Effects of Meta-Cognitive and 5Es Constructivist Instructional Strategies on Biology Students' Achievement and Attitude on Senior Secondary Schools in Kogi State.

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Abstract

The study examined the effects of meta-cognitive and 5Es constructivist instructional strategies on Biology students' achievement and attitude in Lokoja area council of Kogi State. Three research questions and three null hypotheses guided the study. Research design was a pre-test post-test non-equivalent control group design. The population of the study comprised 1034 SS2 Biology students in private, co-educational secondary schools in Lokoja area council of Kogi-State. Using hat and draw method, four secondary schools were randomly selected from 25 secondary schools in the area council of Kogi State. The schools were Kings and Queens College Lokoja, Omodunmi Secondary School Lokoja, Bishop Delise Secondary School Lokoja, Celebrity Secondary School Lokoja. A sample size of 147 SS2 Biology students was obtained from an intact class of 32, 48, 41 and 36 purposively assigned to experimental and the control groups respectively .Experimental group was taught using 5Es constructivist instructional strategy, control group was taught using meta-cognitive instructional strategy. Treatments lasted for six weeks; instruments for data collection were 5Es Constructivist Test (5EsCT), Meta-Cognitive Biology Achievement Test (MBAT) and Biology Students Attitude Scale Test (BSAST). Data collected were analyzed using the mean and standard deviation to answer research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses. The findings shows that students taught Biology using 5Es constructivist instructional strategy achieved better and enhanced positive attitude than their group mates taught using Meta cognitive instructional strategy. There was significant difference in the mean attitude scores of male and female students. It was recommended that Biology teachers should utilize 5Es constructivist strategy when teaching Biology to improve students' achievement and attitude.

Keywords; 5Es constructivist, Meta-Cognitive strategy, Achievement, Attitude, Gender, Biology
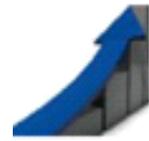
Introduction:

There has been a persisted public dissatisfaction with the achievement of students in science subjects especially Biology over the years in Nigeria. Education is the hub of any developed nation such as Germany, china, America, Austria just but a few. The ability to allow students to interact and think creatively among themselves during teaching and learning is very important in education sector especially in Kogi State and Nigeria at large. Meta-cognition is critically important yet often overlooked component of learning Lovett (2008). Meta-cognition comes from the root word "Meta" meaning behind knowledge. It also means cognition about cognition or knowing about knowing which students engaged in everyday learning of new concepts and controls these processes by organizing, monitoring and modifying as well as evaluating (Blackwell 2007). Meta-cognition is important to students in self-regulation, reflection upon an individual performance, learning and study strategies. Meta-cognitive instructional strategies are those strategies that are designed to monitor cognitive process and controls one's own cognitive goal that has been met (Dike & Worokwo, 2017). These instructional strategies empowered the learner to take charge of his own learning in a highly meaningful fashion (Aurah, 2013).

According to Harman (2012), meta-cognitive instructional strategies allow people to reflect on their own cognitive abilities using the strategy. This strategy helps students to develop skills and understand that concepts are constructed from perceived regularities in objects or events and that the language or symbolic labels are involved. Meta-cognitive skills are skills that allows students to construct learning on his or her own and effective learning involves planning a social setting, monitoring one's progress and adapting as needed and by teaching students these skills all of which can be learned in schools (Blackwell (2007), with other approaches such as 5Es constructivist instructional strategy. Researchers in education such as Eriba &Samba (2012) observed over years that effective teaching usually facilitates learning and make it more meaningful when appropriate strategies are used. In connection with this, Shikaan, (2013) stated that effective teaching helps the learner to learn better, while poor learning would naturally lead to poor learning and consequently poor achievement and negative attitude. In the classroom setting, the constructivist view of learning bends towards a number of methods of teaching and learning styles which encourages students to use active methods of teaching to create more knowledge, reflect on and discuss about what they are doing and how their understanding is fast changing. The teacher understands the students' conceptions and then builds on them.

