**UNIVERSITY OF EDUCATION, WINNEBA**

# THE USE OF CONCEPT MAPPING BY JHS SCIENCE TEACHERS AND ITS EFFECT ON PUPILS' PERFORMANCE IN INTEGRATED SCIENCE

**SAMUEL KWASI BRUKU**

**2015**

**UNIVERSITY OF EDUCATION, WINNEBA**

# THE USE OF CONCEPT MAPPING BY JHS SCIENCE TEACHERS AND ITS EFFECT ON PUPILS' PERFORMANCE IN INTEGRATED SCIENCE

**SAMUEL KWASI BRUKU**

**Thesis in the Department of Science Education, Faculty of Science Education, submitted to the School of Graduate Studies, University of Education, Winneba in partial fulfillment of the requirements for award of the Master of Philosophy (Science) degree.**

**OCTOBER, 2015**

# DECLARATION

STUDENT'S DECLARATION

I, Samuel Kwasi Bruku, declare that this Thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE…………………………………

DATE…………………………………………

SUPERVISORS' DECLARATION

We hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Thesis as laid down by the University of Education, Winneba.

NAME OF PRINCIPAL SUPERVISOR: DR. ERNEST I. D. NGMAN-WARA

SIGNATURE…………………………..

DATE: …………………………………

NAME OF CO-SUPERVISOR: DR. I. K. ANDERSON

SIGNATURE: …………………………

DATE: …………………………………

## ACKNOWLEDGEMENTS

I am very grateful to my Principal supervisor Dr. Ernest I. D. Ngman-Wara and Co-supervisor Dr. I. K. Anderson both of the Science Department of the University of Education, Winneba for their critical attention and scrutiny, valuable suggestions and encouragement which contributed immensely to the successful completion of this research work.

I am also grateful to other lecturers in the Department of Science Education for their suggestions, advice and encouragement. I am highly indebted to all my course mates for their help and constructive criticisms.

I am equally thankful to the twenty-five science teachers and the hundred and two pupils from Adaklu District who were involved in this study for their co-operation.

I am highly grateful to everyone who in one way or the other contributed to the completion of this work. I say God bless you all.

# DEDICATION

This work is dedicated to my mother Madam Mercy Ama Anyomi and my lovely daughter Angela Esenam Bruku.

# TABLE OF CONTENTS

**Content** **Page**

| **Content** | **Page** |
|---|---|

| **Content** | **Page** |
|---|---|

**Content** **Page**

| Content | Page |
| --- | --- |

## LIST OF TABLES

**Table** **Page**

**Table** **Page**

# LIST OF FIGURES

**Figure** **Page**

**Figure** **Page**

## ABSTRACT

The study was to investigate the impact of JHS science teachers' use of concept mapping on the academic performance of JHS pupils. The study was conducted in the Adaklu District of the Volta Region in the Republic of Ghana. The design of the study was pretest-posttest, one group design which employed the mixed method approach. The sample of the study consisted of 25 JHS integrated science teachers and 102 JHS 2 pupils from five mixed public junior high schools. A workshop on concept mapping was organized for the teachers after which the teachers used concept mapping as an instructional approach. Topics involved in the study were Photosynthesis and the Human Circulatory System. Data was collected using questionnaires, lesson observation checklist, science achievement test and interviews. Descriptive and inferential statistics were used to analyse the data. A number of findings emerged from the study: The results of the study showed significant positive effect of the instructional method (concept mapping) on pupils' academic performance in integrated science. The results also indicated a significant positive correlation between pupils' concept map scores and science achievement test scores. Again, the results showed a significant improvement in pupils' participation in integrated science lessons. The results further indicated that both teachers and pupils developed positive attitudes towards concept mapping. It was concluded that concept mapping as an instructional approach had positive impact on pupils' academic performance. The method has therefore been recommended for adoption by all JHS integrated science teachers for teaching and learning of integrated science.

# CHAPTER ONE

# INTRODUCTION

## Overview

This chapter covers the background, statement of the problem, purpose of the study and objectives of the research report. It also includes the significance, research questions, delimitations and the limitations. It ends with definition of terms and the organization of the research report.

## Background to the Study

Science is difficult to teach and to learn because it consists of unfamiliar concepts involving complex relations. The highly conceptual nature of some topics in science makes it particularly difficult for students and the strategies used in the classroom have not sufficiently eased the learning process (Adlaon, 2012).

It has been observed that the use of the traditional methods such as the expository methods which are largely teacher centred do not encourage learners to organize and restructure what has been learnt (Ampiah, & Quartey, 2003). This method encourages students to memorize concepts even in the area of problem solving, analysis and explanation of observed phenomena. This method may be a major contributing factor to the poor performance of students in science. Winther and Volk (1994) expressed the view that, among the several factors that may influence the performance of students, the curriculum and the instructional strategies are those within the control of the decision makers.

As indicated in the 2007 JHS Integrated Science syllabus, there are times when the teacher must show, demonstrate, and explain. However, the major part of a pupil's learning experiences should consist of opportunities to explore various situations in their environment to enable them make their own observations and discoveries and record them. Teachers should help pupils to learn to compare, classify, analyse, look for patterns, spot relationships and come to their own conclusions /deductions. Teachers have to avoid rote learning and drill-oriented methods and rather emphasize participatory teaching and learning during their lessons. Teachers are encouraged to re-order the suggested teaching / learning activities and also add to them where necessary in order to achieve optimum pupil learning.

The desire to improve Science achievements through more effective instructional strategies has led to studies in Concept Mapping Instructional Strategy which places the learner at the centre of the Teaching and Learning situation. The idea of concept mapping has been reported to help learners to make visual connections between concepts and thus enhance learners" understanding of topics in various subjects (Aidman & Egan, 1998; Ajaja, 2011).

