ENHANCING TEACHING AND LEARNING OF BASIC SCIENCE THROUGH THE USE OF META COGNITIVE STRATEGIES.

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Abstract

This study identified the suitable Meta cognitive strategies that can be infused into the teaching and learning of Basic Science and also investigated the effect of these Meta cognitive instructional strategies on students' achievement in Basic Science. The study was carried out in Owerri Education Zone. A descriptive survey design was used for the first section of the study and 2 x 2 factorial design was used for the second section. The population comprised 2,718 Basic Science students and 27 Basic Science teachers in the nine public secondary schools in Owerri Municipal L.G.A. A sample of ninety students was used along with 27 teachers. two research questions and one hypothesis guided the study. Two different instruments namely Meta Cognitive Strategy Questionnaire (MCSQ) and Basic Science Achievement Test (BSAT) were used. Mean and standard deviation scores were used to answer the research questions while Z-test statistics was used to test the hypothesis at 1.05 level of significance. The findings among others were that respondents accepted the strategies listed as suitable Meta Cognitive strategies for teaching Basic Science in Secondary School. Meta cognitive strategy enhanced students' achievement and improved their Meta cognitive abilities. Based on these findings some recommendations were made, among which is that Basic Science teachers should be trained through workshops, seminars and conferences on how to infused and use Meta cognitive strategies as indentified in teaching science to enable student develop their potentials for critical thinking and self regulatory abilities in learning.

The need to improve on the quality of education generally and science in particular has posed great concern to researchers and science educators in this era of quality assurance in education. Education as is the bedrock for sustainable development in any nation and therefore no nation can rise above the quality of her educational system.

Basic Science itself is one of the important foundation subjects required in Junior Secondary School for further study science and technology. Its structure is rooted in the interrelatedness of science subjects and unified nature of scientific knowledge. As a result of its structure, it occupies a very important position in both primary and secondary school curriculum which offers it a very good opportunity to be the foundation stone to the study of separate science subjects in senior secondary school. Examples of these subjects are Chemistry, Physics, and Biology etc.

For Basic to contribute significantly to meaningful learning of the separate science subjects and also help in achieving the goals of science education in national development, it should be properly taught with effective Meta cognitive strategies.

Based on the fore-going, researchers and science educators are highly challenged to discover various Meta cognitive strategies other than the conventional methods That are capable of enhancing students' understanding of science concepts and generally improve their achievement in Basic Sciences and also enable them explain these strategies through which they arrive at what understood and retain what they have learnt for further use.

The conventional methods which include lecture method do not enable students to fully understand science concepts, explain how they understood them or enhance achievement and retention.

Again children who are gifted or naturally intelligent, with the conventional way of teaching science only (without using Meta cognitive strategies) may not be able to explain how they understood what they have learnt in the class lessons.

Furthermore, students if not exposed to several Meta cognitive strategies and encouraged to use them in their study may not understand or be aware of Meta cognitive strategies and cannot apply them in learning.

To this effect, the researcher suggests Meta cognitive teaching strategies in teaching and learning of Basic Science. This is because one of the factors for meaningful learning is to helping students learn a rich repertoire of strategies that results in solving personal and societal problems (Pressley,2004).

Meta cognitive strategies may not be a panacea to academic excellence but have the potential of helping students understand concepts through different strategies internalize what they have learnt and also freely explain the class work (Santrock, 2004).So teachers should be trained to present their lessons using a variety of Meta cognitive strategies instead of using only heavily linguistic activities.

Conceptual Framework

Meta cognition is "cognition about cognition" or "knowing about knowing" (Flavell, 1999), Flavell, Miller and Miller (2002). To this effect, Meta cognitive strategies can be explained as those strategies that student can creatively design to understand what they are being taught and explain and explain how they understand the concepts. Meta cognitive knowledge involves Meta cognitive activities which are methods that students use to examine or monitor and reflect on their current or recent thoughts. Meta cognitive activities require meta cognitive questions such as "how " and "when" to use specific procedures to solve problems, these questions' are generate by teachers to invoke the techniques of knowing from students. Meta cognitive activity also occurs when students consciously adopt and mange their thinking strategies during problem-solving and purposeful thinking

Flavell (1985) further explained the concept of Meta cognition by enumerating the two separate components involved, Fristly, awareness of skills, strategies and resources needed to perform a task effectively-knowing what to do. Secondly, ability to use-self regulatory mechanism to ensure the successful completion of the task knowing how and when to do "the what". Example of Meta cognitive strategies are use of mnemonics, such as, method of loci, rhymes, acronyms, key word, concept maps, self questioning, predict-observe-explain. Etc.

