 than girls 71.5
4. There was no significant interaction effect of treatment and gender on students' achievement in Basic Science [F, (1, 119) = 0.053; P<0.5].

This study has been able to identify appropriate teaching and learning strategies for basic science in secondary schools. The main focus of Liem's and Friedl's constructivist approach is the learner and his or her responses. Since constructivist approach involves learning that take place when a tutor (either adult or capable peer) helps the student to build an extension from his/her previous ideas into new cognitive

territory through a series of small steps of which the students would not be independently capable, eventually when the tutor withdraws, the student is left under the full control of his acquired knowledge. Hence, it can be inferred that constructivist learning approach is an impetus to greater achievement in science.

Recommendations

i. Teachers should embark on constructivist learning approach and de-emphasizes vote learning.

ii. Basic science syllabus needs to be restructured and adequate time should be provide on the school time-table to carry out students and teachers activities suggested on the syllabus.

iii. The language of pupils' mother tongue should introduce.

iv. Conference and seminars should organize for teacher to update and upgrade their knowledge.

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