

Effect of Metacognitive Instructional Strategy on Achievement and Self-Esteem in Basic Science in Nasarawa State, Nigeria

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Abstract

This study investigated the Effect of Metacognitive Instructional Strategy (MCIS) on Self-esteem and Achievement of Students in Basic Science in Nasarawa State, Nigeria. Two research questions guided the study and two null hypotheses were formulated and tested at 0.05 level of significance. Quasi experimental research design of pre-test and post-test of non-randomized and nonequivalent experimental and control group was adopted. The population of the study was 17,761 JS III students from junior secondary schools in the three educational zones in Nasarawa State, 2018/2019 academic session. The sample size was 300 JS III students drawn from six intact classes of 50 students, using simple random technique. Two instruments which comprised of Basic and Achievement Test (BAT), and Basic Science Self-esteem Rating Scale (BSSERS), were developed by the researcher and validated by two experts from Measurement and Evaluation and Science Education Departments were used for data collection. The internal consistencies of the instruments- BSSERS and BAT were obtained using Cronbach Alpha and Kuder Richardson formula as 0.86, and 0.74 respectively. Descriptive statistics of mean and standard deviation scores were used to answer the research questions while the null hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). Results showed that metacognitive instructional strategy was more effective in facilitating students' self-esteem, and achievement in Basic Science than conventional teaching method. The strategy promoted the use of cognitive knowledge of thinking and acquisition of scientific skills as well as mastering concept and principles of Basic Science. The study recommended adequate training and re-training of teachers on the use of metacognitive instructional strategy model for Nigerian Junior Secondary Schools through workshops and seminars organized by school authority or Professional bodies such as Science Teachers' Association of Nigeria.

Keywords: Metacognitive, Instructional Strategy, Self-Esteem, Achievement, Basic Science.

Introduction

In Nigeria, the Basic Science programme succeeded integrated science in July, 2016 with the appropriation of the UBE Fund. The programme is regarded as a reinforcement of 6-3-3-4 policy on education. Despite the efforts of Nigeria for scientific and technological development, it has been observed that there is ineffective teaching and learning of basic science which strongly retards the nation's progress in achieving laudable objectives and goals of developing scientific literate citizens (Eriba & Samuel, 2018).

The state of Basic Science teaching/learning is fast deteriorating in Nasarawa State. This view is attested to by the abysmally low rate of enrolment of students in core subject like physics, chemistry and biology. Consequently, students lose interest towards basic science. Therefore, some measures must be taken to stimulate the interest of students by introducing new instructional strategy for teaching of basic science. It seems that we need to reappraise basic science curriculum objectives vis-à-vis the intellectual status of the average learners at the secondary school level (Idowu, 2013). Basic Science is a subject that provides basic training in scientific skills required for human survival, sustainable development and societal transformation. It implies that the programme is an attempt to provide a holistic presentation of science for sustainable development of an individual and society. Is a programme established to aid understanding of the world around an individual (Wakili, 2018).

The principal reasons why the Nigerian government started Basic Science teaching in Nigerian secondary schools based on 9-3-4 education system are as follows: It provides students at the junior secondary school level a sound basis for continuing science education either in single science subjects or further integrated science; it enhances the scientific literacy of the citizenry; it allows students to understand their environment in its totality rather than in fragments; it allows the students to have general view of the world of science; the processes of science serve as unifying factor for the various science subjects (Nwagbo, 2014).

Metacognition is referred to as the highest order of mental thinking level that is attained when students take active control over cognitive process when engaged in a task. Metacognition is also described as the cognitive functioning of a person and a second order form of thinking that include a variety of self-awareness processes which help learner to plan, monitor and control own learning. In metacognition, learners are not only aware of their own knowledge and thinking but are also in control of both of them. The essence of metacognition in teaching is to enable students to develop their own cognitive potential by thinking along with the teacher during teaching activities. These thinking processes which emanated from the use of different instructional models enable students to execute a task which they cannot accomplish independently. There are several instructional strategies that facilitate student's metacognition, one of which is metacognitive scaffolding. The metacognitive scaffolding teaching strategy is one of the several metacognitive instructional strategies (Nodoushan, 2018).