Theoretical Framework

The concept of Meta cognition is based on the learning theory of a renowned social constructivist psychologist called Vygotsky (Pollard, 2005). He believed that learners working to understand and cross their zone of proximal development, could be supported by their own disciplined and reflective thinking, in addition to the assistance offered by more capable adult and peers. He called this self regulation.

Empirical Studies

Several researchers have also reported that Meta cognition has really improved students' achievement and helped them become critical thinkers, (Wool Folk, 1990 and Pollard, 2005).In agreement with other researchers, Santrock (2004) enumerated different ways of helping students use Meta cognition. He noted that many students are unaware that Meta cognitive strategies can help them learn and he also advised that teachers should model effective strategies in teaching students Basic Science.

Santrock reported a case where Meta cognitive skills were taught to 30 students to help them solve a problem in mathematics. They were taught 30 lessons (i.e.) one lesson each day. The mathematics lesson involved mathematics story problems in which the teacher guided the low achieving students in learning to recognize when they did not know the meaning of word used, did not have all of the information necessary to solve a problem, did not know how to breakdown complex problems into specific steps, did not know how to carry put computation. After the 30 days lesson the students who were given this Meta cognitive training had better mathematics achievement and better attitude towards mathematics. It is based on these foundations that the researcher was poised to determine the suitable Meta cognitive strategies that could be used in developing Meta cognitive skills

in students in Basic Science, and investigate the effects of these skills on students' achievement in Basic Science.

Statement of the Problem

The researcher observed that despite the fact that students are taught Basic Science Concept with effective pedagogical methods that favour their varied learning styles and active participation in the classroom, students still do not develop Meta cognitive abilities to explain 'how they know what they know' and also do not remember much of what they have learnt. This can be evidenced in the way students respond to probing questions raised by the teacher to ascertain the learning process used by the students in solving problems and also in general performance in achievement test (cognitive test).

It has also been noted by educators like Pressley (1983), and Santrock (2004) that some students learn and remember very little of what they have learnt while some remember more than others. Contributing to what causes these variations (Problem). Santrock stated that students are not aware of Meta cognitive strategies.

Contributing his own view as to what causes the problem, Pressley suggested variation among students in Meta cognitive abilities. Pressley maintained that if students are given instruction on suitable cognitive strategies, they can apply what they had not been able to apply before the instruction. The worry of the research can be stated thus; if these Meta cognitive strategies are identified and infused into Basic Science teaching and learning, can students' achievement be improved? Can students' Meta cognitive abilities (skills) be enhanced? It is based on this background that the researcher was poised to undertake this study.

Purpose of the Study

The study is programmed to identify suitable Meta cognitive strategies to be infused into the teaching and learning of Basic Science and specifically investigate the effect of the identified Meta cognitive strategies on students' achievement in Basic Science.

Research Question

The following research questions guided the study

1. What are the suitable Meta cognitive strategies to be infused into Basic Science teaching and learning for improving students' achievement and learning strategy.
2. To what extent does the mean score achievement of students exposed to Meta cognitive strategies differ from those of students not exposed to the Meta cognitive strategy instruction.

Hypothesis

There is no significant difference between the mean achievement score of students who were exposed to Meta cognitive strategy of instruction and those not exposed to it.

Design and Procedure of the Research

The study was carried out in Owerri education Zone and precisely in Owerri Municipal L.G.A. of Imo State.

The researcher adopted a descriptive survey design to identify the Meta cognitive strategies and 2 x 2 factorial designs, which involves experimental and control groups with pretest in determining the effect of Meta cognitive instructional strategies on students' achievements in Basic Science. In the descriptive survey design, a questionnaire was used to elicit responses on the perception of the respondents on the suitable Meta cognitive strategies that can be infused in Basic Science teaching. The experiment group received treatment while control group was denied treatment. At end of the teaching session both groups were post-tested.

Population of the Study

The target population consisted of all the students in Junior Secondary school Two (JSS 2) in the nine public Secondary Schools in Owerri L.G.A in the year 2010 which comprised 2,718 students and 27 Basic Science teachers in the nine schools.

Sample and Sampling Technique

Two Junior Secondary School were sampled for the study through simple random sampling technique. The schools were Girls Secondary School, Owerri, and Emmanuel College, Owerri. From each of the schools, forty five students were sampled through simple random sampling technique, bringing the total number of students used for the study to 90. All the twenty-seven (27) science teachers in the nine schools were involved in the descriptive survey aspect of the study.