Concept mapping is a graphical or pictorial way of organizing and representing specific concepts within a broad category in order to show the relationship of one concept to another. The concepts are arranged in a hierarchical order with the most inclusive and most general concepts at the top of the map while the more specific and less general concepts are arranged below the map. Concept maps have been described as semantic devices for representing a set of concept meanings embedded in a frame work of propositions (Novak & Gowin, 1984). Novak and Gowin saw concept maps as twodimensional hierarchical diagrams that illustrate the interconnections between and among individual concepts.

Concept maps have several components that together represent the learners" knowledge on a specific topic. The fundamental component of every concept map is the concept which is referred to as node. Concepts are defined as perceived regularities in objects or events or a record of events or objects that are designated by a sign or symbol (Novak, 1991). They are generally isolated by circles and connected with lines (linking lines) labelled with linking phrases to describe the relationship between the two terms that are connected. The smallest unit of concept map must contain two concepts and a linking phrase which is then identified as a "proposition". As defined above, concepts and propositions are the building blocks for knowledge in any domain. We can use the analogy that concepts are like the atoms of matter and propositions are like the molecules of matter.

Learners struggling to form or construct good concept maps are themselves engaged in a creative process, and this can be challenging, especially to those who have spent most of their life learning by rote. According to Novak (1998), few students at the secondary or college levels have had any formal instruction in learning how to learn. Concept mapping serves as one of the graphical tools to help learners to organize their cognitive frameworks into more powerful integrated patterns as new methods of observing and recording events usually open up new opportunities for new knowledge creation and this makes concept mapping suited to the study of science in order to change the perception of most learners that science is studied by simply memorizing facts (Dorough & Rye, 1997).

Concept maps are useful tools which could help educators in (re)considering the sequencing of topics (Novak & Gowin, 1984). Fundamental concepts in the upper hierarchies of the concept map support less inclusive concepts lower down and so need to be covered early in the module (Edmondson, 1994; 1995; Clark & James, 2004).

A concept map is also not just a learning tool, but an ideal evaluation tool for educators in measuring the growth of and assessing student‟s learning. Through students‟ constructed concept maps, educators are able to see what students do not understand. It provides an accurate objective way to evaluate areas in which students do not yet grasp concepts fully. Concept maps can provide assistance when preparing examination and coursework questions, since they provide a visual guide as to which concepts are most important and need to be assessed (Simon, 2009). Concept Maps can be used in formative or summative assessment procedures. In formative assessment, learners may be asked to make concept maps at various points in the learning process, and teachers can use these maps both to assess the learners‟ understanding and to modify the curriculum. In summative assessment, it can be used at the end of an instructional unit to determine a learner‟s understanding of that unit, and to assign grades (Wallace & Mintzes, 1990; Markham, & Mintzes,1994; Pearsall, Skipper, & Mintzes,1997; Martin, Mintzes, & Clavijo, 2000).

There is the need for teachers to adopt innovative teaching methods and concept mapping is one of such approaches. Concept mapping lends itself to group work which promotes collaborative meaningful learning. This is in line with the participatory teaching and learning approaches recommended in the integrated science syllabus. For instance, concepts can be presented to pupils in small groups and they will be required to map them to show the relationships that exist between and among the concepts. During the mapping process, pupils will engage in discussions that may involve disagreements and consensus building. This promotes higher forms of thinking and once the pupils are actively involved in the construction or reconstruction of the knowledge, they are able to retain it better and this enhances academic performance. Concept mapping also promotes self-learning. For example, expert constructed full or micro concept maps can be presented to pupils together with a set of leading questions and pupils will be able to learn concepts on their own. Contrary to these, the traditional expository approach limits self-learning and does not lend itself to collaborative learning. It also promotes rote learning which does not enhance retention of knowledge and academic performance.

**Statement of the Problem**

Over the past few years, there have been persistent reports about the poor performance of students in Science at the Basic Education Certificate Examination (BECE) and the West Africa Senior Schools Certificate Examination (WASSCE). The reports of the Chief Examiner of the West Africa Examination Council (WAEC) between 2002 and 2009 indicated that most candidates either failed or obtained very low grades in Science. During this reference period, Social Studies grades were substituted or considered for Integrated Science, for most senior high school (SHS) candidates who applied for admission into the universities and other tertiary educational institutions because most candidates obtained very good grades in other subjects. Some science students even passed their elective science subjects but failed integrated science.

This situation, based on the researcher‟s personal experience as a teacher with students at a number of Senior High Schools can be attributed to alternative conceptions held by some students. These alternative conceptions result in situations where some students can explain a particular concept in elective Chemistry for example, but cannot explain the same concept when asked in Integrated Science. Poor teaching methods adopted by some science teachers can partly be blamed for this situation as researches have indicated that in developing countries such as Ghana, instructional methods exert considerable influence on students‟ achievement and attitude (Schiefele & Csikszentmihalyi, 1995; Cheema & Mirza, 2013).

Wood (2007) reported that the Minister of State in charge of Tertiary Education (Ghana) in 2003, at a conference for the Western, Eastern, Central and Southern African countries on the theme „„Strengthening Mathematics and Science in the Secondary Education”, called on teachers to evolve innovative methods and skills to promote effective teaching of science. The Minister was of the view that poor methods of teaching mathematical and scientific concepts have made them more difficult for most learners and discourages them from pursuing the study of these subjects that the Minister described as cardinal subjects.

The Ghana Education Service recommended that teaching in schools should be child – centred instead of teacher – centred (Curriculum Research and Development Division CRDD, 2012). This is very critical at the Junior high school level because pupils at this level are in their formative years/stages and need to understand some basic concepts well before graduating into senior high school. They also need to develop a positive attitude towards the study of science, as it is expected that scientific experiences in junior high school will cultivate in pupils an interest and love for science that will urge some of them to seek further studies in science as preparation for careers in science.

