EFFECTS OF SELF-REGULATED LEARNING AND METACOGNITIVE LEARNING CYCLE ON ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL PHYSICS STUDENTS IN ANAMBRA STATE, NIGERIA

BY

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BEING A Ph.D THESIS PRESENTED TO THE DEPARTMENT OF CURRICULUM AND INTEGRATED SCIENCE DELTA STATE UNIVERSITY, ABRAKA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DOCTOR OF PHILOSOPHY DEGREE IN SCIENCE EDUCATION

SUPERVISORS: PROF. E.A. INOMIESA
DR. O.P. AJAJA

DATE: JUNE 2015

DECLARATION

I hereby declare that the original work as submitted in this thesis is mine, except as specified in the acknowledgement and references, and that neither the thesis nor the original work contained therein has been submitted to this university or any other institution for the award of a degree

Achufusi, Ngozi Nonye ……..

……

Signature Date

CERTIFICATION

We certify that the Ph.D thesis titled "Effects of Self-regulated Learning and Metacognitive Learning Cycle on Academic Achievement of Secondary School Physics Students in Anambra State, Nigeria", was carried out by Achufusi Ngozi Nonye in the Department of Curriculum and Integrated Science and submitted to the Faculty of Education in Partial Fulfillment of the Requirements for the Award of the Doctor of Philosophy Degree in Science Education.

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Prof. Emperor Kpangban Date……..
Head of Department

Prof.E.P. Oghuvbu
(Dean of Faculty)

DEDICATION

This thesis is dedicated to my children Gerald, Charles and Gloria

ACKNOWLEDGEMENTS

Many people contributed in different ways towards the success of this work and I hereby express my profound gratitude to all of them.

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Abstract

This study was designed to determine the effects of self regulated and metacognitive learning cycle on the academic achievement of secondary school physics students. Five research questions were raised and five hypotheses tested at 0.05 level of significance. The population was all physics students in Anambra State from where a sample of 325 students were drawn with purposive sampling techniques. The design was a quasi – experimental design (two treatment groups and control group) and the instrument was a physics achievement test administered to 325 students after six weeks of teaching. The data collected were analysed using a 3 way Analysis of variance (ANOVA). The result showed the students exposed to self-regulated learning group performed better than students taught with metacognitive learning cycle and lecture method. This showed that self-regulated group had the highest mean score of 44.5 as against the metagonitive learning group which had a mean of 41.18 and lecture method group with a mean of 33.56. The difference in scores for the groups shows that gender had a significant effect on achievement with male students performing better than female students. School location was a factor as there was significant difference between mean scores of urban and rural schools. It was recommended that self-regulated learning strategy should be adopted as an effective strategy in schools alongside the metacognitive learning cycle.

CHAPTER ONE
INTRODUCTION

Background of the Study

Metacognition involves higher thinking processes. Knowing how one thinks is an important act of improving one's thinking process. This is because one cannot figure out how to get to where one is going to except one knows where one is at a particular time. The act of learning how to learn; developing a thinking process which can be applied to solve problems in any learning situation is actually a major goal in education. The relevance of what is learned in school and how to apply same in the real world has been the main concern of education in general.

In the rapidly changing world, the challenges of teaching are to help students develop skills (e.g. science process skills) that will enable them face the challenges of the society they live in. It is an observed fact that the more one knows how one's thought processes go, the more one will be able to develop the aspects of one's thinking that one is weak in and sharpen those thought processes that one excels in.

The development of thinking process is an act of metacognition. Metacognition actually refers to higher level of thinking. An early definition of metacognition was given by Flavel (1976), who referred to Metacognition as "one's knowledge concerning one's own cognitive processes or anything related to them". By this assertion, he meant that Metacognition involves "the active monitoring and consequent regulation and orchestration of information processing activities". It is a learning activity and is described by Flavel (1976) as one of the critical thinking skills. Pintrich and Wolters (2003) defined metacognition

as the process of organizing information in our minds to help accomplish some desired end. This desired "end" can range from deciding what clothes to put on or finding the solution to a complex mathematics problem. Flavel (1976) stated that metacognition involved the knowledge, control and regulation of our cognition. Basically; it involves being aware of our thought processes and being able to condition or control them to a certain extent.

Baird (1990) used the idea introduced by Flavel to provide the formulation that "metacognition refers to the knowledge, awareness and control of one's own learning. This he explained by stating that the learner can control his learning of concepts when properly guided to do so. This metacognition is an essential skill for learning. It ensures that the learner will be able to construct meaning from information and to accomplish this, the learner must be able to think about his own thought processes and identify the learning strategies that work best for him and consciously manage how he learns.

Metacognition according to Alexander and Jetton (2002) include the ability to ask and answer the following questions:

- What do I know about the subject or topic?
- Do I know what I need to know?
- Do I know where I can go to get some information or acquire knowledge?
- Where are some strategies and tactics that I can use to learn this?
- Did I understand what I just heard, read or saw?
- How will I know if I am learning at an appropriate rate?
- How can I spot an error if I make one?

- How should I reverse my plan if it was not positive? (Alexander & Jetton, 2002)

With metacognition, a learner can easily control his thinking process and the learning of concepts, provided an adequate environment is created for him. This control of thinking process, that is metacognition exposes a learner to be aware of the learning process and empowers him to utilize this process in a new learning situation. However, in this learning situation, the teacher has an instrumental role to play by developing a metacognitive awareness in the students. The teacher can do this by allowing the students to answer some fundamental questions and through the responses of the students will observe the learning behaviour of the students. He can equally create other strategies that will empower the learners and enhance better learning situation.

The creation of metacognitive awareness in a learning situation includes the formulation of metacognitive strategies which guides a learner through the learning process. The guidance of some key questions in a metacognitive model developed by Pintrich and Garcia (1994) are in the form of: what are my motives? and what are my strategies? (How do I propose going about getting there). By carefully answering these questions, the learners will then through the learning process achieve a good understanding of the concepts.

Equally, Alexander and Jetton (2002) stated that in tackling a new task; "a child can demonstrate self assessment by asking himself questions about the learning concept such as:-

- What did I find easy or difficult?
- How do I tackle the concept?

- What do I learn?
- What do I have to do accomplish the task?
- How should the learning task be handle?

In the process of answering these questions one after the other, the learner attains better understanding of the concept and this enhances achievement and success in tests. Apart from enhancing success, it will equally enable the learner to gain problem solving abilities which in turn will enable the learner to adapt to new situations (Alexander and Jetton, 2002). There are many aspects of metacognition. These are metacognition of knowledge or awareness, called metacognitive knowledge, metacognitive regulation (regulation of cognition) and metacognitive experiences.

In this work, metacognition of knowledge and regulation or rather a self-regulated learning was employed. Zimmerman (2000) stated that self regulated learning involves the regulation of the general aspects of academic learning.

Firstly, self-regulation of behaviour, involves the active control of the various resources that students have available to them such as their time, their study environment, and their use of other facilities such as peers and class members to help them.

Secondly, self-regulation of motivation which involves controlling changing motivational beliefs such as self efficiency and goals orientation that students can adapt to the demands of a course. In addition, students can learn how to control their emotion such as anxiety in a way to improve their learning.

Thirdly, self-regulation of cognition which involves the control of various cognition strategies for learning such as the use of deep

process strategies that result in better learning and performance.

The aim is usually to get students focus on self comparison instead of comparing themselves to the action of their peers in any learning situation.

Self-regulated learning is a learning which is guided by metacognition, monitoring, planning and evaluating personal progress against a standard and a motivation to learn (Winnie and Perry, 2006). They further stated that the self regulated learners are cognizant of their strength and weaknesses and have a repertoire of strategies they apply to tackle the day to day challenges of their academic tasks.

This self-regulated learning is a four phase regulated learning as developed by Zimmerman (2000). In the teaching of physics in secondary schools. The students were encouraged to monitor learning of concepts in physics like machines, waves light, heat, electricity, energy etc. It consists of fore thought, control, monitoring and self reflection.

The metacognitive learning cycle is a four phase learning cycle developed by Lisa Blanc borrowing idea from the original learning cycle of Robert Karplus. The idea was based on Piaget's model of learning. The metacognitive learning cycle (Blanc 2000) consists of the following stages:

- Concept exploration
- Concept assessment
- Concept introduction
- Concept application.

At each stage of the four phase learning, students are required to keep a note or journal to reflect on the previous learning exercise. The instruction which is designed to teach

especially science concepts, involve identification, demonstration and application of the concept. The final phase which is application gives the student opportunity to explore the usefulness and application of the concept. During the exploration phase, the teacher presents to the students a problem or tasks, the challenge presented to the students is open ended enough too allow for a variety of strategies needed to provide some direction.

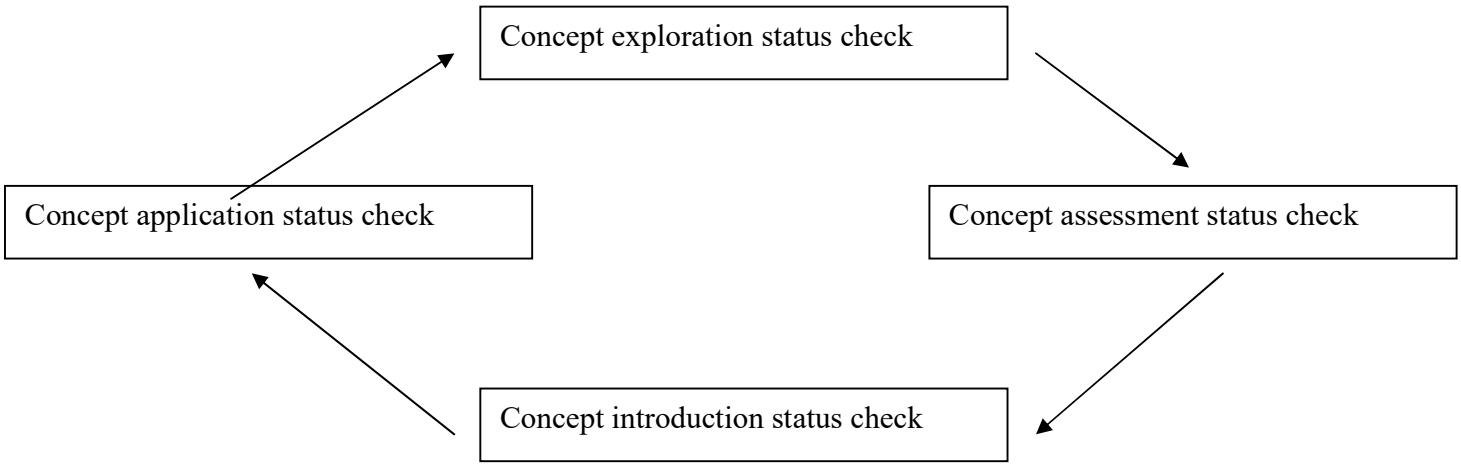
The purpose of this phase is to engage the students in motivating activity that provides basis for the development of a concept. The assessment and introduction phase is to help students assess the concept an derive the concept from the data, students examine their personal knowledge about specific natural phenomenon and teachers assist students in resolving discrepancies in their understanding of concepts. Each student is expected to keep a note where observations are recorded. According to Hennessey (1993), a concept is intelligible if:-

The words make sense to me.

I can give examples.

I can explain the idea to someone in my own words.

Title: Metacognitive Learning Cycle



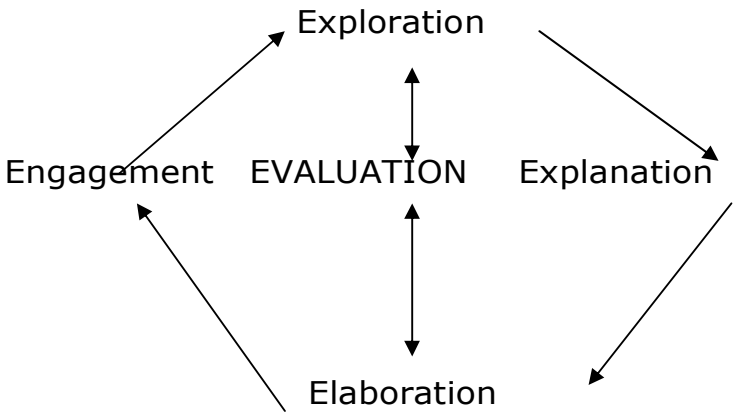
Source: Blanc (2000)

The original learning cycle was an inquiry-oriented science teaching strategy proposed by Robert Karplus in 1959. He was a theoretical physicist and teacher in the field of science education and later a professor of physics in California. This original learning cycle was used as an instructional model which rested on constructivism as its theoretical foundation. Constructivism is a dynamic and interactive model of how human beings learn. This constructivist perspective assumed that students must be actively involved in their learning and that the concepts are not transmitted from teacher to students but rather were constructed mainly by the students. Robert Karplus and his colleagues in the 1960s proposed and used this instructional model based on the works of Piaget. The model was eventually called the learning cycle (Atkin & Karplus, 1962). The learning cycle, apart from resting on constructivism was equally an Inquiry-Oriented science teaching strategy used in research, three decades before the National Science Education Standards (NRC 1996) called for Inquiry as the premier standard for science teaching. Accordingly, they began to teach science to elementary school pupils and later

Myron Atkin, a professor of education developed a Science teaching method called guided discovery (Atkin & Karplus, 1962). This method was influenced by children's mental functioning model of Jean Piaget. The Science Curriculum Improvement Studies (SCIS) was a study method which initially designated three phases exploration, invention and discovery by Karplus and Their (1967). From then, names of phases have been modified and more phases have been added to learning cycle model including the 4.E and 5.E model. An example is the Biological Science Curriculum Study (BSCS). The SCIS trained teachers taught more science, were more open minded, used higher order questions and were more students oriented than the non-SCIS trained teachers.