Constructivist instructional strategy according to Agulonna and Nwachukwu, (2010) focuses on meaning and knowledge construction and not memorization. With this strategy, the learner learns by personally and uniquely developed an understanding and making sense of information. The constructivist strategy considered a hub for science teaching and learning from the chalk and talk method. The constructivist teacher poses a problem and monitor students explanation, exploration and guides students inquiry to encourage new pattern of thinking. Constructivist knowledge can be applied across learners of all ages including adults. Constructivist view of learning recognizes the fact that students needs time to express
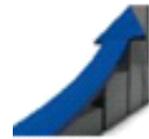
their current thinking, interact with objects, organism, substances, and equipment to develop a range of experiences on which to base their thinking (Naakaa, 2013).

The strategy provides a built-in-structure for creating a constructivist classroom. There are different models of constructivist instructional strategies. These models range from 6E, 7E, 5E approaches. The 5Es is an instructional model based on constructivist approach to learning. This model arranges learning experience so that students have the opportunity to construct understanding of a concept over time. The Biological Science Curriculum Study (BSCS) a team lead by the principal investigator, Roger Bybee, developed the instructional model for constructivism, called the Five "Es". The 5Es allow students and teachers to experience common activities, use and build on prior knowledge and experience, construct meaning and assess their understanding of a concept. The 5Es describes a phase of learning that leads students through five phases which are described using words that begins with letter "E" namely; Engage, Explore, Explain, Elaborate and Evaluate to study Biology courses.

Explore

Engage   Explain

Teaching

&

Learning

Evaluate   Elaborate
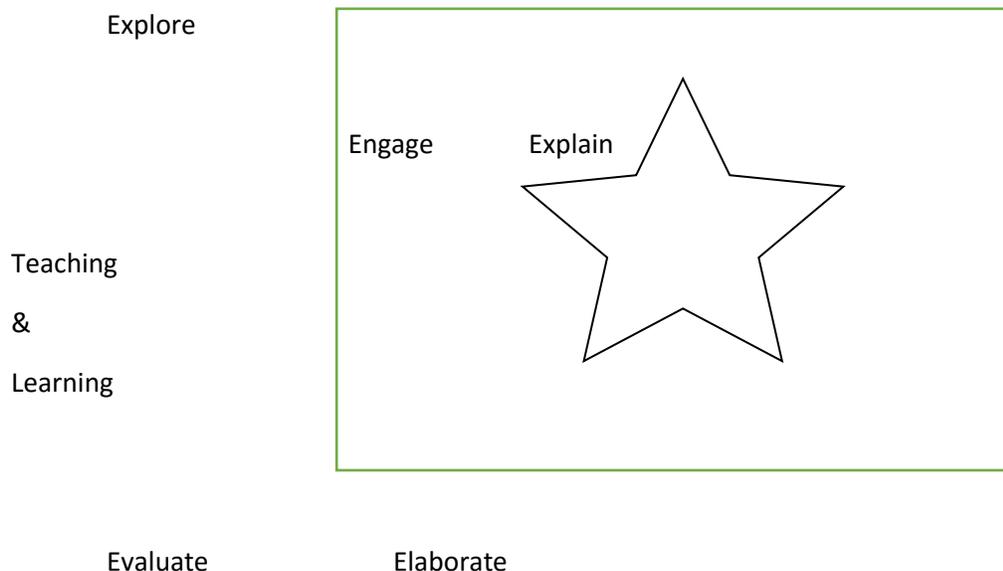
5Es Model
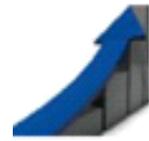
Biology science teaching and learning particularly Biology largely depends on the provision of qualitative teaching using good instructional strategies arising from a combination of factors among which is standard classroom and constructivist teacher. Despite this importance attached to science several research reports indicate that students' achievement and attitude towards Biology in secondary school science is poor. (Vijayalalashmi, 2008; (Adodo & Gboro, 2012). Biology, according to Sorajini (2007), is the branch of science that deals with the study of life. The knowledge of Biology promotes the understanding of the relationship of man and his environment, with interrelationship to living and non-living things. Mandor (2013) revealed some challenges to ineffective Biology education include inadequate or inappropriate instructional designs adopted during lessons in Nigerian schools (Ali & Adesina, 2008; Awodeyi, 2009; Smith, 2010; Ike, 2011). Okorie (2007) attributed the underachievement of students in Biology as poor methodology in our secondary schools. According to Okorie, (2007) chalk and talk method has been mostly widely used science teaching method due to unequipped laboratories, large class size coupled with unconducive learning environment, wrong spellings of biological terms which could be used to effectively communicate Biology knowledge. Biology can be studied in open field, waters, bushes, parks and other places where life exist. In the study of Biology, the main objects of study for the understanding of biological principles are in the learning and teaching strategies.

