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Use of Metacognitive learning model in improving academic achievement of physics students

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Abstract
This study was carried out to provide alternative strategy for teaching physics which appears to students as abstract. The study investigated the use of metacognitive learning model to improve achievement of physics students in secondary schools in Anambra State, Nigeria. Two research questions and two null hypothesis guided the study. The design was a quasi-experimental research design. The population was 1730 SS one students in physics in government owned schools. Multi stage sampling was employed in selecting 134 students from two co-educational schools. A physics achievement test (PAT) was the instrument for the study. A trial test was conducted on the instrument and was found to have reliability coefficient of 0.81 using Kuder Richardson formula 20. Data collected were analysed using mean, and standard deviation to answer the research questions and the Analysis of Covariance (ANCOVA) used to test the hypothesis at 0.05 level. Findings revealed that there was a significant difference in the mean achievement scores of physics students taught with metacognitive learning model than those taught using conventional lecture and recommendation is that workshops should be organized to educate teachers on viable teaching methods.

Keywords: metacognitive learning model, improving academic achievement, physics students

Introduction

Science as a body of knowledge involves studying nature and natural phenomenon through observations, testing, experiments, evaluating among others. The basic sciences, physics inclusive is highly needed for scientific and technological development of any nation. Physics and other sciences has helped in the development of modern inventions. Implications in this, is that Nigeria may not develop technologically if the subject physics as well as other sciences are not adequately taught in our colleges. Poor achievement in physics has been blamed on many factors, the teacher factor, students factor, teaching method and the organization of physics curriculum which made it difficult for meaningful learning to take place.

Studies by Achufusi (2011) [2], Bohada (2012), Jegede and Awodun (2013) [7], stressed the fact that the teaching methods used does not bring physics learning into real life situation of the learners. Rote learning was encouraged and physics learning made abstract that the students are made passive participants in the learning process. This independence in the acquisition of physics knowledge is hindered. Thus, the subject of this study was to find out a method or strategy through which students' achievement in physics can be enhanced. A way of enhancing achievement in science as stressed by Achor (2011) [1] is for the science teacher to provide strategy in which students can take active control of their cognitive process. This is because science learning is a constructive process and knowledge construction requires active participation of the learners.

The use of metacognition is act of reflecting about one's thinking, dated back to Plato who emphasized the importance of reflecting through dialogue. Metacognition in learning can be both reflective and self-regulated. It is reflective when someone thinks about one's thinking while self-regulated metacognition means that someone go about learning by planning control comprehensive monitoring and evaluation of processes and goals among other. Metacognition is higher order thinking which involves active control over the cognitive processes, Flavel, (1970) as cited in Pintrich (2002) [8].

The conventional lecture method mostly used by teachers is basically direct instruction where teacher dominates lesson and students are passive learners. (Achufusi 2015) [2]. While the conventional lecture mandates teachers to actively control instructions in class, the metacognitive learning model or strategy and its skills allows students to take active, independent part in the class exercise. Thus the study will compare the achievement of students who took part in learning with lecture method and metacognitive learning model.

Equally, the study addressed the gender imbalance among students. This is because gender differences has been examined resulting in a substantial body of knowledge. Researchers such as Eluche *et al*, Achufusi (2011) [2], Okeke (2011) found that boys perform better than girls in mathematics and sciences while Ezendu (2013), Ezeh (2013) found that girls out performed the boys in sciences. Due to the inconclusive views of researchers on gender performance, this study investigated the use of MLM in enhancing academic achievement of physics students.

Basically in this study the metacognitive model developed by Lisa Blan C (2000) borrowing idea from flavel's idea of metacognition. The model is four phased learning cycle made up of concept exploration, concept invention, concept assessment and concept evaluation.

The theory behind this piaget theory of cognition and Ausubel theory of meaningful learning.

Research Questions

- What are the mean achievement scores of physics students taught physics with metacognitive learning model (MLM) and those taught with conventional lecture method (CLM)
- What are the mean achievement scores of male and female students taught physics with MLM.

Hypotheses

- There is no significant difference in the mean achievement scores of physics students taught with metacognitive learning model and that of those taught with the conventional lecture method (MLM)
- There is no significant difference in the mean achievement scores of male and female physics students taught physics with MLM.

Methods & Materials

The design used for the study is quasi-experimental, for specifics, the non-randomized pre-test control group design. This design according to Nworgu (2015) is used to estimate the causal impact of an intervention on its target population without random assignment. This design is chosen because it involved selecting group, upon which a variable is tested without any random pre-selection processes. The independent variable was the metacognitive learning model (MLM), while the independent variable was physics achievement. The figure represents this

Group	Pretest	Treatment	Post-Test	C= Control gp
E	0_1	X_1	0_2	E= Expt gp
O	0_1	X_2	0_2	01= pre test
				X= group treatment

Area

The area of the study is Anambra State. This state comprised of six education zones, 21 local government areas and 261 schools (PPSC Commission 2019). It is located in Southern East geopolitical zone of Nigeria. Various state and federal universities are in the state and a mixed breed of public and private workers hence the study will benefit a lot of people both students, teachers, workers and researchers.

Sample and Sampling Technique

A multi-stage sampling technique was used. Firstly, simple random sampling by lucky dio was used in selecting 2 out of 6 education zones in the area. Secondly, purposive sampling was used to select 4 co-educational schools in the two zones. Third, simple random sampling (Balloting without replacement) was used to select 2 schools, one placed into control and the other, experimental group.