As an instructional model, the learning cycle provides learning experiences recommended by the National science education standards. Initially this learning cycle has the phases designated as Exploration, Concept introduction and application (Karplus and Their 1967). It follows Bybee's five step models of Engagement, Exploration, Explanation, Elaboration and Evaluation. Here evaluation is not actually the last step because evaluation occurs in all four parts of the learning cycle.

Bybee's Five Step Models



According to Karplus and Their (1967) engagement is the first stage and is the time when the teacher is on center stage. The purpose of engagement is to:

Focus students' attention on the topic, pre-asses the students' prior knowledge and inform them about lesson's objectives. Exploration stage involves students being actively involved in collecting and organizing data in-order to solve the problem.

The evaluation of this stage involves students focusing on collection of data rather than the product of the students' data collection.

Explanation involves students using the data they have collected to solve the problem and report what they did and try to figure out the answer to the problem that was presented.

The Elaboration stage involves the teacher giving new information that extends what the students have been learning in the earlier parts of the learning cycle.

Physics is basically a natural science falling in the same group with biology and chemistry as a science subject. Physics probes into the science of life which is concerned with the motion of objects, energy and matter. Physics has been defined by Anagbogu (1997), as a science of motion, energy and matter. By this definition, it is observed that naturally physics finds application in almost everyday life activities, such as motion of objects, speed and acceleration of objects (living and non living things). Forces and friction as experienced between two surfaces in contact and machines parts are explained in physics as a subject. As a science describing energy, Physics is seen in natural phenomena such as light, heat, sound, water,

winds and tides. Applications of Physics are seen in motors, generators, electricity, magnetism and in most electronic devices and computer gadgets.

Akpan (1999), described physics as science in action. This is because in the field of science and technology, the knowledge of Physics is highly needed. Physics cannot be talked of without bringing in science and technology. Technology is the systematic study of methods and techniques employed in industry, research, agriculture and commerce. It is used to describe the application of scientific discoveries in the provision of machines and the solution of problems which confronts man. Thus it is appropriate to conjecture that any advancement (particularly by way of solving a problem that confront man) occasioned by technology implies a "technological development".

It is worthy of mention, that the first technological development of man was the production of fire through the rubbing of stones (by friction) by the early man and this is explained by basic knowledge of Physics.

There are applications of physics in electronic devices; vehicles; aircrafts; in life activities as in sports, medicine and communication.

Since all these importance of Physics are known, it is quite sad and unfortunate that this subject which is studied as a school subject in senior secondary schools in Nigeria, records low enrollment and poor performance in the West African School Certificate Examinations (WASSCE).

The consequences of this is that students who hoped to study science and science related courses at the tertiary institutions like

pharmacy, medicine, engineering, computer science, medical sciences, health sciences have their hopes dashed by the fact that they failed to pass physics at credit levels in SSCE.

Analysis of WAEC result for the years 2006, 2007 and 2008 showed that compared to all the other sciences, physics recorded a low enrolment and greater percentage failure. (See Appendix A).

Ivowi (1999) while giving reason for the poor enrollment noted that teachers do not take extra pains to explain physics concepts to the students and do not know the level of the students' misconceptions in Physics. A lot of other factors have been identified by researches as being responsible for the low enrollment and achievement in Physics.

In Particular, Akpan (1999), Abudullahi (1998) and Ivowi (1999) identified lack of students interest; lack of mathematical aptitude and misconceptions as major factors militating against students' achievement in Physics. Ivowi (1986, 1999) as cited by Akpan (1999), identified misconceptions in physics and poor instructional strategy as the major factors militating against performance in Physics. Part of the WAEC Chief Examiners report in Physics in 2006, pointed out that the weakness of candidates were poor definition of terms like Ohms law, simple harmonic motion Rotational, oscillatory motion and Snell's law of refraction in Physics. Stating of terms in vague language equally arises due to misconceptions.

The Chief Examiners reports (2007) equally stated that "most candidates could not distinguish between significant figures and decimal places and could not equally define terms appropriately. This meant that students scored low in exams which made their general performances poor as was observed

by the researchers who have examined Physics many years ago. Studies by Ajayi (2002) and Adeyemi (2008) have shown that the extent of poor performance of students in public examinations. Several factors contributed to these such as Teacher factor, inadequate instructional strategy; contributes to the poor achievement in physics.

Teacher factor is one of the factors identified as militating against performance in physics. Some of the teachers are inadequately prepared to teach Science and some are poorly trained Ivowi (1999). Teachers mostly use the lecture method. This method is quite convenient to them as it helps them to cover the syllabus fast. Some students may not under the concept and so resort to rote learning. This leads to poor performance. The argument is that since the lecture method is not so effective, other methods should be tried to see if learning will be improved. Hence the reason for this study to see if metacognition will enhance achievement in learning physics.

The lecture method involves informing students what they are expected to know by using textbook and lecture. Next, the concept is verified to the students Then the students are allowed to answer questions and work problems.

Research works had shown contradictory evidence in students' academic achievement in science due to gender. For instance, Ifeakor (2003) found that there is no statistical significant difference in the achievement of males and females in Chemistry and Biology.

Anaekwe (1997) found that boys are more interested in physics than girls. This trend of differences in male and female achievement in science has shown that teaching method and

other factors apart from sex can influence students' achievement by gender. Anderson (2001) in his own exposition pointed out that few American women are seen in science and science related professions like engineering and technology. This must have stemmed from the fact that the basic sciences are more or less perceived as masculine subjects. According to Okeke (1990) differences in interest and performance observed between boys and girls in physical sciences may be attributed to unequal science experiences and the childhood training of the sexes.

School location as a factor in science is that area in which the school is located which may affect teaching and learning. Okeke (1990) arguing on the causes of differences in academic achievement in schools declared that the difference could be attributed to schools seemed to result more from social environment than from the quality of the school itself. Izuwah (1994) in his work examined the academic performances of rural and urban primary school students in East central state at different levels. He found that urban primary six pupils perform better at distinction and credit levels than rural primary six schools while there were no significant differences between urban and rural schools at the pass level.

Okeke (1990) stated that schools in urban areas particularly schools in the state capitals were better equipped and staffed than the rural schools. The discriminatory attitudes against schools cited in rural areas is not peculiar to Nigeria alone, schools in some advanced countries may not claim to be completely guiltless of this obnoxious act as studies done stated.

Jegede and Oyebanji (1997) opined that meaningful instructional strategy appears to be a solution to gender

differences in science achievement. It is therefore reasonable to determine gender related differences in physics using metacognitive learning cycle.

Therefore, the instructional models of using metacognitive learning cycle and self regulated learning are expected to seek ways to help students' attain meaningful understanding and better performances in physics. Hence, the focus of this study is to examine the extent to which the use of these instructional strategies foster students' learning and academic achievement in physics.

Statement of the Problem

The method of teaching has been a source of interest to educators. Many researchers Ivowi (*1986) and* Akpan (*1999*) have indicated that a lot of factors hinder the learning of physics. Among the factors are: the poor teaching methods, inadequate resources, unavailability of instructional materials and misconceptions in physics among other factors. Although many studies have been conducted to find solution to these problems; it is quite known that the concepts of physics are abstract. The instructional strategies most prevalent in our schools today are teacher dominated. The outcome of this teacher dominated approach is that the learners become passive and often adapt to rote learning and memorization of concepts. This may not promote sound acquisition of knowledge and enhance high achievement of the individual subjects. There is therefore a pressing need to move away from an approach that makes the learner passive to an approach that favours and empowers the learner to take responsibility for learning. It is the belief of the researcher that self regulated learning and

metacognitive learning cycle could be one of the several methods that could help us to achieve this objective. The potentials provided by self-regulated learning and metacognitive learning cycle need to be explored. The problem which this study therefore seeks to solve is:-

Will the application of self regulated learning and metacognitive learning cycle in teaching, considering gender and school location as moderating variables improve the student's achievement in physics?

Research Questions:

The following research questions were raised to guide the study:-

1. Do the mean achievement scores of students taught Physics concepts with metacognitive learning cycle differ from scores of other students taught with the lecture method?
2 Does gender affect achievement of physics students taught with self-regulated learning and metacognitive learning cycle?
3 Does school location affect the achievement of physics students taught with metacognitive learning cycle and self regulated learning?
4 Is there any interaction effect between gender and method of teaching (ie metacognitive learning cycle and self-regulated learning) on physics achievement?
5 Is there any interaction effect between school location and method (i.e. metacognitive learning cycle and self regulated learning) on physics achievement?

Hypotheses:-

The following null hypotheses were formulated for testing at 0.05 level of significance to guide the study:

Ho_1: There is no significant difference in the mean achievement scores of physics students taught with self-regulated learning and metacognitive learning cycle as compared with lecture method.

Ho_2: There is no significant difference between the scores of male and female Physics students taught with metacognitive learning cycle and self regulated learning.

Ho_3: There is no significant difference in the achievement scores of physics students in the urban and rural schools taught with self-regulated learning and metacognitive learning cycle.

Ho_4: There is no interaction effect between gender and method (MLC & SRL) on students' achievement in physics.

Ho_5: There is no interaction effect between method (MLC & SRL) and school location on students' achievement in physics**.**

Purpose of the Study

This study was aimed at determining the effects of self-regulated learning and metacognitive learning cycle on students' achievement in physics. Specifically, it was intended to:-

1. Determine the effects of *self-regulated* learning on achievement in physics.
2. Find out the effects of metacognitive learning cycle on the achievement of physics students.
3. Establish if there was any interaction effect between method and gender on students achievement in physics.
4. Establish if there was any interaction effect between school location and method on physics students achievement.

Significance of the Study:-

The findings of this study will be of immense benefit to the students, the teachers, parents, educators and the society at large.

The students will benefit maximally from the findings in that they are offered opportunity to create their own learning experiences and control their own learning. Students are most actively involved and learn better when they control their learning than being presented with concepts in a passive way. The metacognitive learning model suggests that the learner is allowed to generate a perception of what task is, construct a plan and enact study strategies based on the perception of performance. This shows vividly that the students having undertaken the learning exercise by adapting the model will on their own create a perception of what learning task is all about thereafter, they will construct a plan to guide their learning of concepts.

The teachers will benefit from this study in that the awareness of metacognitive learning model and self regulated learning as instructional strategies are created. Thus entails the teachers will begin to use these strategies having seen the advantages over the lecture method.

The parents stand to gain from the findings of this study. Parents are usually encouraged when their children perform well in exams.

The educators and scholars will benefit from findings of the study in that they are informed of the new strategies which can be developed as a research topic and study guide. This can be utilized in and outside school environment. Metacognition

involves thinking which can be applied to life activities, even in market situations.

The society stands to gain from the findings of this study. The metacognitive learning model in physics emphasize hands on and mind -on activities. To this end, the society stands to gain from the rich resources of metacognition. The model will provide the society with the required and equipped human resources for the attainment for a self-reliant nation as well as a great and dynamic society.

In curriculum development, the findings of this study will be of great importance. This study will inform curriculum developers of the need for metacognitive based curriculum and instruction.

Finally, the study will be of significance to the populace in Nigeria as a whole. This is because metacognitive learning ensures not only the statement of instructional objective but also include making such objectives known to the learner before hand. It can be applied to life situations.

Scope and Delimitation of the Study:-

The scope of this study was limited to the concept of machines and waves which was taught in the senior secondary school (SS2) physics students sampled from all the schools in Anambra State.

Specifically, the types of waves, properties, wave equation, simple machines, levers, complex machines, and calculations on machines were taught the SS2 physics students as contained in the syllabus.