Some researchers have conducted studies in the area of concept mapping as an instructional strategy and some of the reports have shown that the strategy had positive impact on learners‟ understanding (Ampiah & Quartey, 2003), academic achievements (Anamuah-Mensah, Otuka, & Ngman-Wara, 1996; Bello & Abimbola, 1997) and attitudes towards the study of science (Sizmur & Osborne, 1997; Meteku, 2010; Appaw, 2011).

Junior High School pupils in the Adaklu District of the Volta Region have been performing very poorly in science in the BECE over the years. Based on the Educational Management Information System (EMIS) reports from the District Education Office, the District Director of Education, at a stakeholders‟ forum in the District Assembly Conference Hall in August 2014 noted that the Adaklu Anyigbey District placed last in the Volta Region and placed second to last nationwide in the 2012 BECE performance rating. Also, in the 2013 BECE, the District targeted 61% passes but recorded only 44%. The percentage passes in the District further dropped to 28.9% in the 2014 BECE with the best candidate scoring aggregate thirteen (13) and five out of the twenty-five public junior high schools scored zero per cent (Asiegbor, 2014). Asiegbor (ibid) indicated that Observations made during school inspections showed that most teachers in the District employed mainly the traditional expository approach in their lessons contrary to the learner centred approaches emphasized in the curriculum.

Interactions with some of the integrated science teachers in the District revealed that lack of science equipment in the schools coupled with the teachers‟ inadequate knowledge and skills of improvisation created the situation where the teaching of science is limited to theory lessons while in fact most topics of the subject are better understood through practical lessons. In fact, Eshiet (1987) was of the view that adequate provision and appropriate use of science practical equipment and other instructional materials are important factors in promoting skills acquisition in consonance with the objective of developing manipulative skills in learners. The situation in Adaklu District demands that the teachers are exposed to teaching methods and techniques that can be employed in the classroom to better enhance pupils‟ understanding of what is taught and learned even in the absence of the practical lessons.

Concept mapping is one of such methods that can deal with the situation because it has been reported to facilitate meaningful learning by providing a means for students to draw together the concepts they have learned in a resourceful and integral manner (Dorough & Rye, 1997). The effect of concept mapping approaches in enhancing meaningful learning in science has to be explored further in Ghanaian junior high schools since available literature shows that only few of the studies on concept mapping in Ghana have been done at the junior high school level including the study conducted by Anamuah-Mensah, Otuka and Ngman-Wara (1995) on the topic "Introduction of Concept Mapping in Junior Secondary School Using Energy". It is for this reason that the researcher decided to carry out this study in the Adaklu District to improve JHS science teachers‟ instructional methods through concept mapping, in order to improve JHS pupils‟ performance in integrated science.

**Purpose of the Study**

The primary aim of this research was to investigate the use of concept mapping by JHS science teachers and how it affected the academic performance of JHS pupils in integrated science particularly in the Adaklu District. In addition, the study was expected to help the JHS science teachers and pupils to develop more positive attitudes towards the teaching and learning of integrated science respectively.

**Objectives of the Study**

The objectives that guided the study were to:

1. equip JHS science teachers with the knowledge and skills of concept mapping through a workshop on concept mapping
2. help JHS integrated science teachers and pupils to develop more positive attitudes towards the teaching and learning of integrated science using concept mapping
3. improve pupils' participation in integrated science lessons through the use of concept mapping by the integrated science teachers
4. improve pupils" academic performance in integrated science through the use of concept mapping by JHS integrated science teachers.

**Research Questions**

The study was guided by the following research questions:

1. To what extent will a workshop on concept mapping equip JHS integrated science teachers in Adaklu District with knowledge and skills of concept mapping?
2. What is the attitude of JHS integrated science teachers in Adaklu District towards the teaching of integrated science before and after the workshop on concept mapping?

3. What are the teaching and learning difficulties of JHS integrated science teachers and pupils in Adaklu District?
4. To what extent will the use of concept mapping by JHS integrated science teachers impact on their interest in teaching integrated science?
5. To what extent will the use of concept mapping by JHS integrated science teachers impact on their self-efficacy beliefs about teaching science?
6. To what extent will the use of concept mapping by JHS integrated science teachers impact on the interest of their pupils in the study of integrated science?
7. To what extent will the use of concept mapping by JHS integrated science teachers impact on pupils‟ participation in integrated science lessons?
8. To what extent will the use of concept mapping by JHS integrated science teachers impact on academic performance of their pupils?
9. Is there correlation between pupils‟ concept map scores and their science achievement test scores?

**Hypotheses**

The following null hypotheses were also tested:

1. JHS integrated science teachers in Adaklu District will not show positive attitudes towards the use of concept mapping.

2. The use of concept mapping by JHS integrated science teachers in Adaklu District will not significantly impact on their pupils" participation in integrated science lessons.

3. The use of concept mapping by JHS integrated science teachers in Adaklu District will not significantly impact on the academic performance of their pupils in integrated science.

**Significance of the Study**

It is expected that the knowledge and skills of concept mapping acquired by the JHS integrated science teachers in the Adaklu District through this research study could help the teachers to move away from the use of purely traditional expository approach to a blend of the traditional methods with the concept mapping strategy which is more learner-centred. It is also expected that the use of concept mapping by the teachers will lead to an increase in the levels of pupils" participation in integrated science lessons, result in better understanding of concepts and improve academic performance of pupils in integrated science. Furthermore, the outcome of the study could serve as a source of information to the Science Coordinator and the training officer at the District Education Office for planning and organizing capacity building workshops for teachers in the District.

Again, the result of the study could help to improve the academic performance of pupils in other subjects because the use of concept mapping strategy helps pupils to learn how to learn and this is very critical as it establishes a sound foundation for general academic performance.