Instrument

Instruments for data collection was a physics Achievement test consisting of 25 questions selected from past standardized SSCE examination questions. Although the questions are standardized, they were given to three experts in measurement and evaluation to establish the face and content validity with a table specification. After, it was given to 30 students outside study area to answer. The reliability of the instrument was established using Kuder Richardson formula (KR-20) and a value of 0.81 was gotten as the reliability coefficient.

The physics achievement test was administered as pretest to both the experimental and control groups in the 2 schools before treatment. The regular physics teachers in the schools were trained for two weeks as research assistants. They helped in the research by teaching group A with the metacognitive model and group B with conventional lecture method under the researcher's guidance. After the teaching (treatment) exercise a post test was given to the students (Reshuffled pretest). The data collected were analyzed using mean. They hypotheses were tested at 0.05 significant level using analysis of covariance (ANCOVA). The ANCOVA was used to take care of the initial group difference that existed due to non-randomization of the participants used for the research.

Result

Results are presented and analyzed as follows:

Research question I: What are the mean achievement scores of physics students taught with metacognitive teaching model (MTM) and those taught with lecture method (LM)?

Table 1: Mean and mean gain scores of students on (MTM) method

Student	No	Pretest	Post test	Mean gain
MTM	70	43.41	64.56	21.15
CLM	64	36.43	46.95	10.52

Table 1: showed that students taught with MTM had a mean value of 43.41 and a mean gain of 21.15 in contrast to the (CLM) group with a mean of 36.43 and mean gain of 10.52. This showed that the metacognitive learning model had effect on the achievement of physics students.

Research question 2: what are the mean achievement scores of male and female physics students taught with metacognitive leaning model?

Table 2: Mean and mean gain scores of male and female students taught with metacognitive learning model (MLM) N=70.

Gender	N	Pretest	Post test	Mean gain
Male	39	45.96	66.97	21.01
Female	31	38.98	60.15	21.17

Table 2: shows that male physics students taught with MTM had mean post test of 66.97 while female students had 60.15. the mean gain of 21.17 and 21.01 respectively.

Hypothesis I: There is no significant difference in the mean achievement scores of physics students taught with metacognitive leaning model (MLM) and those taught with lecture method (CLM).

Dependent variable: Posttest

Table 3: Analysis of Covariance on effect of method on the achievement of students in physics

Source	Type III Sum of squares	Df	Mean of Square	F	Sig
Corrected model	41960.45[a]	2	20980.23	384.04	.000
Intercept	5187.97	1	5187.97	9496	.000
Pretest	31100.16	1	31100.16	569.28	
Method	3910.77	1	3910.77	71.59	.000
Error	7121.09	132	54.63		
Total	491017	134			
Corrected Model	49172.54	133			

Table 3 showed the main effect of method on the achievement of student taught with MLM and those taught with CLM. F (1,134) = 71.59, P = 0.00 α = 0.05. This showed that there is significant main effect of treatment method on the academic achievement of students, as a result, the null hypothesis of no significant difference in the mean achievement scores physics student taught with metacognitive learning model and those taught with lecture method is rejected. Therefore there is a significant difference in the mean achievement scores of students taught physics with MLM and CLM in favour of MLM group.

Hypothesis 2: There is no significant difference in the mean achievement scores of male and female physics students taught physics with metacognitive learning model.

Dependent Variable – Protest

Table 4: Analysis of convenience on the achievement of male and female students taught physics using Metacognitive Learning Model.

Source	Type III Sum of squares	Df	Mean of Square	F	Sig
Corrected model	14782.82	2	7391.41	199.80	.000
Intercept	4782.79	1	4782.79	64.58	.000
Pretest	14184.18	1	14184.18	191.52	.000
Gender	0.13	1	0.13	0.01	.95
Error	5036.44	68	74.06		
Total	324615	70			
Corrected Total	19819.26	69			

Table 4 shows that there is no significant differences in the mean achievement scores of male and female students taught physics using Meta cognitive learning model.
F(1,68) = 0.01, P = 0.95 > α - 0.05. Thus the null hypothesis is accepted, there is no significant difference in the mean achievement scores of male and female studentst aught with metacognitive learning model.

Summary of Findings

1. Metacognitive Learning Model had effect on the academic achievement of students in physics as those exposed to it had higher mean gain than those who are not exposed.
2. Female students taught with metacognitive learning model had higher mean achievement scores than the male counterparts.
3. There is a significant difference in the mean achievement scores of students taught physics using metacognitive learning model and those taught using lecture method in favour of MLM group.
4. There is no significant difference in the mean achievement scores of male and female students taught physics using MLM.

Discussion

Who revealed that poor performance of physics students do s significantly depend of gender as evidence from research findings. This entailed that metacognitive learning model is a potent method of enhancing achievement of students in physics. The students were given the opportunity to make use of their initiative to channel out ways through which they can solve their learning difficulties. It gave them full opportunity for personal discovery of their ability and this agreed with the study of Achufusi (2011) [2] whose study revealed that physics achievement of students was more favoured by self-regulation than the use of lecture method. It also agreed with findings of Jejede and Awodun (2013) [7].

On the effect of MLM on achievement of male and female students, The female students exposed to the MLM outperformed their male counterparts but the hypothesis testing showed no significant difference in the achievement of students by gender. It agreed with views Eluche *et al.* who revealed that poor performance of physics students do s significantly depend of gender.

Conclusion

The study concluded that MLM significantly improved the achievement of students in physics, gender has no significant effect on the achievement of students taught with MLM. The implication of this is that the MLM is not gender bias. The school authorities should create avenues for effective use for MlM to enhance the achievement of students generally.

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