Operational Definition of Terms

Some concepts used in this work are defined as follows:-

Metacognitive learning cycle: Is an inquiry based learning consisting of four phases, concept exploration, concept assessment, concept introduction and concept evaluation.

Self- Regulated Learning (SRL):- Is a way of encouraging pupils to control their learning experiences by subjecting them to a four phase learning model. The phases are forethought, control, monitoring and application. It is a process in which students actively and constructively monitor and control their own motivation, cognition and behaviour towards the successful completion of academic tasks.

Metacognition is thinking about ones own thinking processes. It is a way of controlling one's thinking about concepts, monitoring one's learning and concept. It is all about control and monitoring.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter dealt with the review of related literature. The literature has been reviewed along the following topics:

- Theoretical framework of the study.
- Conceptual frame work.
  - Concept of Metacognition and Self-Regulated Learning.
  - Self-regulated learning strategies.
  - Metacognitive Learning Environment.
  - Strategies for Metacognitive Environment.
  - An overview of teaching and learning of Physics.
- Gender differences in Science.
- Review of Empirical Studies.
- Appraisal of the Review.

Theoretical frame work of the study:

Theories related to this work are the piagets theory, Vygostky theory, Ausubels theory and theory of constructivism. Theoretical Framework of this Study is based on theory of constructivism. Constructivism is a theory of knowledge with roots in psychology and physiology and is used to explain how we know what we know.

Central to constructivism is the conception of learning. Von Glasersfield (1995) stated that from the constructivist perception, learning is not a stimulus-response phenomenon. It requires self regulation and the building of conceptual structures through reflection and abstraction, He further adds that "Rather than behaviours or skills as the goal of instruction, concept development and deep understanding are the main foci". For educators, the challenge is to be able to build a

hypothetical model of the conceptual worlds of students, since their worlds could be very *different* from what is intended by the educator. In this paradigm, learning emphasizes the "process" not the product. How one arrives at a particular answer and not the retrieval of information is what is important.

Learning is a process of constructing meaningful representations of making sense of one's experiential world. In this process, students' errors are to be seen in a positive light and as a means of gaining insight into how they organize their experiential world. In this view of learning, knowledge grows in such a way that learners organize and manage their experiences so that their actions maximize desirable results and minimize undesirable ones.

The learner also evaluates the viability of these conceptual structures, tests and identifies them to greater or lesser extent in order to increase their utility.

Okebukola (1997), listed the features of constructivist Science as: Students autonomy and initiative should be accepted and encouraged by respecting independent thinking, teachers should help students attain their own intellectual identity. Students who frame questions and issues and then go about analyzing and answering them take responsibility for their own learning and become problem solvers.

- The science teacher should ask open -intended questions and allows wait time for responses. The ways science teachers ask questions and the ways students respond will structure the success of the students' inquiry.
- Higher level of thinking is encouraged. The science teacher challenges students to reach beyond the simple factual response. He encourages students to connect and summarize concepts by analyzing, predicting, justifying and

defending their ideas.

- ❖ Students are engaged in dialogue with the teacher and with each other. Social discourse helps students change or reinforce their ideas. Students can build personal knowledge base that they understand. Meaningful classroom dialogue occurs when they express their ideas.
- ❖ Students are engaged in experiences that challenge hypothesis and encourage discussion when allowed to make predictions; students, often generate varying hypotheses about natural phenomena.
- ❖ The class uses raw data primary sources and manipulates physical and interactive materials.

The relationship between this study and the constructive approach is that we should look at the triadic interaction between the person (i.e. beliefs about success); his or her behaviour e.g. engaging in a task and the environment (e.g. feedback from a teacher). Zimmerman (2000) specified three important characteristics of a person's self-learning as: Self observation (monitoring one's activities);

- Self-judgment (Self-evaluation of one's performances) and;
- Self-reactions (reactions to performance outcomes).

The extent one reflects on his or her progress towards a learning goal is the extent to which she has effectively self--regulated. The primary goal of teachers in the· school career is to produce self -regulated learners by using theories on information processing model.

CONCEPT OF METACOGNITION AND SEL-REGULATED LEARNING.

Metacognition according to Flavel (1976) is an active monitoring of one's thinking. Cubukcu (2008), referred to it as the move to greater knowledge, awareness and control of one's learning. Abedi and Neil (1996) refer to metacognition as the student's self awareness of a knowledge base in which information is stored.

Anderson (2002) described metacognition as an act of planning, monitoring, deduction and evaluation of learning. By examining and monitoring their use of learning strategies, students have more chances of success in meeting their goals. Students should be explicitly taught that once they have selected and began to, use the specific strategies, they need to check periodically whether or not those strategies are effective and being used as intended.

Essentially, metacognition refers to "thinking about thinking", being aware of the learning process and utilizing that in new learning. The teacher therefore has an instrumental role to play in developing metacognitive awareness (Peer and Reid, 2001). They further stated that in developing the metacognitive awareness, the teacher will allow students ask themselves these questions:-

- Have I done this before?
- How did I tackle it?
- What did I find easy?
- What was difficult?
- Why did I find it easy or difficult?
- What did I learn?

- What do I have to do to accomplish this task?
- Should I tackle it the same way as before?

Peer and Reid (2001), in a study on metacognition and learning styles stated that metacognition and learning styles can provide the learner with self-knowledge and make the learning process more efficient and effective. The learning styles need to be considered along side the need to develop metacognitive awareness. Learning is a process and applies to literacy as well as to other aspects.

In their model of metacognition, Pintrinch and Wolters (2003) suggests that the learner develops perceptions of task demands, engages in metacognitive monitoring, selects and implements cognitive strategies that are appropriate for the task demands and evaluates task performance while reflecting on the effectiveness of the cognitive strategies. The model suggests an interaction between personal factors and situational factors such as the task and test demands, the coordination of goal setting and metacognition and also the use of cognitive learning strategies and self reflection.

The role of metacognition is very important in learning as metacognition relates to the learner's awareness of thinking and learning. Peer & Reid (2001) descried it as thinking about thinking; and showed in a study that dyslexic children who have poor metacognitive awareness adopt in-appropriate learning behaviours in reading, spelling and writing.

Afflerbach and Pressley (1995) stated that metacognition involved these processes: (a) planning (b) monitoring (c) control and (d) reaction and reflection. Studies conducted on Reading and metacognition demonstrated that successful comprehension does not occur automatically but depends on directed cognitive effort referred

to as metacognitive process. This metacognitive process can be expressed through strategies in a situation such as "procedural, purposeful, effortful, willful, essential and facilitative processes.

Models on metacognitive learning developed by Pintrich and Garcia (1994) were dedicated to resource management. The strategies of the model were concerned with the control of the general conditions associates with learning. These are crucial in terms of metacognitive awareness and knowledge and these questions are:

- ❖ What do I want out of this (what are my motives?)
- ❖ How do I propose going about getting there? (What are my strategies).

Another important metacognitive model set forth by Winnie and Butler (2005) has these basic stages.

- Task definition;
- Goal setting and planning
- Enactment and
- Adaptation.

This model suggests that the learner generates a perception of what the task is and the available resource; he constructs a plan for addressing the task; enacts study strategies, and makes changes to his or her cognitive structure based on perceptions of performance.

Cubucku (2008) developed a model on metacognition named Cognitive Academic Language Learning Approach (CALLA) model of teaching and learning strategy which includes five steps:

(i). Preparation**: -** The purpose of this phase is to help students identify the strategies they are already using and to develop their metacognitive awareness of the relationship between their own mental processes and effective learning. The teacher explains the importance of metacognitive learning strategies.

(ii). Presentation**:** This is related to modeling the learning strategy. The teacher talks about characteristics, usefulness and applications of the strategy through examples.

(iii). Practice**:** In this phase, the students had the opportunity of practicing the learning strategies with an authentic learning task.

(iv). Evaluation**:** The purpose of this is to provide students with opportunities to evaluate their own success in using learning strategies, thus developing their metacognitive awareness of their own learning processes.

(v). Expansion**:** In this final phase, students are encouraged to use the strategies that they found most effective apply these strategies to new contexts and devise their own individual combinations and interpretations of metacognitive learning strategies.

In another model, the Problem Based Learning (PBL) developed by Afflabach Pressley (1998) the metacognitive functions in a learning process were listed as follows:- Developing perception, thinking and problem solving.

CONCEPT OF SELF-REGULATED LEARNING

The term" Self regulated" can be used to describe learning that is guided by metacognition (thinking about one's thinking) (Zimmerman, 2000; Winnie and Perry, 2006). In their opinion the self regulated learners are cognizant of their academic strengths and weakness and have a repertoire of strategies they apply to tackle the day to day challenges of their academic tasks.

Winnie and Perry (2006) opined that students who are self regulated learners believe that opportunities exist to take challenging

task, practices their learning, develop a deep understanding of subject matter and exert effort that will give rise to academic success.

In educational psychology literature researches have linked these characteristics to success in and beyond school.

- ❖ Self-regulation from the social cognitive perspective looks at the triadic interaction between the person and the environment. Zimmerman (2002) specified three important characteristics of self regulated learning as,

- ✓ Self-observation (monitoring one's activities)
- ✓ Self judgment (self-evaluation of one's performance)
- ✓ Self reactions (reactions to performance outcomes)

Thus, the extent that one accurately reflects on his or her progress towards a learning goal and appropriately adjusts the actions to maximize performance is self-regulation. For example, the primary goal of teachers is to produce self regulated learners by using such theories as Information Processing Model (IPM) and by storing the information into long term Memory, the learner can retrieve it upon demand and apply it to tasks, thus becoming a self-regulated learner.

The self-regulated Learning suggests that student engage in their own learning processes on **metacognition, behavioural** and **motivational** levels, (Zimmerman 2000). Within self regulated learning, students are empowered with a common set of self regulating strategies in which they couple those strategies with a set of individually developed skills they have constructed over the course of their academic careers and personal experiences. Zimmerman 2000), noted that the aim of self-regulated learning is to get students to focus on self comparisons instead of comparing themselves to the actions of their peers in any learning situation. The self-regulated learning is a built-in learning process, whereby students develop goals

and skills as well as apply those skills to given learning situation and internalize his or her own behaviours and acts upon those behaviours and reduce their tendencies for negative behaviours. Winnie and Butler (2005) viewed it as a process in which individual students, actively and constructively monitor and control their own motivation, cognition and behaviour towards the successful completion of academic tasks.

Many researches agree that self- regulated learning is a multidimensional process in which there is a set of four recurring phases, in a general ordered sequence that materialize with the attainment of self regulated skills Zimmerman (2000) Stated:-

Phase I: Forethought

This refers to the planning before hand. Before actual performance can begin, this step needs to be addressed as it facilities a platform for action. Within this stage, the student internalizes a given problem or desired outcome, creates short and long term goals of the learning experience. The students' ask themselves various questions in the preplanning phase, the students knows when to start, where and how to start. The student's ability to set goals and plan strategically is affected by various personal beliefs. Self-reaction, self-observation and self-judgment affect student abilities to both set goals and maintain positive self- efficacy (Zimmerman and Shunck 2000).

Phase 2, Performance Control

It refers to performance control within learners (Shunk and Zimmerman 2000). Within the performance phase, students focus their attention and take account of distractions in their learning environment,

Phase 3: Self-monitoring, which updates the learners about their progression in concluding a problem or performing a tasks. (Shunck and Zimmerman 2000).

Phase 4**:** Self Reflection

Within the self-reflectjon phase, students reflect and evaluate their reactions to performance goals compared to the outcomes. The students assesses their achievements or failures, adjust their self-efficacy and during this self reflection phase adapt to potential learning (Zimmerman 2000). The students ask themselves if they have accomplished what they planned in the forethought phase or coped with distractions and evaluate work environments.

In order for students to develop excellent self-regulated learning skills, they must thoroughly monitor their own performance, compare their performance to their goals or objectives by reexamining their findings and continuously engage in personal reflective processes (Schunk and Zimmerman, 2000).

Self-Regulated Learning Strategies

This learning integrates strategies and mental processes that learners consciously engage to help themselves learn and achieve healthier grounds academically (Schunk and Zimmerman 2000). These are out-lining, summarizing, highlighting text, rearranging materials, brainstorming and creating mental maps and web mappings. These organizational steps once implemented can make student focus more on overall goals or objectives.

Students can document their progression through note taking, mark recording or the creation of a portfolio. The

students can also use environmental cues in developing self-regulated strategies by retrieving pieces of information from a Library search, the internet interviews, re-reading their textbooks or analyzing previous tests or records.

The teachers application to this should be

•Anticipate students to question about their information strategies and skills.