## Delimitations

The study was delimited to five out of twenty-five public Junior High Schools in the Adaklu District of the Volta Region. A JHS from each of the educational circuits was selected. The JHS integrated science teachers from the five schools constituted the sample for the study. Also, second year pupils in the selected schools were considered for the study. The study was also delimited to two main topics in the second year JHS integrated science syllabus namely, Photosynthesis and the Circulatory system of humans. The topics were selected based on the fact that answers provided to questions on some aspects of these topics by some candidates at the 2013 BECE revealed that there were alternative conceptions in the minds of some of the candidates and these had to be investigated and addressed. Also, these topics were in the scheme of work of the teachers for the second term of the 2014/2015 academic year which coincided with the data collection stage of this study.

## Limitations

The small sample size used in the study could affect the internal validity of the study and would therefore not allow for generalization of the findings beyond the schools in the District. In addition, the duration of the study and the number of topics considered may not be enough to generate the expected impact on the academic performance of the pupils.

## Definition of Terms

For the purpose of this study, the key terms used are defined within the context of the study as follows;

**Concept mapping:** Concept mapping is a graphical or pictorial way of organizing and representing specific concepts within a broad category in order to show the relationship of one concept to another.

**Expository approach/method**: This refers to the traditional method of teaching in which the teacher mainly gives detailed explanation of concepts and theories to learners and demonstrates, rather than allowing and guiding the learners to construct or reconstruct their own knowledge. The teacher occasionally asks questions and answers students" questions.

**Attitudes towards science:** This refers to teachers" and pupils" behaviour towards science education, including interest in science, perceptions about science as a subject and participation in the teaching and learning of science.

**Science achievement**: This represents the statistical difference in the mean of continuous assessment test scores for first term and the science achievement test scores after treatment.

**Organization of the Research Report**

Chapter two captures the review of literature relevant to the study. This focuses on theoretical framework, psychological foundations of concept maps, epistemological foundations of concept maps, concept mapping and achievements, attitudes towards science, the JHS integrated science syllabus as well as pupils" learning difficulties.

Chapter three describes the methodology used in the study. It spells out the research design, population, sample and sampling techniques, instruments, data collection procedures and data analysis.

Chapter four presents and describes the results and findings of the study with reference to the purpose and objectives of the study. It also deals with the interpretation and discussion of the findings of the research with reference to previous findings as reviewed in chapter two and presented by hypotheses.

Chapter five summarizes the research findings, draws conclusions and offers recommendations that may benefit stakeholders such as policy makers, educational authorities, teachers and pupils. Suggestions are also offered for future research work.

# CHAPTER TWO

## REVIEW OF LITERATURE

### Overview

This chapter of the research presents a comprehensive review of relevant and related literature on the topic under investigation. A theoretical framework for the study is presented. It addresses the psychological and epistemological bases for the use of concept mapping as a teaching approach. The chapter also reports on studies done on concept mapping and its impact on pupils" understanding of science concepts and their academic performance. Again, the chapter reports on studies that looked at the effect of concept mapping on pupils" attitude towards the study of science. It further looks at how concept mapping has been used for remedial teaching.

### Theoretical and Conceptual framework

The history of science teaching has evolved from the transmission of knowledge approach through discovery approach to constructivism where we are now. The transmission approach of teaching and learning which is strongly linked to expository teaching is characterised by teachers standing in front and telling their pupils about scientific ideas (Bennett, 2003). This view implies that pupils" role in the learning process is largely passive rather than active. The limitations experienced with the transmission approach led to the development of other teaching methodologies which are learner-centred including discovery learning and constructivism.

Discovery learning is a form of self-directed learning which emphasizes the presentation of science to pupils in a way that will allow them to conduct their own inquiries into the nature of things (Borich, 2004). Discovery learning sees pupils as having a much more active role in their learning. Constructivist view of learning holds that people construct their own meanings from what they experience, rather than acquiring knowledge from other sources (Bennett, 2003; Trowbridge & Bybee, 1996). Specific examples among constructivist approaches include Concept Mapping, Cooperative Learning and Learning Cycle.

Concept mapping is a pictorial way of organizing specific concepts within a broad category in order to show the relationship of one concept to another. The map depicts a hierarchical relationship in a manner that organizes the broadest information at the top of a tree-like figure and branching off to more specific information; each branch links a more general concept to a more specific concept, (Crandell, Naomi & Soderston, 1996). The hierarchical structure for a particular domain of knowledge also depends on the context in which that knowledge is being applied or considered. Therefore, it is best to construct Concept Maps with reference to some particular question that the map seeks to answer, which is referred to as a focus question.

Concept maps were developed in 1972 in the course of Novak"s research programme at Cornell University where he sought to follow and understand changes in children"s knowledge of Science (Novak & Musonda, 1991). His work was based on the theories of Ausubel (1963), who stressed on the importance of pupils" prior knowledge and the ability to learn new scientific concepts (Ajaja, 2011). According to Ausubel (1963), meaningful learning is defined as the non-arbitrary, substantive fitting of new ideas or verbal propositions into cognitive structure. For meaningful learning to occur, the new idea must have potential meaning and the learner must possess relevant concepts that can anchor new ideas. The learner must also consciously relate the new ideas or verbal propositions to relevant aspects of the current knowledge structure in a conscious manner. Unlike meaningful learning, in rote (or memorized) learning, new concepts are added to the learner's framework in an arbitrary and verbatim way, producing a weak and unstable structure that quickly degenerates. The result of meaningful learning is a change in the way individuals experience the world; a conceptual change.

The process of meaningful learning can be improved by concept mapping. During concept mapping, the learner graphically represents concepts in a hierarchically arranged structure and begins to progressively differentiate among concepts. During the process of integration reconciliation, the learner reorganizes relationships between concepts and does not compartmentalize them (Novak, 1990b). The fundamental idea in Ausubel‟s cognitive psychology is that learning takes place by the assimilation of new concepts and propositions into existing concepts and propositional frameworks held by the learner.