Out of the twenty seven teachers, six teachers were selected for teaching session only. Three of them were taught some Meta cognitive strategies by the researcher, after which they were asked to teach these Meta cognitive strategies to students. The total sample used for this study was 117 subjects (27 teachers and 90 students) both the training of teachers and teaching of students were carried out on Saturdays to avoid disrupting the official school programme.

Instruments for Data Collection

Two instruments were used for the study, namely Meta Cognitive Strategy Questionnaire (MCSQ) for the descriptive survey aspect of the study and Basic Science Achievement Test (BSAT). The first instrument was adapted from Pressley (1983) and Santrock (2004). The second instrument (BSAT) was structured by the researcher based on the topics mapped out for the teaching session.

The first instrument (MCSQ) consisted of 14 statements which boarders on perception of the Basic Science Teachers on the suitability of the Meta cognitive strategies in the teaching and learning of basic science It was administered to the 27 Basic Science teachers involved in the study. It was structured on a four point scale with weights attached as follows: Strongly Agree (SA)= 4, Agree (A)= 3, Disagree (D)= 2 and Strongly Disagree (SD)= 1.

The positivity and the negativity of the responses were determined based on the average of 2.50 of a four point scale. Any mean score up to and above 2.5 was considered positive while any mean score below 2.50 was considered negative.

The second instrument (BSAT) consisted of 20 objective questions with four options having only one correct answer. The questions were structured from the three topics used for the teaching session as follows:

(i) Meta cognitive strategies
(ii) Skeletal system
(iii) Classes levers

In this instrument students were presented some questions which tested their awareness and use of Meta cognitive activities. Some of the problems (question) required them to explain the techniques or strategies they employed in solving the problems such as, how, when, where, and why of the strategies. Students' explanations were scored individually by the researcher. The second instrument (BSAT) was used for both pre-test for the experimental and control groups.

Validation of the Instruments

The two instruments (1^{st} and 2^{nd}) were first given to two experts in science education and two experts in measurement and evaluation. They critically examined the items to ensure that they are suitable enough for collecting the registered data. Through their criticisms and remarks some items were re-structured to suit the purpose, through this process, validity was ensured.

Reliability of the Instruments

The two instruments were administered to two groups of respondents in a pilot test who were qualified to be the subjects but were not listed for the study. After two weeks interval, the instruments

were again administered to the same groups respectively. The two sets of scores were correlated using Pearson Product Moment Correlation (PPMC). The correlation co-efficient obtained were 75 and 72 for BSAT and MCSQ respectively. These indicate that the instruments were reliable enough to be used to collect data for the main study.

Table I:

Some Meta Cognitive Strategies and Methods that can be Infused into the Basic Science Lesson.

S/N	Meta Cognitive Strategy	Techniques For Instruction
	Motivating students to develop desire to use the strategy (being aware of strategy)	By the use of explanation Making them to remember material by understanding it rather than just rote learning. Students were encouraged to understand it and give it meaning, elaborate on it and personalize it. Students were given relevant concepts and ideas to remember and then were asked how they can related the concepts and ideas to their own personal experiences and meaning. They were asked to practice on and elaborating a concept so that they can process information deeply.
	Assisting students in organizing what they put in their memory.	Students were taught to organize information hierarchically through the use of concept maps. Students were asked to do more practices arranging and re-working materials that require some restructuring. Techniques used were, peer-tutoring, co-operative learning, scaffolding and so on.
	Teaching students' mnemonics: types of mnemonics are: method of loci, rhymes, acronyms keywords.	Memory aid (mnemonics) for remembering information was taught students using co-operative learning, direct explanation, peer tutoring and cognitive coaching.
	Self questioning e.g. What is the example of what I have just read? Why is it important	Direct explanation
	Time management (planning the next move)	Peer tutoring and direct explanation
	Predict-observe-explain	Co-operative learning

Adapted from Pressley (1983), Santrock (2004) and Wool folk (2009)

Procedures for the Treatment Session

First, three of the six Basic Science Teachers selected for the teaching session were trained by the researcher on Meta cognitive strategies. The training of teachers lasted for 6 weeks in predetermined secondary school. A minimum of 80 minutes was spent on each lesson once in a week (on Saturdays). Lesson for both the teachers and students took place on Saturdays.

Week 1: the first was used for opening ceremony. There was formal introduction of the programme and its purpose. Participants shared their views on motivation, students, with high retentive memory and low retentive memory.

Week 2: Teachers (participants) were introduced to Meta cognitive strategies and the need to infuse them into basic science lesson and also the need to teach students these strategies for meaningful learning and subsequent application in solving other problems.