- Understand that younger students need guidance when outlining their goals.
- Model their desired skills or strategies
- Encourage and support students when their SRL strategies have been misused.
- Breakdown task into individual mechanism
- Provide positive and negative corrective feedback to students at each step.
- Maintain authentic assessments within student performance

Concepts of Thinking

Thinking consists of a number of processes or mental acts, which are behind any intelligent speech or action. An intelligent person thinks before he speaks or acts, thus the concept of thinking is a unique quality of a rational being. The rational power of an individual involves the processes of recalling and imagining; classifying and generalizing; comparing and evaluating, analyzing and synthesizing; deducing and inferring (Lawson 2004).

These processes enables one to apply logic and evidence to his ideas, attitudes and actions and to pursue better whatever goals he may have. The development of the ability to think is a common purpose of an educational exercise. The ability to think

is the central purpose to which the school must be oriented if it is to accomplish either its traditional tasks or new tasks brought about by changes in the world (Lawson 2004).

Thinking ability is conceived by Inhelder and Piaget (1958) as a matter of attaining capabilities of reasoning and logical operations which make up formal operations. This stage of development is attained in the early adolescent years and commonly exhibited between the ages of 14 and 15. The formal operational thinking includes the idea of control of variables like seeking to isolate the influence of a particular variable. Gagne (1990) is of the view that the study of science as it reflects the activities of scientists requires the use of formal operational reasoning. Finke, Ward and Smith (1992) proposed that creative thinking involves two distinct processing stages: the exploratory stage and generative stage. Their model provided useful examples of cognitive properties.

Kamii (1980) believes that thinking cannot be divorced from knowledge and knowledge involves the mind as a whole. On the question of how can knowledge be acquired? and how can one be sure that what he/she thinks she knew was true?

Aspy (1980) generally described the term thinking as one of the many processes in which a person does something internally to answer a problem or to do something with data beyond storing and retrieving the data.

Thinking involves mental ability, which is behind any intelligent speech, action or reasoning. Scientific thinking is not a disembodied set of procedures imposed on those who are bold enough to seek entry into the realm of science. Rather, the advance scientific thinking is that of scientists who think deeply

about concepts.

It involves, observation, inferring, trying to find out, that is experimenting, generalizing on a concept around an individual in the environment. Kuhn (1993) observed that young children are busily engaged in exploring the world around them-finding out how things work and constructing experiments to test their limits.

The scientific thinking does not come naturally but can be describe as an argument since science is a social activity. This is because science is a social activity and is advanced through thought processes that occur between persons and not just within the person involved.

Kuhn (1993) opined that students should engage in the practice of thinking to enhance the quality of scientific thinking. Science is an exploration.

Matteis, Spooner and Yoshida (1996) in their exposition stated that in science education, developing thinking skills implies scientific and reasoning abilities.

The concern to teach thinking skills has been embraced by United State of America (USA); Japan and Soviet Union (USSR). The Japanese educator as observed has pressed a growing concern for developing students thinking skills. In a study by Matteis et al. (1996); they found a moderately strong and almost identical correlation between the reasoning skills as measured by a Group Assessment of Logical Thinking (GALT) test and an integrated process skill as measured by a Test of Integrated Process Skills (TIPS) of both the USA and Japanese students.

Ennis and Sutton (1990) defined thinking ability as the mental ability to deal reasonably with questions about what to

believe for analyzing the decision about what to believe and for identifying the items that should be included in any thinking curriculum.

Several studies Rynearson & Taraman (2008) indicated that learning experiences are explicitly designed to develop reasoning skills and can lead to achieve goal to various degrees. They reported that improved critical thinking skills observed in a science thinking project was transferable to everyday life and that the learning condition necessary to improve critical thinking skills also improved academic achievement.

In the same vein, Odom and Kelly (2001) opined that one approach that provides students with experiences in generating both declarative and procedural knowledge is the "learning cycle". Brown (1998) stated that the inquiry teaching strategies such as the learning cycle and guided discovery etc are used to engage learners in formal operational reposing skills which are significant predictors of science achievement and thinking abilities.

The Science Curriculum Improvement Study (SCIS) learning Cycle and metacognitive learning cycle

This is an instructional strategy, which is an arrangement and format of activities designed to achieve education objectives (Abraham, 1994). An instructional strategy can be thought of as having two components; curriculum materials and instructional methods.

The instruction which is designed to teach science concepts is divided into three phase,

a. Identification of a concept
b. Demonstration of a concept and
c. Application of the concept.

This learning cycle approach according to Abraham (1994) is an inquiry- based instructional strategy which involves giving students experience with the concept to be developed. The final phase gives the students the opportunity to explore the usefulness and application of the concept.

The purpose of this phase is to engage the students in motivating activities that will provide a basis for the development of a specific concept and new vocabulary pertinent to the concept. This phase also provides an excellent opportunity for students to examine their personal knowledge about specific natural phenomena and for teachers to assist students in resolving discrepancies in their understanding of the natural world.

This metacognitive learning cycle is a four-phase approach in which students may be asked to reveal and reflect upon the condition or status of their science ideas. Status refers to the four conditions under which a learner will construct knowledge.

Each student is expected to keep a journal where he/she records his/her ideas and the condition of those ideas. According to Hennessey (1993);

A concept is intelligible:-

The words make sense to me. I can give examples.

I can explain the idea to someone else in my own words.

META COGNITIVE LEARNING ENVIRONMENT

A Metacognitive learning environment is an environment that encourages awareness of thinking.

In the creation of metacognitive environment, metacognitive behaviour is modeled to assist students in becoming aware of their own thinking. The more students are aware of their thinking processes the more they can control such

matters as goal, disposition and attention.

When students are aware of how committed (or uncommitted) they are to reaching goals; of how strong or weak their disposition to persist or how focused their attention to a thinking or writing task, then they can regulate their commitment, disposition and attention.

Studies on characteristics of metacognitive environment are of the view that metacognitive environment include:-

(a) Experiential: MLC offers opportunity to discuss with peers questions and learn from each other. Hence there are the cognitive connections between content knowledge; prior knowledge; personal experience and information to be learnt. According to Yule (2004), when students are forced to memorize the conclusive knowledge without their exploration and experience, learning does not take place. In experiential learning environment, the instructors and learners shift from focusing on teaching to experience and learning.

(b) Creative: Metacognitive learning environment stimulates the students' creativity, liberation and exploration into the creativity depending on the power of students of the outside controlling power. The environment provides a creativity inspiring activity.

According to Chang (2002), the process of stimulating the internal power of students is preparation with a set of problematic issues that arouse curiosity and insight.

(c) Apprenticeship: The environment combines apprenticeship and organized education. Apprenticeship involves teaching students to use different strategies while the teacher withdraws instruction as the students become more proficient but he is

available as a model for the students. Yule (2004) explained that the situation enables the learner to consolidate what he brings to the situation with the knowledge of the community.

To enhance metacognition in the classroom, the following should be observed:

- Identify what students know and what they do not know. Teachers should encourage students to write what they already know about the topic and what they want to learn from the topic.
- Talking about Thinking: Teacher should think aloud so that students should follow by demonstrating thinking. Students can be paired to solve problems. Small groups can be formed to play teachers.
- Keeping a Thinking Journal: A thinking journal is a diary of process in which students reflect upon their thinking; make note of their awareness of ambiguities and inconsistencies and comment on how they have dealt with difficulties.
- Planning and Self-Regulation: Teachers should help students assume responsibilities for planning and regulating their learning, by teaching them to plan the learning activities. A self regulated learner is aware when he knows a fact or when he does not and accepts responsibility for his achievement.
- Debriefing the Thinking Process: The chosen activities should direct the students thinking processes to develop awareness of strategies which can be applied to other learning situations.

The teacher does this by guiding students to review the activity, gather data on thinking processes and feelings and identifying the processes used.

- Self Evaluation: Teachers should help students analyze their individual thought processes. This will help students identify

the learning patterns they fit in. Those learning patterns are story telling, organizers, needing examples to remember.

Guided self evaluation can be introduced through group inferences and checklists or focusing on thinking processes.

Strategies in Creating A Metacognitive Environment/ Behaviour:

In creating a metacognitive environment;

1. The teacher should model their reflective thinking aloud. Teachers are role models. As students observe and hear the teacher think aloud, their learning gets faster.
2. Evaluative questions can be asked such as: What do you notice about how you learnt or mastered the topic or when you understand what you read? What is it that caused the difficulties when you read? What area felt difficult? (Livingston 1997).

To develop a metacognitive behaviour, Livingston, (1997), identifies six strategies namely:-

1. Identifying "what you know" and "what you don't know"
2. Talking about thinking.
3. Keeping a thinking journal.
4. Planning and self -regulation.
5. Concluding the thinking process (Teacher guides students to review activity, gather data and evaluate their success).
6. Self-evaluation.

Metacognitive Learning Strategies

Metacognitive strategies involve "active monitoring and consequent regulation and orchestration of cognitive processes to achieve cognitive goals". This include interpretation of ongoing experience or simply making judgements about what one knows or

does not know to accomplish a task as other features of metacognition.

Chamot & O'Malley (1994) believes that metacognitive strategies are those that allow students to plan, control and evaluate their learning and have the most central role to play in improvement of learning. Anderson (2002) believes that developing metacognitive awareness leads to the development of stronger cognitive skills.

Metacognitive strategies as defined by Chamot and O'Malley (1994) are special thoughts or behaviour that individuals use to comprehend, learn or retain information.

Oxford (2000) defines these strategies as "actions, behaviours, steps or techniques students use; often unconsciously to improve their progress in apprehending, internalizing and using the learning strategies".

These strategies as divided by Chamot & O'Malley into three branches are: Cognitive, metacognitive and socio-affective and each of these includes lots of sub-strategies such as "rehearsal; organization; summarizing; deducing and imagery. The direct strategies are memory; cognitive and compensation while indirect strategies include Metacognitive, affective and social".

Supporting their findings, Oxford (2000) in their own studies found that "strategy training can enhance both the process of language training and the product of changes in student language performance".

Teachers who use strategy training become enthusiastic about their roles as facilitators of classroom learning. Strategy training makes the students to be more oriented and aware of their needs.

In Oxford's (2000) model, two approaches in teaching

learning strategy are identified; the direct and indirect training. The direct training, learning instruction involves informing students about the value and purpose of learning strategies, whereas the indirect or embedded training is guidance in the use of learning strategies that is embedded in task materials but not explicitly defined as a strategy. To have successful learning instructions these requirements are met:

- The strategy training should be based on students' attitudes, beliefs and needs. It should include explanations; handouts and activities, brainstorming and materials for reference and home study.
- The strategy training should be explicit; overt; and relevant and should provide plenty of practice with varied tasks involving authentic materials.
- The strategy training should not be solely tied to the class at hand.
- The strategy training should be somewhat individualized; as different students prefer or need certain strategies for particular tasks.
- The strategy training should provide students with a mechanism to evaluate their own progress and to evaluate the success of the training and the value of the strategies in multiple tasks.

An Overview of Teaching and learning of Physics in Nigeria

Over the years, Physics teaching delivery in Nigerian Secondary Schools has attracted the attention of the populace as a result of the state of students' performance in private and public examinations. Worried by persistent mass failure of

Nigerian students in the Senior Schools Certificate examinations (SSCE), the governor of Anambra State, Mr. Peter Obi provided every school with equipped science laboratory between 2008 - 2010.

In recent years, much attention has been focused on the role of practical work in Science and Technology Education Winnie & Butler (2005). The emphasis is to provide learners with opportunities to develop skills that could be used in investigative process in science to obtain first hand experience of scientific phenomena and relationship.

In another study, Eze (1992), noted that teaching strategies have been known to influence students interest in science.

There is no consensus of views on the contributive factors that affect Nigerian students' interest in science. According to Balogun (1985), Okebukola and Jegede (1986), Nigerian students generally have interest in science. However, Akpan (1991), showed that Nigerian students find science difficult not only because the disciplines seem to be masculine but also the discipline is perceived as understanding and leads to unattractive careers.

It should be noted that science in general and physics in particular offer perspective career opportunities to students and as such, some students have vocational interest in physics and physics -related careers.

A critical review of literature has revealed that there is a fluctuating trend in students' performance in science subjects at secondary level (Akpan, 1999; Ivowi 1986).

These researchers state that the history of students' under

achievement in science subjects on a prominent scale is not new in Nigeria. A review of the performance of students in physics in recent times shows the same fluctuating trend of students' poor performance.

Although, there was increase in enrolment, yet comparatively, the number passing is lower than number failing. Commenting on the students' achievement in physics, the WAEC Chief Examiner Report (2003), noted that candidates concentrated mainly in familiar questions that demanded recall of facts and there were evidences of misconception of concepts. Other areas of weaknesses include:

- Inability to interpret questions correctly
- Poor mathematical skills.
- Poor definition of terms.
- Poor expressions.