Metacognitive scaffolding teaching strategy is a teaching strategy that emanate from the word scaffolding in the field of construction. Scaffolding is used as a framework support that helps workers to execute tasks that are difficult for them to execute alone without aid. In the field of education, scaffolding refers to the support structure provided for learners to engage in learning activities just beyond their dependent abilities. This support structure is referred to as teaching model consisting of advanced organizer modeling, explicit explanation, instructing, questioning, queuing hint and feedback. The process of using

these teaching models enhances students mental thinking which is referred to as metacognitive scaffolding teaching strategy.

Self-esteem according to the standard account is how a person feels about herself, good or bad, and as manifested in a variety of ways, e.g. in pride or shame, but especially in self-confidence (US Dept. of Health and Human Services [US DHHS]). Because people can feel more or less well about themselves and be more or less self-confident, the standard account asserts that self-esteem can be high, low and somewhere in between. However, high self-esteem is claimed to have a variety of behavioral benefits, Stelson (2015). These include independence, responsibility taking, toleration of frustration, resistance to peer pressure, willingness to attempt new tasks and challenges, ability to handle positive and negative emotions, and willingness to offer assistance to others (ibid.). Obviously, these behaviours are very desirable educationally. People able to handle frustration, take risks and work independently make good learners. High self-esteem is also related to responsibility-taking, imperviousness to peer pressure, emotional stability and altruism, it appears to be crucial to the development of good moral character. Scholars of education and public policy makers have not overlooked these supposed benefits, Sadat (2016).

Bello and Oluwatosin (2014) explain students' achievement on measurement such as achievement test, skill test, and analytical thinking test. It is therefore, not out of place to describe academic achievement as gain in knowledge of students as a result of taking part in a learning activity or programme. Academic achievement is a result-oriented construct that encapsulates the level of the learners' attainment in a desired task (Rix, 2023).

Radioactivity is a phenomenon that occurs naturally in a number of substances. Atoms of the substance spontaneously emit invisible but energetic radiations which can penetrate materials that are opaque to visible light, such as alpha (α), beta (β) and gamma (γ) radiations. The effects of these radiations can be harmful to the living cells but, when used in the right way, they have a wide range of beneficial applications, particularly in medicine. We experience radiation every day and everywhere in the world we live in, and naturally occurring radioactive materials are present in the floor and walls of our homes, schools, offices and in our foods. Moreover, due to the radioactive gases in the air we breathe, our own bodies (muscles, bones and tissue etc.) contain naturally occurring radioactive elements.

Apart from its scientific explanation and utility, most students have some different perceptions about radioactivity, some view radiation as dangerous while others see it as a very difficult topic, (Morales & Tuzón, 2022). It is based on this, that the current research to investigates the effect of metacognitive instructional strategy on self-esteem and achievement of students of JS III in Basic Science in Nasarawa State.

Statement of the Problem

Over the years, several efforts have been made to improve students' achievement and the quality of Basic Science learning in schools. However, these efforts have not yielded the desired results in Nasarawa State. Basic Education Certificate Examination (BECE) in

Nasarawa State from 2012-2020 shows under achievement of students in Basic Science. Judging from the statistics of basic science students' achievement scores, students' passes at credit level and above in Basic Science has been below 30% over a period of eight (8) years. Grades of D7 and E8 are considered as passes, however, they are considered as fail grades. Under achievement in BECE in Nasarawa State among students in Upper Basic Schools do not qualify to pursue sciences at the senior secondary school. If this incessant failure of students in Basic science is not curbed, the level of failure may continue to be on the increase.

The under-achievement in Basic Science among students in junior secondary school according to the result of BECE in Nasarawa State, could be attributed to low understanding of basic concepts of basic science such as radioactivity may be as a result of ineffective teaching strategy employed by the Basic Science teachers along with lack of interest by the students that enable them to learn independently and become active in their learning and activity skills.

The causes and remedies to this under achievement of students in Basic Science have not been identified, thus, the problem remains unsolved. One of the major concerns to science educators and students is the implementation of instructional strategy in Basic Science such as Metacognitive strategy. It is no clear whether metacognitive instructional strategy would enhance students' achievement, interest and self-esteem in Basic Science. That is why, the present study sought to find the effect of metacognitive instructional strategy on achievement and self-esteem and of students in Basic Science in Nasarawa State.