According to Awodeyi, (2019) intelligence is not the only determinant of achievement of a student; it is always associated with many components such as; meta-cognitive, 5Es constructive strategy and students' attitudes. Achievement is the scholastic standing of a students at a given moment. It has to do with the successful accomplishment of goals or the success of a student at a test. According to Adeyemi (2008), the purpose of testing achievement is to help the teacher and the students evaluate and estimate the degree of success attained in learning a given concept. One of the issues at stake in education today is measure of students' achievement. These factors to enhance achievement include; teaching method approaches, social incentives and a host of others Ogunkola,, 2008; Checkley, 2010; and (Obafemi & Onwioduokit, 2013). Achievement can be seen as the ability to perform successfully with students' efforts and skills in Biology (Aurah, 2012). This suggests that if the factors listed can be taken into consideration students may develop a higher positive attitude towards Biology.

Attitude is therefore an important factor needed for a brilliant output of any task. Learners' characteristics such as attitude play a key role in students' achievement in a subject. Students towards science, Bohner and Schwarz cited in Ellah (2015) opine that attitude as a neutral or mental state of readiness, organized through learning experience, exerting a directive or dynamic influence upon individual response to all objects and situation. Attitude can be seen as a short term which can summarize many different behaviors. Researcher such as Adodo and Gbore (2012) observed that attitude is the sun total of a persons' interest towards a certain type of object, or ideas while Onimisi (2006) agreed that attitude embraces all aspect of personality development of individual such as; values, vocational, motives pursuit;
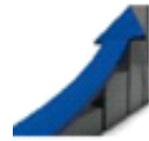
In this study, attitude could be interfered from overt behavior with verbal and non-verbal which may its implications students' achievement in Biology at all levels. Further studies on students' attitude by Eccles (2007) was a longitudinal study of more than 4000 students, the result showed that male students had significantly more positive attitude towards science especially Biology and their achievement was higher than female. Attitude towards science on the basis of gender as well as correlation between attitude towards science with achievement that the mean correlation between attitude and achievement was 0.55 for girls and 0.50 for boys. Gender is described as sex or the masculinity and felinity of a person with male or female boy or girl differences. With subjects such as Biology the correlational where positive for both boys and girls, but stronger for girls than boys. The question for this study therefore posed, which of this strategies meta-cognitive and 5Es constructivist instructional strategies will improve students' achievement and attitude in Biology.

Research Questions:

The following research questions were asked to guide the study;

1. What is the effect of Meta-Cognitive and 5Es a constructivist instructional strategies on mean achievement scores of students in Biology?

2. What is the effect of Meta-Cognitive and 5Es instructional strategies on mean attitude scores of students in Biology?

3. What is the influence of gender on mean achievement score of students in Biology taught using Meta-cognitive and 5Es constructivist instructional strategies?