The teaching of physics in various institutions still remains a serious problem owing to the nature of the subject. Many enthusiastic learners in physics have great difficulty in grasping definite concepts in physics.

Learning by rote has been recognized as one of the factors opposing science teaching. That is a factor that limits the understanding of science to the facility with which individuals can regurgitate facts (Odihiliabo 1998). Researchers like Nwosu (2000), Agusiobo, (1995) and Bassey (2002) stated that there are inadequate resources for the teaching of science subjects in public secondary schools in Nigeria.

Finance is a crucial prerequisite which enables a programme to sustain itself effectively in meeting the commitment of the organization. This idea was observed by Okebukola (1997), when

he lamented that the delay in the educational system in Nigeria today has been largely associated to inadequate funding. He stated that whereas UNESCO prescribed funding level of 15% of GNP for developing countries such as Nigeria, only between 6.0% and 7.5% GNP was allocated to education during the past few decades.

Consequently, provision of facilities, teachers' preparations, teaching instructions, instructional delivery/research and development had suffered untold damage.

Infrastructural constraint in the teaching and learning of physics are enormous. There are inadequate classroom facilities, textbooks, laboratories and laboratory equipment, inadequate electricity supply; plumbing facilities and no portable water supply.

There is scarcity of adequate trained, skilled and equipped manpower resources in physics. Physics education in Nigeria has been placing emphasis on theoretical aspect to the detriment of practical acquisition which provides technical skills that lead to technological advancement. Akpan (1999) observed that students hate physics because of the teachers' authoritarian style. This in effect implies that traditional method of teaching where students study scientific facts and factual memorization of discrete facts limit effective communication in the teaching of physics. There have been great efforts over the years by science educators to improve science achievement through more effective teaching strategies.

But despite efforts to effectively communicate science by the use of several indigenous teaching methods and sophisticated teaching aids in Nigeria, the tendency is to feel that the end has

not justified all the efforts. This is so because not only are some of the examination results getting worse, but the recipients are not getting scientific in their thought pattern and approach to solving problems (Bello 1990). Since instructional techniques exert significant influence on students' achievement in a given subject area (Anaekwe 1997), it may not be out of place to presume that the conventional teaching methods have not adequately delivered the goods, perhaps, the metacognitive strategy could be of greater assistance in facilitating students' achievement in physics.

Hence, there is a need to evaluate the effects of metacognitive learning cycle instructional model on students' achievement in physics.

Traditional Teaching And Metacogitive Learning Model

The traditional teaching approach is the instructional method whereby teacher communicates their ideas to learners by direct verbal discourse. These include lecture method, discussion method, demonstration method, etc. These are all teacher centered instructional approaches. According to Balogun (1982), many secondary teachers use these methods which encourage rote learning. These methods involve the transmission of knowledge by the teacher to passive students. In effect, students are seen as empty vessels into which knowledge is to be poured.

Researches in science education have shown that the method of teaching is mainly by lecture and copying of lecture notes (Olarenwaju 1986). This is not in consonance with the constructivist perspective in science instruction, since science itself is a human intellectual construct which demands that pupils must be actively engaged in thinking if their understanding is to

be secured. Successful science teaching thus requires that students make sense of what they are being taught and asked to learn. Due to the role dominance of the teachers in the traditional approaches, students do not engage in much critical thinking. Teachers do not also assess students' conceptual understanding nor do they direct teaching towards students' level of knowledge. The cognitive demands of scientific tasks as well as reflective though are reduced to a minimum in traditional science instruction (Roth, 1986). Because the teacher has the sole custodian of knowledge, students are unable to construct meaning from problem statements and therefore do not develop problem solving skills.

According to Weiss (1987), science activities are specified as means for developing students' scientific thinking and understanding. However, traditional instructional approaches fail to structure science activities in such a way as to engage students in meaningful thinking.

The emphasis of traditional approaches on coverage of physics concepts, laws, principles, facts within a specified time does not allow opportunity for a learning environment that will enhance conceptual change.

The metacognitive learning model appears to have the answer to this pertinent question. The metacognitive learning cycle and self -regulated learning model is a generalized programmatic approach derived from Piaget's theory of intellectual development especially the aspects of the theory on mental functioning.

The phases of metacognitive learning cycle and self-regulated learning correspond to Piaget's assimilation;

accommodation and organization. Each phase begins with an activity which allows a student to learn through his own experience. The activity requires the student to recall past experiences and develop new experience where none originally exists. The new experience puts the student in a state of disequilibrium because questions are raised which the student cannot give complete answers to.

Literature has revealed some comparisons between metacognition (self-regulated) learning method and traditional approaches.

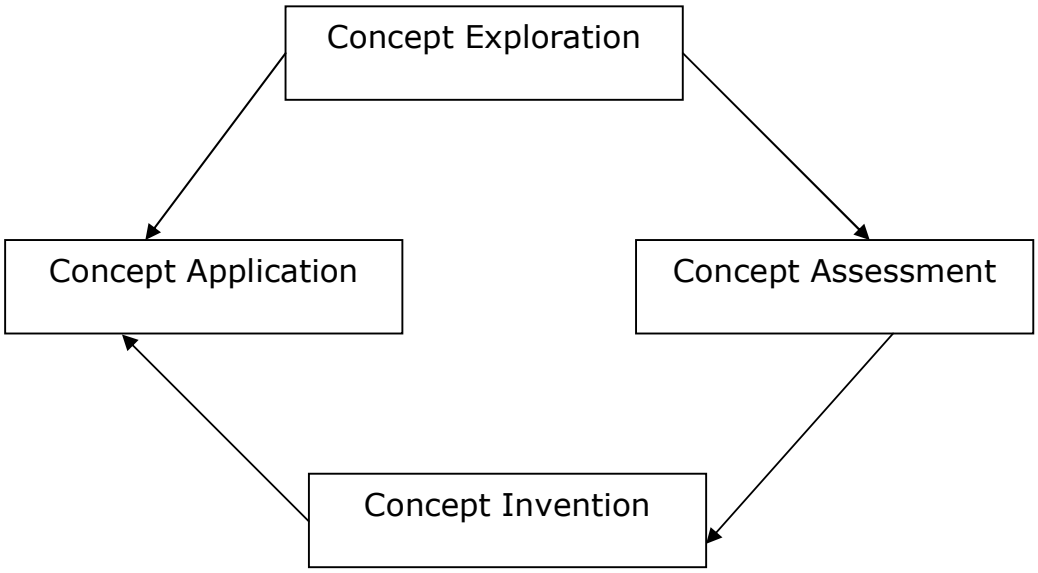
1. The self -regulated learning approach reflects scientific inquiry process more accurately than traditional approaches (Abraham 1997).
2. The self -regulated learning approach emphasis the explanation and investigation of phenomena, use of evidence to back up conclusions and the designing of experiments while traditional approaches emphasis the development of skills and techniques and receiving of information and the knowing of the outcome of the experiment (Abraham ,1997).
3. The self -regulated learning approach and metacognitive learning cycle is superior to traditional approaches in context and achievements for concrete operational students (Pintrich 1994; Winnie and Perry 2006).
4. Therefore the above comparison indicates the need for evaluating the effectiveness of MLC and SRL as one of the metacognition models with reference to the traditional approaches commonly adopted by our teachers in teaching physics in the secondary schools.

Metacognitive Models

(a) The metacognitive learning cycle.

(b) The self -regulated learning.

The MLC is a model developed by Blanc:.(2000) as a four phase based learning model. It consists of concept exploration, concept assessment, concept invention and concept application.



Source: (Blanc, 2000)

At each phase there is a reflection on the status of the student before the next level. Students are encouraged to keep a journal or note to record events at each learning phase and this Improves understanding of concepts.

GENDER DIFFERENCES IN SCIENCE

The association between gender and the response to science education has been widely studied in recent years. There are good grounds for suggesting that there are gender -linked cognitive

differences in terms of cognitive styles learning styles. Balogun (1985), showed that female students show interest in Biology than in Physics and Chemistry. Okeke (1990) pointed out that the differences in interest and performance observed between boys and girls in the physical science may be attributed to unequal science experiences and the childhood training of the sexes.

Extensive researches have revealed significant gender differences in science achievement across many educational systems (Hacker 1991) However there have been conflicting evidences on gender differences in science. Ivowi (1999) found that sex is not significant in the understanding of physics concepts.

Hacker (1991) reported that the differences in performance between boys and girls was not quite clear for physics. At *O*-level, girls did better than boys whereas at Cambridge School Examination (CSE), the reverse was the case.

Anderson (2002) in his own exposition pointed out that few American women are seen in science and science related professions like engineering and technology. In line with the above statement, Gail (1991), asserted that "The practice of physics is associated with the ability to manipulate and control inanimate matter rather than a feminine ability to emphasize, communicate and care. As a consequence, the discipline of physics may come to be embraced by many boys and rejected by many school girls as one of the sciences. Choosing the biological sciences as opposed to the physical sciences thus involves girls on fewer contradictions and they receive more encouragement and support in their choice. Okeke (1990), explained that even

teachers of physical sciences discriminate against females. This discriminating attitude creates a disadvantaged position for the learners during science lessons.

The initial differences in attitude, interest, motivation and learning readiness for science subjects between boys and girls are created very early in the American child. According to Kamii *(*1980*),* this starts in pre-school children stage when boys are provided and encouraged to manipulate certain toys while girls are provided with dolls, cooking and sewing materials. Girls will be over provided and restricted to the home, while boys will be allowed and encouraged to explore the environment, play different games and do hard works. The differential attitudes tend to expose boys more to scientific activities very early in life than girls.

Several studies have been conducted in the area of gender related differences in the academic achievement of students. In the light of this, Obioma (1985), conducted two researches on "The Development and Validation of a Diagnostic Mathematics Achievement Test (DAMAT) for Nigerian Secondary School Students". One of the specific purposes of these studies was to determine the effects of sex factor on the mathematics performance of Junior Secondary School (JS3) students. After administering the DAMAT and analyzing the results, the researcher found out in the two studies that sex is a significant predictor of the students' achievement in Mathematics. Male students achieved higher than female students in mathematics.

In physics, Nworgu (1985), in the development and validation of Physics Achievement Test (PAT); PAT was administered to a sample of SS2 physics students. Findings

showed that male students achieved significantly higher than their female counterparts in Physics.

In further explanation to male students' superiority over their female counterparts, Okeke (1990), attributed this to the following factors:

1) Different socialization patterns for boys and girls at early stages of life.
2) Limited access to education for girls.
3) Lack of support from educational policy makers.
4) Sex differences in the quality of educational experiences of boys and girls.
5) Perceived irrelevances of school science or technology for girls.

Findings from research works had shown contradictory evidences in academic achievement of students due to sex. For instance Ifeakor (2003), Ivowi (1986), Inomiesa (1986), Nworgu (1981), found that there is no statistical significant difference in the performance of males and females.

The studies on gender -related differences in achievement reviewed above do not seem to provide a clear picture on sex differences in achievement in general. Indeed the review conducted indicated an inconclusive and inconsistent trend in the area of male and female students' achievement in the sciences.

In view of the noted inconsistency, there is need to evaluate this issue of gender -related differences using metacognitive learning cycle and self -regulated learning approach to teach secondary school Physics.

REVIEW OF EMPIRICAL STUDIES

Cubukcu (2002), used third year teacher trainees in the English department in Dokuz Eylul University. 130 students (15 males and 115 females) joined the study and 65 students took metacognitive instruction for five weeks. The other 65 students did not take any training at all. One group was randomly assigned as experimental and the other control group. The Homogeneity of the two groups were tested using comprehension achievement test. And value of 0.003 indicated a strong evidence of a difference between control and experimental groups regarding the comprehension tests. The result of the study confirmed that reading comprehension could be developed through systematic instruction in metacognitive strategies training.

In their meta-analysis; Wade, Trathen and Schraw (1990) reviewing reading and metacognition of students on vocabulary and comprehension recruited 67 college volunteers who were mainly selected from the new lexical items taught and given exposure during the course. The experimental group received 45 minutes course for 5 weeks. The test used as assessment tool is pre test and posttest. TOEFL (Test of English as a foreign Language) was used in the pre test and posttest stage of the study. The result showed that mean for experimental group in post test (41.22) was higher than the control group (37.07). This result showed serious implication for learners, teachers and teacher educators in the realm of language learning in particular and education in general and helps teachers in accomplishing their challenging task of teaching. Thus teachers can help learners use different metacognitive strategies to facilitate their learning.

This study provides further evidence of the benefits of

metacognitive strategy training. All the students in both control and treatment groups have gained some metacognitive awareness, which can help them understand what they read.