Purpose of the Study

The purpose of the study was to find out the effects of metacognitive instructional strategy on self-esteem, interest and achievement of Basic Science students in Nasarawa state. Specifically, the study was designed to:

- i. find out the mean self-esteem rating scores of students in basic science taught using metacognitive instructional strategy and those taught using conventional teaching methods;
- ii. find out the mean achievement scores of basic science students taught using metacognitive instructional strategy and those taught using conventional teaching methods.

Research Questions

The following research questions were raised to guide this study:

- i. What are the mean self-esteem rating scores of students taught basic science using metacognitive strategy and those taught using conventional teaching method?
- ii. What are the mean achievement scores of students taught basic science using metacognitive instructional strategy and those taught using conventional teaching method?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

Ho₁: There is no significant difference in the mean self-esteem rating scores of students taught basic science using metacognitive instructional strategy and those taught using conventional method.

Ho₂: There is no significant difference in the mean achievement scores of students taught basic science using metacognitive instructional strategy and those taught using the conventional teaching method.

Literature Review

Mukesh and Sharna (2017) investigated the significance of metacognition in academic achievement. The study was conducted on a sample of 100 students (of B.com) purposively drawn from Maharaja College, Chhattarpur (M.P.). Metacognition Inventory (M.C.I.) constructed by Dr. Punita Govil (2015) was used to assess the met cognitive level of the sample. Sample was divided into two G₁ and G₂. G₁ students acquired less than 55%. Results reveal that there is increased with the level of metacognition. Metacognition enables a person not only to plan out administer or regulate a task but it also helps in when, which strategy is to be used for a task. On gender-wise comparison, it was found that there was no difference between groups on the basis of gender but the scores differ with the performance in academic. Hence, if the students are instructed to increase their metacognitive level with the help of experts; an increase in academic can also be seen. The study pursued a general approach to metacognition without specifying any subject area. This is a different approach from the proposed study which is looking at the achievements in basic science by both genders as a consequence of the application of metacognition as an instructional strategy.

Sadat (2016) examined the impact of cognitive and metacognitive strategy on self-esteem and self-efficacy in students. Self-esteem and academic self-efficacy are the key variables in educational systems that provide the field of growth and cognitive improvement, students' attitudes and skills; therefore, conducting the programs that provide the flourishing field of these variables are with great importance. Academic achievement is influenced by many variables. Some of the most important are cognitive and metacognitive learning strategy, self-efficacy, creativity and emotional intelligence, etc. This study aimed to investigate the effects of cognitive and metacognitive strategy on self-esteem and self-efficacy in students. The method to conduct the study was quantitative and from the branch of descriptive-survey study, and the group of applied studies. The statistical population of the study was first grade high school students in Tehran in 2015/2016 school year that due to the nature of the study, 60 students were selected. The main tools of the study were the questionnaire of cognitive and metacognitive strategy, self-esteem and academic self-efficacy. The results showed that cognitive and metacognitive strategy have significant and positive effects on students' self-esteem and academic self-efficacy. Therefore, since the reviewed literature outcome is geared towards enabling students attain metacognition. It

becomes relevant to the present study which intends to fill the gap by investigating interest and achievement as variables in addition to self-esteem which was investigated by the reviewed study.

Methodology

Quasi-experimental research design of employed pre-test, post-test of one experimental and one control group was employed for this study. The design was considered appropriate for this study since intact classes were used instead of randomly selected samples. The population of the study comprised all the UPPER BASIC III students in the three educational zones in Nasarawa State (West, North and South). Simple random sampling technique was used to draw a sample of 300 Upper Basic III Basic Science Students. Radioactivity Achievement Test (RAT) and Basic Science Self-Esteem Rating Scale (BSSERS) with a reliability index of 0.75 and 0.74 were used for data collection. Mean and standard deviation was used to answer the research question while Analysis of Covariance (ANCOVA) were used to test the null hypotheses at 0.05 level of significance.

Results

Research Question One: What are the mean self-esteem rating scores of students taught basic science using metacognitive instructional strategy and conventional teaching method?

To answer this research question, the same Number of students, mean and standard deviation of pre-test and post-test were used for the two groups. That is experimental and control group in the analysis reported in table 6.