Concept mapping is based on the constructivist model of learning (Nicoll, Francisco & Nakhleh, 2001). Concept mapping has been used widely as a constructivist learning model and it is more widely accepted in Science Education. Constructivists suggest that the learner is not a passive receiver of knowledge, but actively construct meaning in his/her own mind. One of the most important factors that influence this construction of knowledge is what the learner already knows about the topic under instruction and also about other related topics that might impinge upon learning (Taber, 1995). The role of the teacher in this context therefore, is to act as a facilitator; asking questions to seek clarifications, promoting dialogue and discussions among students to reorganize areas of consensus and disagreements. The aim of the students is to make meaning of the new input by relating it to their prior knowledge and by collaborating with others to co-construct shared understandings (Good & Brophy, 2000).

**Psychological Basis of Concept Maps**

According to Macnamara (1982), early human concepts are acquired by children between birth and year three, when they recognize regularities in the world around them and begin to identify language labels or symbols for these regularities. Novak and Canas (2008) believe that this early learning of concepts is basically a discovery learning process, where the individual discerns regularities in events or objects and recognizes these as the same regularities labelled by older persons with words or symbols. After age three, new concepts and propositional learning is heavily mediated by language, and takes place primarily by a reception learning questions and getting clarification of relationships between old concepts and propositions and new concepts and propositions.

A concept map provides a way of representing relations between ideas or words, in the same way that a sentence diagram represents the grammar of a sentence, a roadmap represents the locations of highways and towns, and a circuit diagram represents the workings of an electrical appliance. In other words, concept maps are constructed to represent text structure patterns which serve to help students‟ mental constructs of how texts are organized. By mapping ideas into maps designed to model text structure patterns, teachers help students to visualize relationships and learn patterns. According to

Coll, France and Taylor (2005), the use of analogies and mental models can enhance students‟ understanding of complex and abstract scientific conceptions.

In order to ensure meaningful learning, one area to consider is the complex set of interrelated memory systems. The memory system comprises the short term memory, the working memory and the long term memory. These memory systems show interdependency. The most critical memory systems for incorporating knowledge into long-term memory are the short-term and working memory. Incoming information is organized and processed in the working memory by interaction with knowledge in the long term memory (Crowl, Kaminsky & Podel, 1997). The only limiting factor here is that working memory can process only a relatively small number of psychological units at any one moment (Miller cited in Novak & Canas, 2008). It is noted that retention of information learned by rote still takes place in the long term memory as does information learned meaningfully, the difference is that in rote learning there is little or no integration of new knowledge with existing knowledge resulting in two negative responses. Firstly, knowledge learned by rote tends to be quickly forgotten, unless rehearsed for a longer period. Secondly, the knowledge structure or cognitive structure of the learner is not enhanced or modified to clear up faulty ideas. Thus misconceptions will persist, and knowledge learned has little or no potential for use in further learning and/or problem solving (Novak, 2002). Therefore, to structure large bodies of knowledge requires an orderly sequence of iterations between working memory and long-term memory as new knowledge is being received and processed (Anderson, 1992).

**Epistemological Basis of Concept Map**

It has been argued that new knowledge creation is nothing more than a relatively high level of meaningful learning accomplished by individuals who have a well-organized knowledge structure in the particular area of knowledge, and also a strong emotional commitment to persist in finding new meaning (Novak, 1998). There is an important relationship between the psychology of learning and the growing consensus among philosophers and epistemologists that new knowledge creation is a constructivist process involving both our knowledge and our emotions or the drive to create new meanings and new ways to represent these meanings. Learners struggling to form or construct good concept maps are themselves engaged in a creative process, and this can be challenging, especially to those who have spent most of their life learning by rote. According to Novak (1998), few students at the secondary or college levels have had any formal instruction in learning how to learn. In New Zealand, Bunting, Coll and Campbell (2006) noted that tertiary students in first year introductory Biology class had positive views about concept maps because it promoted their understanding but did not promote rote learning. This became evident because questions which required recall were poorly answered by students.

Concept mapping may be used to facilitate focusing on important information (O'Donnell, Dansereau & Hall, 2002). Activating relevant concepts and connections may trigger or enhance the integration of new information into existing knowledge structures. Furthermore, prior knowledge activation with concept mapping tasks can help learners to identify what they do not know yet. For example, learners may realize that although they know the definitions of two concepts, they might not know whether and how these concepts are related. Concept mapping may lead to a self-regulated planning of further learning activities, such as the generation of questions to be answered later on and an active search for lacking information. This benefit should be especially relevant in less structured learning environments, such as hypertexts, where learners have been found to be particularly vulnerable to disorientation and information overload.

According to Ausubel cited in Adlaon (2012), concept maps have also been used in instruction as advance organizers. Ausubel believes that information /scientific concept is learned more easily if it is organized and sequenced logically. This gives rise to the term advance organizer. Advance organizer concept maps might be constructed by teachers or other experts. The concept map advance organizers can then be used in various ways as part of the classroom experience. He proposes the notion of an advance organizer as a way to help students link their ideas with new material or concepts. Advance organizers are concepts given to students prior to the material actually to be learned to provide a stable cognitive structure directing attention to what is important in the coming material; highlighting relationships among ideas that will be presented; and reminding the students of relevant information already in memory. These organizers are introduced in advance of learning itself, and are also presented at a higher level of abstraction, generality, and inclusiveness. Advance organizers are different from overviews and summaries which simply emphasize key ideas and are presented at the same level of abstraction and generality as the rest of the material. In theory, advance organizers are most effective if they make explicit the relationship among learned concepts that learners already know, thus providing a structure into which the new concepts can be integrated (Ausubel cited in Adlaon, 2012).

Novak and Canas (2008) view concept mapping as an effective tool for evaluating students‟ understanding and argue that text books could include the use of concept maps to summarize students‟ understanding at the end of units or chapters. They believe that there is no hard and fast rule for the educational institutions to use only multiple choice or essay tests for evaluation. National achievement examination bodies like the West African Examination Council (WAEC) could utilize concept mapping as a powerful evaluating tool for assessing students‟ performance; if teachers teach students how to use concept maps and if all students have been given the opportunities to use this tool.