Systematic explicit instruction about the concept of menacing helped students of the other group to comprehend this approach and apply it to different learning tasks. The post-test results showed that the students in experimental group are better readers and also autonomous and strategic learners. Carrel, (1998), in a study on inquiry and metacognition, reported on a soft ware that was designed by them to teach metacognitive skills to schools physics students via the inquiry cycle as applied to Newtonian physics. This report showed that the 7, 8 and 9^{th} grade students developed skills for scientific inquiry. Findings from study demonstrated a positive learning of inquiry skills of models and testing of same physics model. The study also found significant differences existing between students' grade, gender, level of educational advantage and the use of reflective assessment.

In line with metacognitive conceptualization. Well and Matthews, (2000), in a study on alcohol use and metacognition believes that alcohol is an effective strategy for controlling thoughts, reducing self consciousness and managing emotion.

Rasekh and Rangbary, (2003), on metacognitive Strategy training course for learners investigated the effect of metacognitive strategy training through the use of explicit strategy instruction on the development of *lexical* knowledge of English as Foreign language (EFL) students. Group of EFL language learners at intermediate language proficiency level were randomly assigned to a control and experimental group.

Both groups received instruction on vocabulary learning strategies for 10 wks period, only the experimental group received metacognitive learning course during the semester. The training model used was based on the framework for direct language instruction proposed by Chamot and O'Malley, (1994). The result showed that explicit metacognitive strategy training has a significant positive effect on the vocabulary learning of EFL (English as Foreign Language) students.

The research has been descriptive with the aim of eliciting the useful strategies applied by successful learners and result showed that it helps learners become more successful.

Chamot and O'Malley (1994), and Oxford (1990) in another study found that the use of learning strategies in classroom instruction is fundamental to successful learning. Supporting these findings in their studies of six cases, found that metacognitive strategy training could enhance both the process of language learning (the strategies or behaviours learners use and the affective element involved) and the product of language learning (changes in students performance). They also claimed that the training has some positive effect on the teachers.

Teachers also begin to scrutinize how their teaching techniques related (or fail to relate) to their students learning strategies sometimes teachers chose to alter their instructional Patters as a result of such scrutiny. (Oxford ,1990) Anderson and Nashon, (2006), in a study on the predators of knowledge construction investigated how year 11 and 12 physics students' metacognition influenced the development of their conceptual understandings of kinematics. An *interpretive* case study approach was used to investigate students working in

collaborative groups in the context of an amusement park physics program. The metacognitive character of individual learners was demonstrated to have a strong influence on their conceptual development. An organized *school visits* to informal context are important learning opportunities where students are encouraged to manage and direct their own learning. Rynearson and Taraban, (2008), on how to enhance reading comprehension through metacognition supports the view that college select and used reading strategies that are oriented towards success in academic tasks. Wade Trathen and Schraw, (1990) recruited 67 College Volunteers who read a 1S-page passage at the 11^{th} grade level followed by a recall teat. At eight separate points during reading, participants were asked to provide· a retrospective report of their reading strategies.

The findings showed that reading strategies of participants taught with metacognitive strategies were better than others. Anderson, (2002), in Brigham Young University during a National Public Radio broadcast in 1999, reported a sixth grader learning an Game activity on stock said "The game makes me think how to think. He stated, it seems that metacognitive strategies, that allow students to plan, control and evaluate their learning *have* the most central role to play in this respect rather than those that merely maximize interaction and input Pintrinch & Garcia, 1994).

Spada and Wells, (2006), investigated the contribution of alcohol and metacognitive beliefs about alcohol use. The structural regression modeling *revealed* that three of the four metacognitive beliefs about alcohol use (positive metacognitive belief about emotional self-relaxation, positive metacognitive

beliefs above cognitive self regulation and negative metacognitive beliefs about uncontrollability) were independent contributors to drinking behaviour and that when controlling such belief only *negative* social performance alcohol expectance explained variance in drinking behaviour. Metacognition thus played important role in predicting drinking behaviour beyond that of alcohol expectancies. From a metacognitive standpoint, positive metacognitive beliefs about alcohol use motivate individuals to engage in alcohol use as a means of regulate internal states.

Barry and Rosalind, (2001), in San Antonio Texas between April-May 2001, studied on the Representation of learning process and domain knowledge. The models and associated representations were displayed alongside the primary representation of the subject. As students' proceeds through the learning, their affective states cycle through a wide section of emotions. Based upon the application of our proposed model, the learner's cognitive emotive state was reflected. The model enabled the system designer to provide alternative intervention strategies for the learner who is labouring under a misconception ranging from a no-nonsense remedial to allowing learner payout their misconceptions. Azevedo, (2005), of university of Maryland studying on Hypermedia as a metacognitive tool for enhancing student learning, showed that learners of all ages have difficulties deploying key cognitive and metacognitive self regulatory skills during learning about complex and challenging topic.

The learning cycle approach however was superior with respect to producing cognitive reasoning ability. It is more difficult to find unambiguous positive results in content achievement using

the learning cycle approach. Carrel (1992) found no difference in content achievement when comparing three instructional strategies including the learning cycle approach. He showed that although students had greater retention of content with the learning cycle approach than they did with traditional instruction, neither group showed mastery of the concept being taught. In a five-week unit Vermont, (1985), found no difference between the learning cycle approach and lecture/ laboratory strategy in the learning of the mole concept and in the altering of misconception related to the mole concept.

In the study by Heron and Ward (1980), learning cycle activities were developed for three experiments in a college chemistry course. All three experiments required abstract reasoning ability of the students. They found that the learning cycle approach was clearly superior to the traditional approach in one of the three experiments but found no difference in the other two.

Champaigne (1993) found that so many college biochemistry students had a greater understanding of experimental design when taught using the learning cycle than students taught using expository methods, while the expository taught students focused more on data analysis.

Many studies were conducted on the effect of metacognitive learning cycle on teaching and learning as experienced by students and teachers.

Blanc (2000), conducted a study using a revised learning cycle model termed the "metacognitve learning cycle". The study emphasized formal opportunities for teachers and students to talk about their science ideas.

One class was taught using the metacognitve learning cycle and the other class controlled. The Results showed that students in the metacognitive learning cycle classroom not only gained a greater content knowledge but equally experienced more permanent restructuring of their ecology understandings.

Pulmones (2001), on learning chemistry in a metacognitive environment, stated that the students exposed to metacognitive learning cycle in chemistry performed excellently in chemistry concepts

Carrel et al (1998), carried a study of thirty-three female first year college students enrolled in a General inorganic chemistry class at St Scholastic college in Manila, Philippines. The class studied and learned identified topics in chemistry through active participation in metacognitive activities for an entire semester. They were asked to document their metacognitive behaviors, (planning; monitoring and evaluation) as they answered various metacognitive activities questions. Their responses to these questions served as one of the data sources in describing metacognition. The participant's perceptions, insight and realization as they engaged in the various metacognitive activities were elicited using a Questionnaire on the various metacognitive Activities (QMA).

Result on Planning, monitoring and Evaluation showed a reliability of 0.55; 0.77 respectively.

The participants were judged from these results as manifesting high metacognitive behaviour as they obtained an index of 3.21-4.00.

In various studies conducted, metacognitive activities were designed to adher to constructivist principles. Students, discussed,

argued, defended and negotiated their answers to the problems. This demonstrated metacognitive behaviour.

Barry and Rosaline (2001) developed metacognitive Instructional Method; called "IMPROVE" which significantly improved student's achievement in mathematics.

Appraisal of the Review

So far, the study was based on the theory of constructivism, this theory was discussed in details and the classroom implication on the students suggested. The meta-cognitive learning strategies and self-regulated learning strategies were discussed and guideline suggested for use by educators. The meta-cognitive learning environment and the strategies for creating such environment were extensively discussed for educators.

The teaching and learning of physics in Nigeria over the years was reviewed. Equally gender differences and school location in learning of physics was reviewed, the views of researchers were discussed.

Empirical studies done by researchers and scholars in meta-cognition, meta-cognitive learning cycle and self regulated learning were reviewed. The gap to be filled by this study is to present the two methods, meta-cognitive learning cycle and self-regulated learning as viable methods to be used for teaching/learning in schools.

CHAPTER THREE

RESEARCH METHOD

In this chapter, the researcher presents and discusses the method and procedure used in carrying out the study. These were broken down into the design, population of the study, sample and sampling technique; instruments; validation and reliability of the instruments, method of data collection and method of data analysis.

DESIGN OF THE STUDY

A pre-test, post-test non-equivalent control group quasi-experimental design was used. The quasi-experimental design is a design in which the subjects are not randomized and not all the variables are effectively controlled and the results gotten are generalized to entire population (Ali 1996).

The pre-test, post-test design involving three groups was used. The students were of mixed ability and were given the same task. The choice of using this design is because the subjects were not completely isolated to groups rather intact classes were assigned to experimental and control groups.

The pre-test was used to determine the initial equivalence of the groups. The variables were achievement of students Gender (Male and Female), School location (Urban and Rural), teaching strategy (Metacognitive learning cycle, Self-Regulated learning and conventional lecture method. The design that 3x2x2 is represented as shown in table 1

TABLE 1

Representation of Research Design

Grouping	Methods	Research condition	Post-test
Experimental Group 1 (MLC)	0_1.	X_1	0_2
Experimental Group 2 (SRL)	0_3.	X_2	0_4
Control Group (Lecture)	0_5.	_____	0_6

0_1 = Physics achievement test for pre-test (Experimental Group 1) Metacognitive learning cycle.

0_3 = Physics achievement test for (Experimental Group 2) Self Regulated Learning Group.

0_2 = Physics achievement test for post-test (Experimental Group 1)

0_4 = Physics achievement test for post-test (Experimental Group 2)

0_5 = Physics pre-achievement for control group.

0_6 = Post-test for control group

X_1 = Instructional strategy based on MLC.

X_2 = Instructional strategy based on SRL.

Population

The population was composed of all the 12, 760 male and 16, 660 female students giving a total population of 29, 420 students in Anambra State as at April 2011.

TABLE 2

Population Spread in the Education Zones

Education zone	No of candidates	Male Physics	Female Physics
Awka zone	7330	3, 125	4, 205
Ogidi zone	3094	1, 474	1, 620
Otuocha zone	1555	650	905
Onitsha zone	12482	5, 356	7, 126
Aguata zone	2534	1, 030	1, 504
Nnewi zone	2425	1, 125	1, 300
		12, 760	16, 660

SOURCE: State Education Commission Awka

Sample and sampling technique

The sample of this research comprised of 325, SS2 students from six (6) secondary schools, selected through a purposive sampling technique. The sample was drawn from six co-education schools, 3 urban and 3 rural schools. The choice of using purposive sampling is that certain criteria guided the researcher in selecting the subjects for the study. These are:

i. A co-educational school in all zones represented.
ii. Urban and rural schools

TABLE 3

A Sample Spread in Schools Chosen from Education Zones.

Name of school	Education zone	Male	Female	Total
Comprehensive secondary school Onitsha	Onitsha	24	30	54
Capital city secondary school Awka	Awka	23	33	56
Comprehensive (union) secondary school Nnewi	Nnewi	27	23	50
Community secondary school Ekwulobia	Aguata	30	23	53
Community high school Ojoto	Ogidi	29	26	55
Community high school Otuocha	Otuocha	36	21	57
		169	156	325

The procedure for the sample consisted of

(A) Selection of schools for sample as

i. Choosing six co-educational schools out of the six education zones in the state

ii. Choosing three urban and three rural schools

(B) Method of sample selection which consists of

i. Selection of education zone

ii. Selection of secondary schools

ii. Assignment of classes as experimental and control groups.

The subjects were not randomly assigned to groups rather than intact classes were randomly assigned to experimental and control groups. Each intact class were assigned to a treatment condition using a balloting technique specifically. It involved using a student to pick from folded papers in a black bag which are written the treatment conditions. (The meta-cognitive learning cycle and self-regulated

learning). The group left after picking MLC and SRL was the control group.

Instrument for Data Collection

The following instruments were used for the study:

1. Physics Achievement Test (PAT) which is adapted by the researcher from WAEC standardized tests.
2. Meta-cognitive learning cycle package (leaflet) specifying the phases with evaluation at each phase.
3. The self-regulated learning package (leaflet) showing each phase to be taken by students.

The physics achievement test (appendix viii) consisted of two sections. Section A contained questions on students bio-data while section B contained 60 multiple choice items drawn from concepts of Machines and waves as well as types of machines and waves. Options A-D were provided for students to choose the correct one.

It comprised of 60-items multiple choice pre-instructional test selected from topics taught. This was administered to the students and their equivalent level compared before treatment. Physics Achievement Post-Test (PAT) was composed of 60 multiple choice items reshuffled as post instructional test after teaching students with the two strategies of meta-cognitive learning cycle and self-regulated learning. This was used to determine the achievement of students at the end of the instruction. Two instructional methods were used in this study i.e. the instructional methods of MLC and SRL for the use of the two experimental groups. The control groups was taught by the class teachers using lecture method.