Table 1: Mean and Standard Deviation of Students' Self-Esteem Scores Taught Using Metacognitive Strategy and Conventional Teaching Method

Group	N	Pre-test X SD	Post-test X SD	Mean Gain	Total	Mean Difference
Experimental	150	12.10 3.69	31.09 9.03	19.19	43.19	14.81
Control	150	11.45 3.176	16.93 5.24	5.19	28.38	

Table 1 shows a mean self-esteem rating pre-test score of 12.10 with a standard deviation of 3.69 and post-test mean self-esteem rating scores of 31.09 with a standard deviation of 9.03. The mean gain is 19.19 and the total mean scores of 43.19 for the students taught basic science using metacognitive instructional strategy (experimental group), while the mean self-esteem pre-test of the control group is 11.45 with a standard deviation of 3.176; and the post-test of 16.93 with a standard deviation of 5.24. The mean gain is 5.19 with total mean scores of 28.38. Therefore, the mean difference between the experimental group and the control group is 14.81. This implies that self-esteem rating scores of students taught

basic science using metacognitive instructional strategy was higher than their counterparts in the control group.

Hypothesis One: There is no significant difference in the mean self-esteem rating scores of students taught basic science using metacognitive instructional strategy and those taught using conventional teaching method.

To test this hypothesis, analysis of Covariance (ANCOVA) of students taught Basic science using metacognitive instructional strategy and those taught using conventional teaching method was carried out and the result is presented in table 12.

Table 2: ANCOVA of Self-Esteem Rating Score of Students Taught Basic Science Using Metacognitive Instructional Strategy and Conventional Teaching Method

Source	Type III sum of Squares	df	Mean Square	F	Sig.	Corrected Model
15041.402	2	7520.701	137.671	.000		Intercept
13972.599	1	13972.599	255.777	.000		Pre-test
3.482	1	3.482	.064	.801	Group	
14946.545	1	14946.134	273.598	.000		Error
16224.545	297	54.628			Total	
204258.000	300				Corrected	
Total	31265.947	299				

F=273.598; P = 0.000 < α = 0.05 => Reject

Table 2 shows that F=273.598; P = 0.000 < α = 0.05 => Reject.

This means that there is a significant difference in the mean self-esteem achievement scores of students taught Basic science using metacognitive instructional strategy had higher mean self-esteem rating score than those taught using conventional teaching method.

Therefore, Null Hypothesis one (H_{01}) was rejected.

Research Question Three: What are the mean achievement scores of students taught Basic Science using metacognitive instructional strategy and conventional teaching method?

To answer this research question, descriptive statistics of mean and standard deviation of mean and standard deviation of pre-test and post-test of the two groups were used for the analysis reported in table 8.

Table 3: Mean and Standard Deviation of Students' Achievement Score Taught Basic Science Using MCIS AND CTM

Group	N	Pre-test X SD	Post-test X SD	Mean Gain	Total	Mean Difference
Experimental	150	7.47 3.06	23.15 3.24	13.6	30.6	13.95
Control	150	5.05 2.11	11.62 3.43	6.57	16.67	

Table 3 shows the pre-test achievement mean score of 7.47 with a standard deviation of 3.06 and post-test achievement mean score of 23.15 with standard deviation 3.24. The main gain is 13.6 and the total mean score of 30.62 for students taught basic science with metacognitive instructional strategy. While the achievement mean score of the control group pre-test is 5.05 with a standard deviation of 2.11 and the post-test is 11.62 with standard deviation of 3.43, with the mean gain of 6.57; total mean of 16.67. The mean difference between the two group in 13.95, hence there was a difference in mean achievement score of students taught basic science using MCIS that those taught using CMT. Thus, the experimental group had higher mean achievement score than those in the control group.

Hypothesis Three: There is no significant difference in the main achievement scores of students taught Basic science using metacognitive instructional strategy and those taught using conventional teaching method.

To test this hypothesis, analysis of Covariance (ANCOVA) was carried out and the result is presented in table 14.

Table 4: ANCOVA of Achievement Score of Students Taught Basic Science Using Metacognitive Instructional Strategy and Conventional Teaching Method

Source	Type III sum of Squares	df	Mean Square	F	Sig	Corrected Model
Intercept	9975.388	2	4987.694	447.060	.000	
Pre-test	12810.045	1	12810.045	1148.197	.000	
Group	10.585	1	10.585	.949	.331	
Error	7967.407	1	7967.407	714.139	.000	
Total	3313.529	297	11.157			Total
Corrected	103943.000	300				
Total	13288.917	299				

F=714.139; P= 0.000 < α = 0.05 => Reject

Table 4 shows that F=714.139; P= 0.000 < α = 0.05 => Reject.