**Concept Mapping and Academic Performance**

Students‟ performance has been a major focus of many studies examining the effect of concept mapping on learning outcomes. A greater proportion of reported studies indicate that teaching methods have differential effect on both attitudes and academic performance (Nowell, Masini, & Quinn, 2001).

In a research to evaluate learning strategies that could improve student‟s exam performance in general psychology, participating students were given the option of generating concept maps over course materials after the second of three exams, and its impact was assessed using the third exam. It was discovered that lower performing students who participated in constructing the concept maps improved their exam performance such that they were indistinguishable from stronger students who did not participate in the concept map construction. It was also noticed that for initially better performing students who participated in the intervention, their participation actually increased the difference between their exam performance and that of lower performing students who did not participate in the map construction (Berry & Chew, 2008**).**

The linear trends for each group indicated that students who did not construct concept maps declined in performance over time; students who constructed only one map showed stable performance; students who constructed two or more maps showed an increase in performance over time. Students who generated more maps also generated more sophisticated maps. Students who generated concept maps tended to be better performing students early in the semester, although the difference was not statistically significant. However, their relative performance on the post intervention exam was substantially greater than the performance of students who did not participate. Both the number of maps constructed and the number of nodes per map appear related to student learning outcomes. It is believed that students who view or make concept maps will have broader knowledge base and therefore be more able to solve problems compared to those students who learn by rote memorization (Lambiotte & Dancereau, 1991). These findings support prior research showing that generating concept maps is an effective learning strategy across many topics, cultures, and grade levels (Nesbit & Adesope, 2006).

Berry and Chew (2008), were however of the view that there is the possibility that the improvement in exam performance was not due to the intervention per se, but the fact that the intervention forced students to spend more time studying the material than they had on previous exams. It is also possible that the students made other changes in their study strategies in addition to the learning intervention that led to the improvement. Replication and confirmation of these findings is clearly called for to address these and other possibilities. On a pragmatic level, however, the results suggest that this intervention holds promise for teachers who want to recommend concrete strategies to struggling students for improving their learning and performance.

In a study conducted by Asan (2007) on 5th grade science students in Turkey, students" concept map scores were correlated with the achievement of students in a multiple choice test. He reported that the correlation was high hence this provided evidence for the content validity of the concept maps scores. To him these results indicated that students were performing quite similar on concept map item and multiple choice items designed to measure similar content. Asan therefore concluded that concept map scores were indicators of students" knowledge of content which had been emphasized during instruction. Even though Asan (2007) recorded a high correlation between concept map scores and achievement in Biology, Appaw (2011) was of the view that the comparison would have been perfect if the achievement test was essay instead of multiple choice items. This is because there is the tendency of guessing with the use of multiple choice items. Also the impact of concept mapping is evident when it is used for meaningful learning where students express ideas through writing.

Zittle (2002) set out to determine the relative effectiveness in producing analogical transfer of studying text, studying a completed Concept Map, or filling in a blank, but structured Concept Map. The study involved three groups: one that studied text; a second that studied Concept Maps; and a third that selected concepts to fill in Concept Maps. The dependent variable was the number of hints required for solving a set of problems. The text and Concept Map groups were nearly identical, requiring 7.3 and 6.2 hints respectively while the group that filled in the Concept Maps required only 3.4 hints.

Literature also has it that, having sixth grading science students create concept maps before working on laboratory activities produced better long-term retention than using the concept map after the completion of the exercise (Ritchie & Volk cited in Meteku, 2010).

This research leads one to believe that by actually performing any activity, one makes important connections between different senses which will lead to more complete understanding of the materials exposed to. Thus the student would have really learned the concept rather than just memorizing it. In addition to this, it has also been determined that concept mapping aids both teacher and students in converting scientific concepts into a framework for arranging textbook content in a manner that is visual and graphical. If this process is incorporated into lesson plan, it will enable students to remember and categorize information.

Our brains have a remarkable capacity for acquiring and retaining visual images of people or photos. For example, in one study, Shepard (1967) presented 612 pictures of common scenes to subjects and later asked, "Which of two similar pictures shown was one of the 612 seen earlier?" After the presentation the subjects were 97% correct in identifying pictures they had seen. Three days later, they were still 92% correct, and three months later they were 58% correct. This and many other studies have shown that humans have a remarkable ability to recall images. This buttresses the fact that since concept mapping gives a pictorial representation of ideas, students can easily capture ideas in a concept than those counterparts who may not employ concept mapping. It will therefore be prudent that various images within a conceptual framework being taught are integrated into concept maps to enhance iconic memory. This integration according to Novak and Canas (2008) would be possible in the use of concept mapping software like CmapTools.

It was found that people pursuing a bachelor‟s degree in nursing in Australia had better knowledge and understanding of the nursing field after incorporating concept mapping into the curriculum to enable them to link concepts in science with concepts in nursing (Wilkes, Cooper, Lewin & Batts, 1999). This demonstrates how concept mapping can be used as an effective learning enhancement tool to promote understanding of students.

Studies related to concept mapping on achievement generally showed positive results except for few studies. A meta-analysis of 19 studies by Horton et al, cited by Bello and Abimbola (1997) showed a general positive effect of concept mapping on students‟ achievement and attitude when used as an instructional tool.

Ampiah and Quartey (2003) conducted a study on concept mapping as a teaching and learning technique with Senior High School science students in Ghana on the topic: Acids, Bases and Salts. The achievement of two groups, each of 30 students and an average age of 16 years were compared after they had been taught using different strategies. The experimental group was involved in the construction of concept maps while expository technique was used for the control group during each lesson. Analysis of the mean and standard deviation of the scores of the two groups in posttest showed that the experimental group performed better than the control group. Further qualitative analysis of the answers of five students with the highest scores from each of the groups revealed that the experimental group performed better in all questions involving understanding, explanation and application.