Null Hypotheses:

The following null hypotheses were formulated to guide the study and tested at 0.05 level of significance

1. There is no significant difference in the mean achievement scores of students taught Biology using Meta-cognitive and 5Es constructivist instructional strategies.

2. There is no significant difference in the mean attitude scores of students in Biology using Meta-cognitive and 5Es constructivist strategies.

3. There is no significant difference in the mean achievement score of males' and female students taught Biology using Meta-cognitive and 5Es constructivist instructional strategies.

Methodology
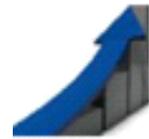
The design of the study was a pre-test, post-test non-equivalent control group design. The population of the study comprised 1034 SS2 Biology students in private, co-educational secondary schools in Lokoja area council of Kogi-State. The area council of Kogi State has 25 secondary schools, using hat and draw method, four secondary schools were randomly selected. The schools were Kings and Queens College Lokoja, Omodunmi Secondary School Lokoja, Bishop Delise Secondary School Lokoja, Celebrity Secondary School Lokoja. Source: the directorate Planning Research and Statistic 2018/2019, Lokoja-Kogi State. A sample size of 147 SS2 Biology students was obtained from an intact class of 32, 48, 41 and 36 purposively assigned to experimental and the control groups respectively. The criteria for selection of the schools were based on well-equipped Biology laboratories, qualified Biology Teachers. 5Es Constructivist lesson plan developed by the researcher and the Meta-cognitive Biology lesson plans constituted the instruments for treatment of the experimental and the control group respectively. These instruments for treatment given to the experimental and control groups lasted for 6 weeks.

Instruments for data collection were developed by the researcher namely meta-cognitive Biology Achievement Test (MBAT) and 5Es Constructivist Test (5EsCT) with 25 multiple choice items each. These questions were used for pretest and posttest. Biology Students Attitude Scale Test (BSAST) comprised of 20 items using rating Scale of agreed, strongly agreed, disagreed, and strongly disagreed. MBAT and M5EsCT were face and content validated while (BSAST) was face and construct validated by three experts; Biology Education experts from the Department of Science Education, Faculty of Education, Federal University, Lokoja- Kogi-State. The internal consistencies of all the instruments were determined using Kuder-Richardson formula-$_{21}$ and found to be 0.75, 0.83 and 0.78 (MBAT, M5EsCT and BSAST). Experimental conditions for the control of extraneous variables were taken into consideration. Experimental procedures were duly followed and the class was structured to cover the fundamental principles and practice in Biology. Regular class teachers subjected the intact groups to pre and post-testing. From the testing, it was discovered that male and female students were 62 and 85 respectively. Mean and Standard Deviation was used to answer the research questions while (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

Results

Research Question 1: What is the effect of Meta-Cognitive and 5Es a constructivist instructional strategies on mean achievement scores of students in Biology?

Table 1: Mean scores of students 'achievement using 5Es and Meta-Cognitive Instructional Strategies in Biology.
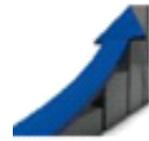
Group	N	Pretest $\bar{X}$	SD	Posttest $\bar{X}$	SD	Gain Score
Experimental group	70	14.80	4.33	29.23	2.80	14.44
Control group	77	15.49	4.20	22.67	3.55	8.18

The data on students' achievement in Table 1 reveals that students taught Biology using 5Es constructivist test using the strategy had mean achievement score of 14.80 in pre-test and 29.23 post-test while the mean achievement score of students taught Biology using meta-cognitive instructional strategy was 15.49 on pre-test and 22.67 in post-test. The students taught Biology using 5Es constructivist instructional strategy had a gain score of 14.44, while their counterparts taught Biology using meta-cognitive instructional strategy had a gain score of 8.18. Therefore, students taught Biology using 5Es instructional strategy performed slight better than their counterparts taught using meta-cognitive instructional strategy. Reason may be the students were acquainted with the step by step strategy as it involved engage, explore, explain, elaborate and evaluates the learning objectives.