Validation of Instrument

The Pre Achievement Test, Post Achievement Test were given to five experts in measurement and evaluation, two examiners of physics who

were secondary school teachers with above 15years experience in physics to assess the content and face validity. The were given the title of study, the purpose of study and the research questions to scrutinize in line with the test items and also the table of specification for the achievement tests.

Initially, 100 questions were generated, after validation, 60 items was selected.

Table 4

Table of Specification

Table of content	**Kno 10%**	**Comp 25%**	**App 30%**	**Ana 35%**	**No of items**
Concept of simple machines 1st and 2nd and 3rd class	01	01	02	01	05
Concepts of waves	01	02	04	02	09
Word problems on concepts of machines pulleys, inclined plane ,screw Block and tackle	01	03	03	05	12
Concepts on velocity ratio, efficiency and M.A of machines	02	03	03	03	11
Concepts of light waves sound wave and water wave	03	03	03	02	11
Total	**09**	**15**	**18**	**18**	**60**

Those resource persons vetted the items for clarity of words, appropriateness to the class level and plausibility of distracters. By this, the face, and content validation of PAT was done.

Reliability of Instrument

The reliability of the instruments was established by administering the 60 items questions (PAT) to 30 students from D.M.G.S Onitsha who

were not part of the sampled student. The scores were tabulated and the reliability computed. (See Appendix II on reliability).

Treatment Procedure

Phase I: Teachers treatment

Week one: Twelve trainee teachers were selected from six schools to meet with the researcher six hours in the week. They discussed the three methods of teaching, MLC, SRL and Lecture. They helped the teacher give student's pre-tests. They were familiar with the three lecture methods.

Week Two: The teachers practiced with the methods in front of researcher. They were now most familiar with what they were expected to teach. At end of week two, six teachers were selected by researcher to help with teaching of experiment

Week Three to Seven: The teachers taught the stipulated topics in their various schools as specified in the package of the MLC and SRL. The teachers in control group taught with ordinary lesson plan supplied by the researcher. The teachers of the two experimental groups, MLC and SRL encouraged their students to keep a note and journal and record observations while the teaching and learning phases were going on. The MLC group observed the phases of concept exploration, concept assessment, concept invention, and concept application. The SRL group observed the phases, fore thought, control, planning and application. For the weeks three to seven which is four weeks the topics of machines and waves were treated accordingly with all the learning phases observed.

Week Eight: The teachers helped the researcher to give the students in all groups the post-tests and helped to collect and collate the scores.

Phase II: Students Treatment

Week one: Pre-tests on PAT were given to two experimental and one control groups.

Week Two:- Experimental group I (MLC) undertook the four phases of the learning cycle I with reflection on status of science concepts recorded in provided exercise books.

Experimental group2 (SRl), undertook the four phases of self-regulated learning with observation by the researcher.

The concepts of machines were taught them. The control group, (Lecture) discussed with teacher on the classification of simple machines, complex machines.

Week Three:- Experimental group I (MLC) and group II (SRL) students compared data with help of the teacher, they classified the simple machine i.e. Levers into first, second and third class according to operation they wrote their reflections in their journals and verbalized their ideas.

Controls group (conventional) continued on their normal lesson activities.

Week Four: - Experimental Group I and II: - Assessment phase and monitoring phase (SRL) on concept of machines and waves. They isolated machines and waves into various classes and answered questions the teacher asked and recorded their activities and observations in their exercise books.

Control Group: - Did normal class lessons with class teacher on types of machines and waves.

Week Five to Seven:- Experimental group I and II:- were taught other concepts in waves according to before learning phases of the two groups under the supervision of the researcher, the MLC & SRL plan was followed strictly by students

and teachers.

Control Group: solved problems on the concepts taught.

Week Eight:- All students in two experimental groups and one control group were given post-test at the end of the exercise.

METHOD OF DATA ANALYSIS

The research question and hypotheses were answered using the three way Analysis of Covariance (ANCOVA) and pair-wise multiple comparison.

CONTROL OF EXTRANEOUS. VARIABLES

The following measures were taken to control extraneous variable likely to adversely affect the conduct of the experiment. The six schools used were selected from the six education zones: Aguata, Ogidi, Awka, Otuocha, Orumba and Nnewi zones. Each of the schools was 50km away so there was no form of interaction and contamination.

Equivalence of Test:

The test to be given as pre-test was reshuffled and used as post test six weeks later. This ensured that the pre-test did not affect the post -tests.

Teacher variable Experimental Bias:

The research assistants used had similar qualifications and number of years of experience. They were trained and used by the researcher to avoid experimenter's bias.

Intact classes were used so that the administrative set up of the schools was not be disrupted.

It removed the effect of intervening variable or stabilities of independent variable to the point that their effects have not been unduly influenced by, intervening variables.

It removed bias which results from using intact groups whose

equivalence on certain measures may not have been determined.

CHAPTER FOUR

PRESENTATION OF DATA:-

This chapter dealt with the analysis, Interpretation and presentation of data obtained through the application of the procedure in chapter three.

RESEARCH QUESTION 1:

Do the mean achievement scores of students taught Physics concepts with metacognitive learning cycle and self-regulated learning differ from score of other students taught with the lecture method?

Table 5 Mean PAT Achievement Scores and differences between the Pretest and Post Test of experimental and control group.

Groups	NO of Cases	Pretest mean	Post Test mean	Mean difference	S.D
MLC	108	21.07	41.18	20.11	1.57
LECTURE	108	20.57	33.47	12.90	1.94

Table 5 shows that MLC and Lecture groups with mean scores of 21.7 and 20.57 were slightly equivalent at the Pretest level. After treatment, the Post test mean of the MLC group was increased to 41.18 with mean difference of 20.11 while that of lecture group increased from 20.57 to 33.47 with a mean difference of 12.90. Results, showed that metacognitive learning cycle MLC enhanced achievement better than lecture method.

Research Question 2: Does gender affect achievement of physics students taught with self-regulated learning and metacognitive learning cycle.

Table 6 Mean PAT achievement scores of male and female students taught physics using MLC and SRL.

Groups	Sex	N	Pretest measures	Post Test Measures	Mean Difference	S.D
MLC and SRL	Male	169	22.83	43.285	2.46	6.72
	Female	156	22.3	45.281	23.25	6.33

Table 6 showed that the measures of male and female students of 22.83 and 22.03 are equivalent. After treatment, the mean scores of the male students became 43.285 while that of female students became 45.28.

The mean difference of male was 20.46 while that of female was 23.25. The standard deviation of male was 6.72 and female 6.33 showing male score were much scattered from male. The above result showed that female students taught physics with MLC and SRL performed higher with a mean difference of 23.25 than the male students using same method with a mean difference of 2.46.

Research Question 3: Does school location affect the achievement of physics students taught with MLC and SRL

Table 7 Mean PAT Achievement scores.

Groups	Sex	N	Pretest Mean scores	Post Test Mean scores	Mean difference	S.D
MLC & SRL	Urban	172	20.326	44.866	23.486	4.98
Lecture	Rural	153	20.310	36.975	16.412	5.33

Table 7 showed the mean gain of the urban students was 23.486 while mean gain of rural students was 16.412. This showed that students in urban schools achieved better than the students in the rural school

when taught with selfregulated learning and metacognitive learning cycles.

Hypothesis I: There is no significant difference in the mean achievement scores of physics students taught using self regulated learning and metacognitive learning cycle compared with those of lecture method.

Table 8 Three way ANOVA summary Table of difference in achievements among students taught using SRL and MLC as compared with lecture method.

Source	Sum of squares	DF	Mean Squares	F	Sig.
Corrected model	7225.162	11	656.83	31.28	.000
Intercept	50088.784	1	50088.78	2385.57	.000
Groups	1203.896	2	6010948	28.67	.000
Sex	10.335	1	10.335	.492	.483
Location	795.447	1	795.447	37.885	.000
Error	6571.928	313	20.997		
Corrected total	13797.089	324			

The result $P<0.001$ clearly shows significant difference between the students taught physics with metacongnitive learning cycle and self regulated learning as compared with students taught with lecture method. The F-ratio is 31.283 is greater than F critical of 3.09. Thus since Fcal>Fcritical, the hypothesis I is rejected. Thus there is a significant difference between.

A scheffe test on multiple comparisons between groups in table 9 showed that achievement of students in three groups was highly significant with self regulated learning group achieved better than

other groups with mean difference of 2.825 between self-regulated and metacognitive and mean difference of 10.0185 between self regulated and lecture method.

Table 9 Scheffe Test of Multiple comparisons

i experimental gps	j exp groups	Mean dff (i-j)	Std error	Sig
Self Regulated	Metacognitive	2.851	.6221	.000
	Lecture	10.018	.6236	
Metacognitiv	Self - Regulated	-2.8251	.6221	.000
	Lecture	7.1934	.6221	.000
Lecture	Self Regulated	-10.0185	.6236	.000
	Metacognitive	-7.1934	.6221	.000

Hypothesis 2: There is no significant difference in the achievement scores of male and female students taught with metaconitive learning cycle and self regulated learning.

Table 10 Three way ANOVA comparison of gender and method of teaching

Source	Type III sum of squares	dF	Mean square	F-value	Sign
Sex	10.335	1	10.335	.492	.483
Location	795.447	1	795.447	37.885	.000
Group/Sex	1.245	2	.622	.030	.971
Error	6571.928	313	20.997		
Corrected total	13797.089	324			

Computed P<0.005 Fcritical= 3.09

Table 9 showed that F-ratio of gender compared with teaching method is 0.030 which is smaller than critical value of 3.27. The level of sig is .0971 which is non –significant. Thus the null hypothesis is accepted so there is no significant difference in the achievement of male and female physics students taught with metacognitive learning cycle and self-regulated learning.

Hypothesis 3: There is no significant difference in the achievement scores of physics students in the urban and rural schools.

Table 11 Summary of ANOVA comparison of location with teaching method.

Source	Type III Sum of Squares	Df	Mean Squares	F	Sig.
Groups	1203.896	2	601.948	28.669	.000
Location	795.447	1	795.447	37.885	.00
Group & Location	31.340	2	15.670	.746	.475

Table 10 Showed that f-ratio for location against method is 37.885 and is greater than critical f at 3.27. This showed that fcal>fcritical so hypothesis is rejected so there is a significant difference in the achievement scores of urban rural school dwellers.

The level of significance .000 showed it is significant, thus there is a difference in the achievement of urban and rural students.

Research Question 4: Is there any interaction effect between gender and method on physics achievement.

Hypothesis 4: There is no significant interaction effect between gender and method on students' achievement in physics.

Table 12 Summary of ANOVA analysis on METHOD, GENDER & LOCATION.

Source	Type III Sum of squares	Df	Mean square	F	Sig.
Corrected model	7225.162	11	656.833	31.283	.000
Intercept	50088.784	1	50088.784	2385.569	.000
Groups	1203.896	2	601.948	28.669	.000
Sex	10.335	1	10.335	.492	.492
Location	795.447	1	795.447	37.885	.000
Group & Sex	1.243	2	.622	.030	.971
Groups*Location	31.340	2	15.670	.746	.476
Sex*Location	11.989	1	11.989	.571	.450
Group* Sex* location	103.560	2	51.780	2.466	.087
Error	6571.928	313	20.997		
Total	126942.000	325			
Corrected Total	13797.089	324			

Table 10 Showed that f-value for group and location of 0.746 is smaller than critical f of 3.09, the hypothesis is rejected. The level of significance at 0.475 showed that there is no significant interaction effect between method and gender.

Research Question 5: Is there any integration effect between location and method on physics achievement.

Hypothesis 5: There is no significant interaction effect between location and method on physics achievement.

Table 11 showed that F value for interaction between Groups, Sex, Location, is 2.466 showing that there is no interaction effect between location and method of teaching.

DISCUSSION OF RESULT

The study mainly dealt with the effects of Selfregulated learning and metacognitive learning cycle on achievement of Secondary School Physics Students.

The study is highly significant especially at this point in time when there are complaints and cries of poor performance of students in Physics and other sciences.

The overall poor performance have blamed on instructional methods of teaching, inadequate laboratory and instructional materials and misconceptions in physics. This has thus led many researchers including this to seek for alternative teaching methods and other means to proffer a solution to this out cry. This study is thus very significant as it has opened and educated further a teaching method in both the Metacognitive learning cycle and Self Regulated Learning.