Week 3: Some Meta cognitive strategies (cognitive monitoring strategies) were listed against the different techniques of teaching them (see table2). Direct explanation was used in combination with other techniques in teaching them these strategies. At the end of the lesson, teachers were asked to study these strategies more at home to be conversant with the when, how, why and where to apply them subsequently.

At the end of every lesson, these 3 basic science teachers were tested using workbook containing Meta cognitive question such as how, when why and where to apply the strategies, they were asked to answer the question in their individual workbook. This enabled the researcher to see their areas of difficulties. and the researcher then though more light on such areas.

In weeks 4 and 5, the researcher taught them two topics on Basic Science; the skeletal system and classes of lever respectively with Meta cognitive strategies infused into the lesson. The two topics required the use of Meta cognitive strategies, the same format was followed in the two lesson taught, most importantly they were asked to practice at home.

Week 6: Teachers were asked to come with two lesson notes prepared with the predetermined basic science topics requiring Meta cognitive strategies and skills. There was no teaching, instead they practiced teaching with their lesson notes, after which the programmed ended formerly.

Week 7: The three teachers who received treatment were asked to teach the students in experimental group while the other three who did not receive treatment taught the control group using the Convention (lecture) method. The first-lesson given to the experimental group was awareness of Meta cognitive strategies (lecture requires Meta cognitive strategies) while the control group was kept busy with a different topic which was not included in the instrument for post-test (studying science with interest). In both groups, each, teacher taught one lesson. The teachers in experimental group were asked to teach students the way they were taught.

Week 8 and 9: The three basic science teachers who received treatment taught the experimental group the same two topics they were taught and the basic science teachers who did not receive treatment taught the control group the same topics. The class was not an intact fact class; rather students were given post test with the second instrument which has part A and part B. The first part A contains Meta cognitive strategy awareness questions, section B contains cognitive question on the two topics taught. The two parts were scored independently.

Data Analysis and Presentation of Results

The research questions were answered using mean scores and standard deviation, while the hypothesis was tested using z-test at 05 significant level. The data were presented in tabular form based on the research questions and the hypothesis.

Table 2: Mean and Standard Deviation Scores on Teachers' Perception of Suitable Meta Cognitive Strategies.

S/N	Statement	N	X	SD	Decision
	What is your perception about the following as suitable Meta cognitive strategies				
	Awareness of Meta cognitive strategies and the materials needed to perform a task effectively (knowing what to do and how to do it)	27	3.20	1.30	A
	Identify the main idea or concept	27	3.23	1.42	A
	Learning and rehearsing information (constant	27	3.60	1.60	A

practices)				
Forming association or images using mnemonic e.g. Coding, acronyms, method of loci, rhymes, keywords etc				A
Organizing of new materials to make it easy to remember (using concept maps)	27	3.52	0.83	A
Applying test taking techniques	27	3.74	0.71	A
Check to see if you understand (self questioning)		3.52	0.82	A
Predicting outcomes	27	3.63	0.01	A
Motivating students to develop desire to use the skill	27	3.67	0.76	A
Outlining and note-taking	27	3.33	1.48	A
Developing appropriate scheme for making sense of the materials	27	3.62	0.90	A
Evaluating the effectiveness of an attempt at a task using the new strategies	27	3.70	0.87	A
Deciding how to apportion time (time management in studying)	27	3.52	1.57	A
Revising and switching to other strategies to overcome any difficulties encountered.	27	3.44	1.57	A

From the table above it is observed that the entire items (1-14) have mean scores greater than 2.50 which is average score with liker and is therefore regarded as the minimum acceptable mean rating for positive result. It indicates that respondents generally agreed on the items listed in table 2 as suitable Meta cognitive strategies that can be infused in the teaching and learning of Basic Science.

Research Question 2

To what extent does mean score achievement of students exposed to Meta cognitive instructional strategies differ from the mean score achievement of those denied of the treatment.

Table 2: Post-Test Mean Score Achievement of the Experimental and Control Group.

Groups	NO	Mean	SD
Experimental groups	45	65.13	2.68
Control group	45	44.33	1.23

Data in Table 2 shows that the mean score achievement of students in experimental group is greater than those in control group. This implies that the mean achievement of students in experimental group differ from those in control group in the achievement test.

Table 3: Test of No Significant or Experimental and Control Groups in Basic Science Achievement Test (BSAT).