Anamuah-Mensah, Otuka and Ngman-Wara (1996), in their study in a secondary school in Ghana using concept map reported that, students preferred concept mapping as a teaching approach to the traditional method of teaching. Also the students emphasized that concept maps are precise and comprehensive, making it a good technique for learning. The students made an insightful observation that apart from the method being precise and comprehensive, concept maps present at a glance, the major concepts in a topic and how they relate making the topic whole rather than a set of disintegrated concepts. The students commented that the discussions between teacher and students and among students themselves during concept mapping class promoted friendliness and cooperation among them and above all understanding of the concept. The students also accepted the fact that, concept mapping was good for revision before examination. It was indicated in their report that the discussions among the students "led to personal knowledge of the individuals becoming public knowledge" (Anamuah-Mensah, Otuka & Ngman-Wara, 1996, p. 15).

Bello and Abimbola (1997), also conducted a study among over 400 Nigeria Secondary School students to determine the comparative effects of two forms of concept mapping instructional strategies on students‟ achievement in relation to the topic Evolution. A combination of clinical interview protocol, essay and multiple-choice tests were used to collect data which was analysed using variance and t-test statistical techniques. The results indicated that the two forms of concept mapping instructional strategies improved students‟ performance and reduced students‟ misconceptions and alternative conceptions of the theory of Evolution.

**Pupils' Attitude towards Science**

In this context, pupils‟ attitudes refer to the way pupils behave towards the study of integrated science based on how they perceive the subject. Several factors have been reported to account for the negative attitude of pupils towards science subjects. These factors are related to school and science class environment, the individual and even external factors such as the status and rewards conferred on the science based carriers (Woolnough, 1994).

According to Chieppetta, Waxman and Sethna cited in Kaya, Dogen and Kilic (2005), it is difficult to change pupils" attitudes and perceptions towards integrated science, due to the complex nature of human learning. Also, it is easier to improve pupils" academic achievements in integrated science than attitudes and perceptions towards the subject. In his study with 86 SHS biology students on the topics: nutrition in mammals, plant anatomy and transport in plants, Meteku (2010) noted that concept mapping instructional method helped students to improve both their academic achievements in biology and their attitudes towards the subject. Analysis of results from a post-test on attitude towards biology indicated a statistical significant difference in favour of the experimental group who were taught through the concept mapping method. He explained that, at the end of the treatment, students from the experimental group were much better prepared to pursue biology courses in future contrary to earlier perceptions gathered from the pre-test of questionnaire on attitude towards biology that biology was very difficult to understand and also not interesting. He attributed the change in attitude to the fact that concept mapping helped the students to understand the learning process of developing interrelationships, creating meaningful schemes and constructing knowledge bases. Once they were able to learn in this fashion, knowledge retention and performance were better and these became motivating factors that made them to develop interest in the subject. The studies reviewed clearly showed that concept mapping as an instructional strategy improved both students" attitudes and achievements.

There is the need to conduct this present research to investigate the impact of concept mapping on the academic performance of junior high school pupils especially in rural settings. This is because most of the literature found are on international studies and the few internal studies were also mainly conducted at the senior secondary levels and in urban settings.

**The Junior High School Integrated Science Syllabus**

The JHS integrated science syllabus covers three years of Junior High School education. The organisation of the syllabus is based on scientific themes that pupils can relate to in their everyday experiences, and related also to commonly observed phenomena in nature. The basic aim is to enable pupils to appreciate the links between seemingly different topics and thus allow the eventual integration of scientific ideas. The themes are: Diversity of matter (the Living and Non Living things); Cycles; Systems; Energy and Interactions of matter. These themes provide a broad based understanding of the environment and scientific phenomena and should help build a foundation upon which pupils can rely for further study (CRDD, 2007; 2012).

Although the content of the syllabus is organized into five themes, the units under each theme are not to be viewed as separate blocks of knowledge. In general, there are no clear boundaries between the themes since there are some common topics between the different themes. In particular, it should be noted that Systems, Energy and Interactions are closely related. Another feature of the syllabus is the Spiral Approach. This is characterized by revisiting concepts and skills at different levels with increasing degrees of depth at each stage. The spiral approach has the benefit of matching scientific concepts and skills to pupils‟ cognitive development. It therefore helps pupils to build a gradual mastery of scientific skills.

From the statements above, it can clearly be deduced that concept mapping is one of the best approaches that should be used to teach integrated science topics at the junior high school level in order to achieve the objectives of the integration and spiral approach desired by the syllabus. The general aims of the subject can only be most effectively achieved when teachers create learning situations and provide guided opportunities for pupils to acquire as much knowledge and understanding of science as possible through their own activities (CRDD, 2007; 2012).

Group work is widely used in science teaching, with calls to increase its implementation in the classroom. The possible impact of concept mapping within such strategies has been explored by few authors (Roth & Roychoudhury, 1993; Correia, 2012), with studies concentrating on the quality of the discourse generated between students as a result of collaborative mapping activities.

The foregoing discussions are indicative of the fact that the curriculum planners intended that the approach to integrated science teaching at the junior high school level should be purely learner-centred, activities oriented and must also be through collaborative learning. The collaborative knowledge construction is supported by concept maps because they improve communication among participants. The need for a linking phrase to clearly state conceptual relationships makes concept maps very useful for organizing our own ideas, as well as sharing them with other people.