Research Question 2: What is the effect of Meta-Cognitive and 5Es instructional strategies on mean attitude scores of students in Biology?
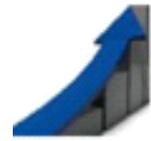
Table 2 Mean achievement score of Students' Attitude in Biology

Group	N	Pre-test $\bar{X}$	SD	Post-test $\bar{X}$	SD	Gain Score
Experimental group	70	1.24	2.64	3.08	6.76	1.85
Control group	77	2.56	2.35	2.78	7.74	0.12

Table 2 indicates that students taught Biology using 5Es constructivist strategy had a mean instructional strategy had a gain score of 0.12. Therefore, students taught Biology using 5Es constructivist instructional strategy had a higher mean attitude score than their group counterparts taught using the meta-cognitive instructional strategy.

Research Question 3: What is the influence of gender on mean achievement score of students in Biology taught using Meta-cognitive and 5Es constructivist instructional strategies?

Table 3: Mean achievement scores of male and female students in Biology

| Gender	N	Pretest $\overline{X}$	SD	Posttest $\overline{X}$	SD	Gain Score
Male	62	15.32	4.11	28.11	3.12	12.60
Female	85	15.43	4.20	23.61	4.45	9.14

Table 3 indicates that the mean achievement scores of 15.32 in pre-test and 28.11 in post-test for male students while female students had a mean achievement score of 15.43 in pretest and 23.61 in post-test. Male students had gain score of 12.60 while of 9.14 for female, therefore, male students had higher achievement score than their female counterparts.

Hypotheses Testing

Null hypothesis 1: There is no significant difference in the mean achievement scores of students taught Biology using Meta-cognitive and 5Es constructivist instructional strategies.

Table 5: Analysis of Covariance of Students' Means Achievement Score in Biology

| Source of Variation	Sum of Square	df	Mean Square	F	Sig.
Corrected model	1743,748	8	717,968	31,749	000
Intercept	5127,154	1	5127,154	746,824	000
Pre-test	174,430	1	175,430	25,553	000
Method (Treatment)	631,404	1	631,404	91,971	000
Gender	102,082	1	102,082	14,869	000
Error	961,138	140	6,865		
Total	105993,000	149			
Corrected total	2704,884	145			
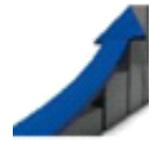
R squared = .645 (Adjusted R squared = .624)

Table 5 shows that there is significant effect of methods on students' achievement in Biology F (145) =91,971, P=0.00<005. The null hypothesis therefore was rejected indicating that there was significant difference in the mean achievement score of students taught Biology using 5Es and those taught using meta-cognitive instructional strategy. Data in Table 5 also revealed significant influence of gender on students' achievement in Biology F (145) =18.869, P=0.00<0.05. The null hypothesis was rejected indicating that there was significant difference in the mean achievement score of male and female students in biology using 5Es constructivist instructional strategy.

Null Hypothesis 2: There is no significant difference in the mean attitude scores of students in Biology using Meta-cognitive and 5Es constructivist strategies.

Null Hypothesis 3: There is no significant difference in the mean achievement score of males' and female students taught Biology using Meta-cognitive and 5Es constructivist instructional strategies.