Groups	N	Df	X	SD	Z-CAL	Z critical	0.05
Experimental group	45	88	65.13	2.68	7.48	±1.96	NHR
Control group	45		44.33				

Data analysis on Table 3 above shows that -calculated (7.48) is greater than the value of Table Z (±1.96). This indicates that there is significant difference between the mean achievement of students in the experimental and control group on Basic Science Achievement Test.

Discussion

The result of this study in respect to research question on shows that all the items listed (item 1-14) were generally accepted as suitable Meta cognitive strategies that can be used in teaching and learning of Basic Science for improving students' performance.

This was indicated by the positive responses of the respondents. All the items on Table two have mean scores greater than 2.50 which are minimum acceptable mean score for a positive response.

The findings agree with the Meta cognitive strategies identified by Pressley (1983), Santrock (2004) and Wool Folk (2009). They noted that these strategies when appropriately infused into the teaching and learning of different subjects make positive impact on students' learning.

The result of the study with regard to regard question two mean achievement of students exposed to and taught with Meta cognitive strategies is greater than the mean achievement of students denied the strategies (control group). (65.13>44.33). the finding is in agreement with the finding of Santrock (2004), Pressley, Borkowski and Schneider (1989) and Pollard (2005). They carried out study on the effect of Meta cognitive strategies on students' performances. They noted that student' benefits when they are taught Meta cognitive strategies that help them in gaining meaningful learning and solving problems in class work. Pressley, Borkowski and Schneider (1989) assert that students benefits when their teacher models the appropriate strategy and overtly verbalizes its steps. Then students subsequently practice the strategy guided and supported by the teacher's feedback until the students can use it autonomously.

The result of the study in respect to the hypothesis (Table four) shows that the value of z-cal (7.52) is greater than the value of z-critical (±1.96) at 05 level of significance. This indicates that there is significant difference between the mean achievement of students in experimental and control groups in BSAT; hence the null hypothesis was rejected for the alternative hypothesis. The finding supports the assertion made by Okebukola (2002) that the task of the teacher is to help the learners learn powerful learning approaches like Meta cognitive strategies that can empower the learner to take charge of his or her own learning in a highly meaningful fashion. Kuhn (1999a, 1999b) reported that Meta cognitive strategy is a proven stronger focus of effort to help students become better critical thinkers especially at Junior and senior secondary school.

Santrock (2004) reported serious progress in students' knowledge of meta- cognition in solving problems and enhancing performance in achievement test. He advised that teachers should model effective strategies since many students are not aware of meta-cognitive strategies. The findings of this study also support the findings of the following researchers, Ashman (1997), Wool folk (1990). They suggest that direct explanation of the meta-cognitive strategies should be given to students stating the what, how, when and where to be used.

Conclusion

The study investigated the effective meta-cognitive strategies that can be infused into the teaching and learning of Basic science and also the effect of Meta Cognitive Instructional Strategy (MCIS) on the achievement of students in Basic Science. It was found that meta-cognitive strategies are very good tools in developing students' potential for critical thinking and self-regulation in learning. It was also found that with meta-cognitive strategy instruction followed by constant practice and teachers' guide, students were able to apply these strategies autonomously in solving problems. They were able to understand and explain the, what, how, when and where to use different strategies. In the post-test, students who were not exposed to the strategy instruction (control group), performed poorer than students in the experimental group in both Basic Science Achievement Test (BSAT) Arid Meta Cognitive Strategy Training Test, (MSTT) however, both group made some gains over the pre-test score.

Recommendations

Based on the findings of this study, the researcher recommends as follows.

- Teachers should be trained through workshops, seminars and conferences on how to infuse and use suitable Meta cognitive strategies as listed in table 1 in teaching Basic Science to enable students develop their potential for thinking and self regulatory abilities in learning.
- Teachers should train students on Meta Cognitive Strategies (MCS) through direct explanation and other techniques like co-operative learning, peer tutoring, concept mapping because they are proven learning strategies.
- Students should be encouraged by parents at home and teachers at school to employ MCS when learning.
- Policy makers and curriculum designers should incorporate the use of MCS in producing curriculum materials because of its effectiveness in enhancing Students achievement.
- Textbook writers of Basic Science and other STM subjects adopt the method of infusing meta-cognitive strategies in writing science textbooks by projecting topics with the appropriate meta-cognitive strategies since it is not enough just to teach students content knowledge without teaching students how to improve their learning and study strategies.
- Examination bodies like WAEC, NECO, and NABTEB etc should take advantage of these findings and adjust their evaluation techniques as to include meta-cognitive questions (MCQ).
- Peer tutors can incorporate meta-cognitive strategies into tutoring session because of its effectiveness in enhancing students' achievement.

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