Major findings of this study are:

i. That the metacognitive learning cycle enhanced achievement of students better than the lecture method.
ii. The students taught with self-regulated learning achieved better than the lecture method group of students.
iii. Self-regulated learning group of students achieved better than metacognitive learning cycle and lecture method group of students,
iv. Gender did not affect achievement of students thought with metacognitive learning cycle and self-regulated learning.
v. School location affected the achievement of students in that students in urban areas achieved better than students in rural areas
vi. There is no interaction effect between method and gender and between method and school location.

These findings implies that Self Regulated Learning was more effective in enhancing learning and achievement in physics better than Metacognitive Learning Cycle and also lectures method. This finding is in agreement with Zimmerman (2000), Carrel (1998) and Azevedo (2005) who in their separate studies regulated the learning of the students and reported a better achievement of those students compared with their counterparts. They found that with SRL, students are empowered with a common set of strategies which they couple with a set of individually developed skill they constructed in course of their academic carrier in order to effectively undertake a learning process. These students develop these skill & goals and apply them to a learning situation (Zimmerman 2000, Winnie and Butler 2005, Schunk and Zimmerman 2000). Apart from self regulated the Metacognitive learning cycle greatly enhanced achievement in physics. Thus while Zimmerman et al gave credence to self-regulated learning as viable teaching model, Afflerbach and Pressley (1995).

Pulmones (2001), Peer and Reid (2001), Cubuku (2008), Anderson (2002) highly credited metacognition as a viable teaching strategy, Blanc (2000) equally showed Metacognitive learning cycle as a teaching method which greatly improved achievement in any subject. It agreed with Alexander and Jetton (2000) who stated that child can demonstrate self assessment by asking himself questions about the learning concept such as. What did I find easy on difficult. How should my task be handled?

In the process of answering these questions, the learner attains better understanding of the concept which enhances achievement.

There was no significant difference in mean achievement score between male and female students taught physics concept using Metacognitive learning cycle and self regulated learning.

This result is in agreement with Ifeakor (2003) who reported in her study that there is no significant difference in achievement of male and female in science subjects. Result agrees with Ivowi (1999) Inomiesa (1986), Nworgu (1981) who found that there is no significant difference in performance of male and female students. This result of no gender effect on achievement may be as a result of the innovative instructional model of Metacognitive learning cycle as recommended by Blanc (2000) borrowing idea from Karplus original learning cycle and equally using the SRL model by Zimmermen and Schunk (2000). Both involved four learning phases.

There is in this study an indication that the level of learning is higher for SRL group than the MLC group and lastly the lecture method.

In this study, there is a clear indication of the role of Metacognition in creating the learners awareness of thinking and learning. The process of metacognition involves (a) Planning (b) Monitoring (c) Control (d) Reflection. In this study, it is clearly indicated that the students in this process of learning through Metacognitive learning cycle and SRL were involved in the process of metacognition. They planned, their learning process, monitored and reflected on the learning that is why they were able to achieve higher scores than the lecture method groups.

Moreover, in their studies Afflerbach and Presssley (1995) stated that metacognition involve expressing students through strategies in learning task such as "procedural" purposeful, essential and facilitative processes. All these make for meaningful learning as students construct their learning as they go through phase.

This importance of self regulated learning is equally specified by Zimmerman (2000) are

- Self observation
- Self judgment
- Self reactions

This is clearly shown with the SRL scoring 44.59 and the post hoc analysis indicated that SRL performed better than other groups.

Another finding of this study indicated a significant difference between urban and rural school students. The post hoc analysis to indicate the direction of significance showed that urban students performed bettered than rural students.

This finding agrees with Izuwah (1994) who in his study reported that urban primary six pupils performed better at distinction and credit level than rural primary six. Also it is in line with Okeke (1990) who stated that schools n urban areas especially in state capitals are better equipped and staffed than the rural schools.

Equally in this, it was found that there was no interaction effect between gender and method of instruction. The male and female students taught with the two treatments performed at same rate. There was no significant interaction effect between school location methods on the achievement in physics.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter summarized the research study, drew conclusion based on the findings of the study and made appropriate recommendations to improve the teaching and learning of physics concepts in the Secondary Schools.

Summary of Research:-

The purpose of the study was to find out the effect of Metacognitive learning cycle and self-regulated learning on the achievement of physics students.

Specifically the study:-

- Compared the relative effectiveness of the two methods of Metacognitive learning cycle and self-regulated learning in teaching physics concepts.
- Found out if gender effected the achievement of physics students taught with the two methods.
- Found out if school location affected the achievement of physics students taught with the two methods (MLC and SRL).
- Found out if there was any interaction effect between gender and method of instruction on achievement in physics.
- Found out if there was any interaction effect between school location and method of instruction on achievement.

The design for the study was the quasi-experimental design which used pretest, post-test and six co-educational school and six intact classes. The study employed a 3x2x2 factorial design. The design consisted of three institutional groups (Metacognitive learning cycle, self regulated learning and lecture methods). These formed the independent variable, Gender (Male x Female) school location (Urban x

Rural) and repeated testing pretest and post test gave the 3x2x2 factorial design.

The population consisted of al the senior secondary school class II physics students from all the 258 secondary school in the six education zones of Anambra State. The sample consisted of 325 students drawn by purposive random sampling from the six co-education. Twelve teachers from the six co-educational school schools were initially trained but later six used to present the materials to the subjects. Later, at the end of training session, the instructors were given copies of the instructional manuals comprising six week instructional units, a comprehensive lesson plan to guide teaching and instructional materials.

The research instrument was a physics Achievement Tests (PAT) consisting of 60 item questions on machines and waves. Face and content validities of the instruments were ascertained. Kuder Richardson 21 formula was used to obtain a reliability co-efficient of 0.82. All the subject were tested before and after the treatment.

The mean and standard derivation score as well as analysis of covariance ANCOVA were used to analyze the data. A pair wise comparison with Scheffe test was computed to indicate the direction of significant cases

Major findings of this study are:

i) That the metacognitive learning cycle enhanced achievement of students better than the lecture method.

ii) The students taught with self-regulated learning achieved better than the lecture method group of students.

iii) Self-regulated learning group of students achieved better than metacognitive learning cycle and lecture methods group of students.

iv) Gender did not affect achievement of students taught with

metacognitive learning cycle and self-regulated learning.

v) School location affected the achievement of students in that students in urban areas achieved better than students in rural areas.

vi) There is no interaction effect between method and gender and between method and school location on physics achievement.

Conclusion

The use of metacognitive learning cycle and SRL as instructional strategies in the schools enhanced learning as shown in the achievement scores of students taught with the two instructional methods.

Gender has no remarkable influence on the achievement of students taught using the metacognitive learning cycle and selfregulated learning. School location has an effect on students' achievement because students in urban schools achievement better than students in the rural schools.

Since science teachers occupy a critical position in the realization of the goals of science education, the refinement of the society, the provision of quality education and the building are goals to be achieved.

Teachers at all levels of education system need to alternate their teaching methods during teaching to enable them achieve the educational goals. This means that secondary school teachers must be properly educated and prepared by their educators in colleges through proper exposure to all the available pedagogical methods in the benchmark.

Finally attendance at workshops and conferences is also important for all practicing physics teachers in all level of education system.

Recommendation

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

1. Physics teachers should incorporate self regulated learning and Metacognitive learning cycle as teaching methods in teaching physics, sciences and other subjects.
2. Teacher training programmes should include metacognition i.e. Metacognitive learning cycle and self regulated learning strategies to enable teachers teach effectively. This will ensure that the physics teachers are adequately trained on the use of these methods.
3. Students should be encouraged to be active participants of their own learning by having their controlled and self-regulated.
4. Science educators and curriculum planners should be aware of these innovative strategies and there is a need to review curriculum content to reflect metacognition.
5. Textbooks for use in school include elements of self-regulated learning and Meta cognitive learning cycle. The phase should be emphasized in texts so that students learning through phases.
6. Seminars and workshops should be organized on Metacognitive learning cycle and self-regulated learning so that such awareness is created.
7. Government should utilize the services of education bodies like STAN and NUT to organize seminar workshops, in-service training to educate teachers on the use of this innovative teaching method.

Contribution to Knowledge

The findings of this study has contributed the following to knowledge:

1) It has moved studies on self-regulated learning and Metacognitive learning cycle a step further as an instructional strategies for teaching for teaching concept in physics.

2) The awareness of using metacognitive learning cycle and self-regulated learning as viable teaching methods has been created.
3) The teachers have been made to use these strategies to improve the learning of their students.
4) The students are now been compelled to use these two methods to control their learning situations.
5) Learning is generally improved through the use of self-regulated learning and metacognitive learning cycle
6) The findings have also added to the volume of literature on Metacognitive cycle and self-regulated learning as instructional strategies.

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APPENDIX A

(Table 1.1)

Table 1.1 STATISTICS OF RESULT.

Subjects	No that sat	Credit 1-6 NO	Pass 7-8 NO	Failure No	%
Biology	5, 113	2896	1237	980	19.1
Chemistry	2,146	1023	598	525	24.4
physics	1,941	860	531	550	27.3
Biology	5,952	3,458	1294	1,200	20.16
Chemistry	2,118	1208	508	402	19.1
physics	1,927	1003	404	520	26.8
Biology	6,455	2789	2000	676	14.7
Chemistry	2,514	1300	737	277	19.0
physics	1,906	1124	397	385	21.9

Source West African Examination council (WAEC) Awka

APPENDIX I

Validity test

Table: table of specification for Taxonomy of machines and waves

Mentals skills

Content	Kno 10%	Comp 25%	App 30%	Ana 35%	No of test
Concept of simple machines 1st, 2nd and 3rd class levers	01	01	2	01	05
Concepts of waves	01	02	04	2	09
Word problems on concepts of machines pulleys, included plane, screw Block and tackle	01	03	03	5	12
Concepts on velocity ratio, efficiency and mechanical of simple machines	02	03	03	03	11
Concepts on frequency, velocity and wavelength of waves	01	03	03	05	12
Concepts on light waves (lenses minors) depth and sound waves, best waves	03	03	03	02	11
TOTAL	**09**	**15**	**18**	**18**	**60**

APPENDIX II

Test on Reliability

TEST	RTT
PAT	**0.819**

Kuder – Richardson Formula 21. An Estimate of Test Reliability.

K-R.21 is determined by

$$r^1 = \frac{kd^2 - \bar{X}(k-\bar{X})}{D^2(k-1)}$$

The reliability is calculated thus, where the standard deviation of scores (S.D.) = 31.49

The mean of Scores $\bar{X}$= 6.76

The number of items (K) = 60

$$r^1 = \frac{(60 \times 3.04) - 46.8(60-46.8)}{(3.04)^2(60-1)}$$

$$r = \frac{435.36}{531} = 0.819$$

$$= 0.82$$

APPENDIX III

Distribution of Schools

Name of school	Education zone	Male	Female
Comprehensive secondary school Onitsha	Onitsha	24	30
Capital City Secondary School Awka	Awka	23	33
Community Secondary School Ojoto	Ogidi	29	24
Community High School Achina	Aguata	30	23
Community Secondary School Otuocha	Otuocha	37	20
Comprehensive (Union) Secondary School Nnewi	Nnewi	27	23
TOTAL		**169**	**156**

APPENDIX IV

TABLE OF RELIABILITY TEST

S/N	Scores Over X 60	$X-\overline{X}$	$(X-\overline{X})^2$
1	40	-6.8	46.24
2	45	-1.8	3.24
3	46	-0.8	0.64
4	45	-1.8	3.24
5	50	43.2	10.24
6	45	-1.8	3.24
7	46	-0.8	0.64
8	50	+3.2	10.24
9	40	-6.8	46.24
10	50	+3.2	10.24
11	45	-1.8	3.24
12	44	-2.8	7.84
13	43	-3.8	14.44
14	42	-4.8	23.04
15	46	-0.8	0.64
16	47	+0.2	0.04
17	44	-2.8	7.84
18	45	-1.8	3.24
19	46	-0.8	0.64

20	47	+0.2	0.04
21	45	-1.8	3.24
22	47	+0.2	0.04
23	46	-0.8	0.64
24	48	+1.2	1.44
25	42	-4.8	23.04
26	50	+3.2	10.24
27	52	+5.2	27.04
28	48	+1.2	1.44
29	46	-0.8	0.64
30	45	-1.8	3.24
TOTAL	1405		276.20

Mean $\overline{X} = \frac{1405}{30} = 46.8$

$S.D = \sqrt{\frac{\sum(X-\overline{X})^2}{N}} = \sqrt{9.20}$

S.D = 3.04

Kuder Richardson r

$$r = \frac{Kd^2 - X(K\overline{X})}{d2\,(k-1)}$$

$$r = \frac{(3.04)(60) - 46.8(60-46.8)}{(3.04)^2(60-1)} \quad r = \frac{435.36}{531} = 0.81$$