Table 6: ANCOVA of Student's Attitude towards Biology

Source of Variation	Sum of Squares	df	Mean Square	F	SIG
Corrected model	3521,287	8	440,161	10,702	000
Intercept	3219,841	1	3219,841	78,289	000
Pre-test	482,005	1	482,005	11,720	000
Method (Treatment)	1021,755	1	1021,753	24,844	000
Gender	91,980	1	91,980	2,236	137
Error	5757,840	140	41,127		
Total	79994,000	149			
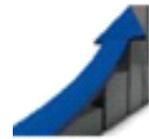
| Corrected total	9279,128	145

R=Square=379 (Adjusted R square=344

Table 6 shows that there is a significant effect of 5Es constructivist strategy on students' attitude to Biology F = (145) =24,844, P = 0.00<0.05. The null hypothesis therefore was rejected, indicating that there was significance difference in the mean attitude score of students taught Biology using 5Es and those taught using meta-cognitive instructional strategy as control. Table 6 further reveals that there is no significant influence of gender on students mean attitude score in Biology F (145) = 2.236, P = 0.137>01.05. The null hypothesis was not rejected meaning there was no significant differences in the mean attitude scores of male and female student taught biology using 5E constructivist instructional strategy.

Discussion of Findings

The 5Es constructivist method of instruction was slightly higher than meta-cognitive instructional strategy when subjected to test in enhancing students' achievement in Biology. Null Hypotheses testing indicated that instructional treatment is a significant factor in the mean achievement in Biology. This finding agreed with the earlier findings of Samba and Eriba (2012) that students taught Biology using effective instructional strategy achieved more than their group counterparts' hence improving achievement in science. The difference in achievement might have been because the students were allowed to construct knowledge in a sequential manner by themselves, there by imbibing the scientific process involved in learning Biology. The 5Es constructivist instructional strategy was more effective because the instructions were characterized by active students' involvement thereby increasing students' interest in Biology. Result on the influence of gender on the mean achievement score of the students in Biology using 5Es constructivist instructional strategy performed slightly better than the female group mates. The test of null hypothesis on Table 5 shows that gender is a significant factor in the mean achievement score of students in Biology. The finding support of Ajaya (2015) that male students taught chemistry using constructivist-based teaching strategy had higher mean attitude score than their female counterparts. The findings of Lovett, (2008) indicated that male students performed better than their female counterpart in Biology. This disagreed with the findings of Agogo, 2012 who found that high achievement in favour of girls in chemistry achievement test was recorded. This could be because of the different socialization process of male and female persons in which the male is expected to explore their environment than female.

Findings also showed that students taught Biology using 5Es constructivist strategy had higher mean attitude score in Biology than meta-cognitive instructional strategy. The findings of this study is in agreement with that of Ukozor and Uzomah (2010), that students taught Biology using constructivist strategy had higher mean attitude to Biology than their group mates.
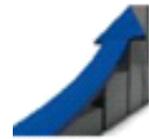
The result of the study on the influence of gender on mean attitude score of students in Biology revealed that male students had higher mean attitude score in Biology than their female counterparts. The test of hypothesis shows that the difference in mean attitude scores is not statistically significant. The findings in line with Ukozor and Uzomah (2010) that male students had higher mean attitude score than their female counterpart. Therefore, 5Es constructivist instructional strategy promotes students' achievement and attitude in Biology as leaving the students to find things up themselves by constructing their own knowledge.

Conclusion

This study has shown that 5Es constructivist instructional strategy enhances Biology achievement slightly better than meta-cognitive strategy. More so, students taught Biology using 5Es constructivist instructional strategy had a higher attitude towards Biology than students taught Biology using meta-cognitive instructional strategy as control method. However, gender is not a significant factor influencing students' achievement in and attitude towards Biology.

Recommendations

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

1.   The Biology and science teachers should engage the students in constructing their own ideas and information using 5Es instructional strategy.

2.   Biology teachers should utilize 5Es constructivist strategy when teaching Biology to improve students' achievement and attitude.

3.   The state Ministry of education in conjunction with the Biology curriculum experts should organize seminars, workshop and conferences to train and re-trained Biology teachers in the use of 5Es constructive instructional strategy

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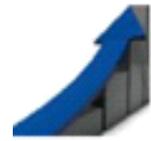
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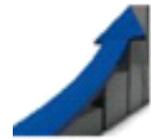
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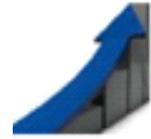
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