Based on this finding, the hypothesis was rejected showing that metacognitive instructional strategy had effect on the achievement of students in Basic Science.

Discussion of Findings

The findings from this study revealed that there was a significant difference in the mean self-esteem rating scores of students taught basic science using metacognitive instructional strategy than those taught using conventional method. Because the mean self-esteem score of students taught basic science using MCIS is higher than those taught with CMT. However, the analysis of Co-Variance (ANCOVA) at $p \leq 0.05$ indicated that there is a significant difference in the mean self-esteem rating scores. This, therefore, made the null hypotheses to be rejected. This was because the nature of instruction delivered to the students, by dividing them according to groups, as well as, scaffolding them, when the need arise, gives the students room for interaction between the group by expressing self, result in developing high self-esteem. Similarly, the difference in the scores and their counter parts could be as a result of students' disposition to learn, both the students had equal opportunity to participate actively. The implication of the finding is that MCIS instructional strategy had effect on the self-esteem means rating score of students taught basic science using metacognitive instructional strategy than their counter part. The finding is in agreement with Foche (2022) and Sadat (2016) who observed that academic achievement is influenced by self-esteem and others variables. This is because students were motivated through activities they were engaged in which boosted their self-esteem and invariably aid their achievement academically. Also, students with strong self-esteem were more likely to view setbacks as temporary and surmountable, leading them to persist in their efforts to overcome difficulties. Another reason could be that students' self-esteem motivated them to participate in class discussions, asking questions, or pursuing advanced coursework. This willingness to engage enhanced their learning experiences which lead to increase in their achievement.

From the findings of this study revealed that mean achievement scores of students taught basic science using metacognitive instructional strategy (MCIS) was significantly higher than those students taught with conventional method of teaching (CMT). The null hypothesis one was rejected. The reason for the higher achievement by the experimental group maybe they were trained in metacognitive instructional strategy and their metacognitive level was raised through training in reflective thinking toward cognitive experiences, which result in developing the effect of metacognitive instructional strategy on self-esteem, interest and achievement of students in basic science. It could also be that the experimental group had more innovative instructional strategy which they were familiar with. This was absent in the conventional method of teaching. The social interaction during the scaffolding teaching between the students and the teacher provided by MCIS was completely absent in CMT. This finding is in agreement with Godspower and Iheuko (2017), Hatice and Mustapha (2017) for teaching basic science concepts has a significant and positive on students' achievement. Saher and Fatima (2019), Jayapraba and Kanmani (2015) also found out that students exposed to metacognitive instructional strategy manifested higher sense of efficiency and appeared to be more competent sciences than students taught using conventional method of teaching.

This is because students were motivated through activities they were engaged in which boosted their self-esteem and invariably aid their achievement academically. Also, students with strong self-esteem were more likely to view setbacks as temporary and surmountable, leading them to persist in their efforts to overcome difficulties. Another reason could be that students' self-esteem motivated them to participate in class discussions, asking questions, or pursuing advanced coursework. This willingness to engage enhanced their learning experiences which lead to increase in their achievement.

Conclusion

Based on the findings of the study, effect of metacognitive instructional strategy on self-esteem and achievement of students in Basic Science enhanced student's achievement, self-esteem and MCIS is more efficacious than CMT. There was a significant difference in the mean achievement, and self-esteem, in basic science of the experimental and control group. The result has also shown that metacognitive instructional strategy provide instruction in metacognitive skill on self-esteem, and achievement of students in basic science, that would be students become aware of what and how to learn, and the role of the teacher is therefore to make the learner develop this type of awareness, so that they can learn to plan, monitor, regulates and evaluate their taught processes.

The result of hypotheses 1 and 2 were rejected, so that is, there is a significant difference between.

Recommendations

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

- i. Basic Science teachers should make use of this strategy as it encourages and motivates students to have high level of self-esteem.
- ii. Ministry of Education should organize workshops, seminars and in-service training to equip teachers with the necessary skills in the use of metacognitive instructional strategy to develop student with high interest in Basic Science.

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