**Pupils' Learning Difficulties and how they can be remediated through Concept Mapping**

Teaching and learning are two elements that have a complex relationship with none of them functioning in isolation. Therefore, an investigation of learning difficulties will also require a consideration of the teacher and his/her work. It is common knowledge that some people with various levels of education, including those with no professional qualification have been employed as teachers. This suggests that a large number of teachers teaching integrated science at the basic school level are likely not to be professionally trained (Antwi, 1992). What the teacher knows and can teach effectively in the classroom is the most important factor resulting in student achievement. In other words, teacher qualification is tied to student achievement and therefore, teacher capacity becomes critical for school improvement efforts (Greenwald, Hedges, & Laine, 1996). In such situations where the teacher is deficient in the subject matter and pedagogical skills due to inadequate training, it becomes difficult for the pupils to develop interest in the subject and also to make sense of what is being taught. According to Showers (1990), when teacher education focuses on acquisition of theoretical knowledge only, it typically results in little skills and negligible transfer to classroom practice thus limiting successful learning. Also, Shulman (1987) was of the view that pedagogical reasoning is linked to the practical aspect of teaching through teachers‟ comprehension of purposes, subject matter structures and the ability to transform these through stages of preparation, representation, selection and adaptation. This notion of teaching should underpin teacher education pedagogy in the training colleges. One very critical skill required by teachers is questioning skill. The effect of questioning on teaching and learning, either from the perspective of teachers asking questions of students or of students questioning the teacher on the course material cannot be under estimated. Teachers need to learn how to question for critical thinking because questioning is associated with many well-established learning processes such as depth of processing, transfer-appropriate processing and retrieval practice (Karpicke & Roediger, 2007). Kochhar (1985) was of the view that without the adoption of the right methods of teaching, the best of the curriculum and the most perfect syllabus cannot be successfully implemented. He also contended that, there is no single or particular means to successful teaching and therefore teachers should be able to use combination of methods, devices and techniques to make teaching and learning interesting, vital and living.

There are other findings that revealed that, high teacher absenteeism, frequent loss of instructional time and poor management were major problems that hinder effective and efficient delivery of basic science concepts to pupils at the basic level (Fobih, Akyeampong & Koomson, 1999). It has been noticed that teacher absenteeism which leads to loss of instructional time is on the increase especially at the basic schools due to the fact that a lot more teachers are pursuing distance learning programmes to upgrade themselves. These teachers may be absent from school on Fridays and Mondays in order to travel to and from weekend classes. Even sometimes, instructional time is lost because some of the teachers spend their teaching periods working on their lecture assignments. Concept mapping can be employed to reduce the impact of teacher absenteeism on pupils based on the fact that the approach lends itself to self-learning. For instance, teachers can map out concepts they intend to teach and attach lesson objectives and some evaluation items (questions) which can be given to pupils to help them learn the concepts on their own when teachers, for critical reasons cannot be in class with their pupils. This position is also based on the strength of concept mapping to facilitate and even stimulate imaginations of the learner (McAleese, 1999).

Very vital in the teaching and learning process is communication which is heavily dependent on language. Pupils‟ inability to read and write due to low vocabulary or language hinders communication during the teaching and learning process. It has been observed that pupils with low vocabulary have difficulty asking questions for clarification when they have not understood the concepts being presented to them. Even in some cases where they fully understand what is being taught, they are unable to communicate their understanding verbally or in writing to others due to inadequate vocabulary. Concept maps can help address this situation. For example, if a concept map is displayed during a lesson, pupils who have understanding of the concepts taught but have difficulty constructing good sentences in English are more likely to communicate their understanding appropriately by reading the propositions from the map when questions are directed at them. According to Nobahar, Tabrizi and Shaghaghi (2013), there is a relationship between strategy use and confidence in language learning. They noted in their study that students who have had difficulties in writing a foreign language, by succeeding in the application of concept mapping strategy, would be able to improve their self-efficacy and expository writing accuracy.

**Summary**

The review established that concept mapping was developed by Novak in Cornwall University in the 1970s and has its theoretical foundation in Ausubel‟s cognitive theory of meaningful verbal learning and constructivism.

The review has also shown that concept maps are graphical tools for organizing and representing knowledge. Using concept maps helps the individual to present concepts hierarchically from the most inclusive, most general at the top, to the more specific and less inclusive (Novak & Canas 2008). The literature further revealed that concept maps can be used for teaching and learning in the classroom, evaluation, curriculum design and for capturing expert knowledge.

Looking at the effectiveness of concept mapping, the literature provided empirical evidence for differences in Science achievements in favour of concept mapping groups in most cases. Also, there were no statistical differences between the achievements of males and females, indicating that it is a good technique for teaching both sexes in the classroom. It was indicated by students that concept map construction is time consuming. It was confirmed that concept mapping promotes meaningful learning (as against rote learning) as those in the concept mapping group achieved higher in areas of comprehension and application than their convention teaching method counterparts. This study used the concept mapping alone because it is quite effective and innovative but less used in our Ghanaian schools as used extensively in the western countries.

Finally, the literature revealed that the traditional method is teacher centred and it encourages rote learning. However in the SHS and JHS, it is the method frequently used by most science teachers (Wood, 2007). Other studies indicated that students exposed to the traditional method normally perform lower than their counterparts exposed to other teaching methods that are more learner-centred. However, there were some cases in which there were no significant difference between the traditional method and the methods compared with.

# CHAPTER THREE

# METHODOLOGY

## Overview

This chapter describes and explains how the research was conducted. It deals with the research design, population and sampling, instrumentation, data collection and analysis procedures.

## Research Design

The research was a case study which employed the mixed method research design approach to investigate the effect of JHS science teachers" use of concept mapping on the performance of JHS pupils in integrated science. A one group pretest-posttest approach was used to test the hypotheses underlying the study. This design was appropriate for the study because intact groups rather than random groups were used. The use of intact classes was adopted because it minimizes the Hawthorne effect better than when the subjects are drawn randomly from different classes and put into experimental groups. This contributes to the generalizability of the findings (Ary, Jacob & Razavieh, 2002).

This design however has a weakness which is the threat to internal validity due to differential mortality based on the fact that some of the subjects taking part in the pre-test may not be available for the post-test and also some extraneous factors such as age, ability, maturation and previous learning experiences could not be controlled in this study (Trochim, 2000; Baumgartner, Strong & Hensley, 2002). To mitigate the effect of differential mortality, the data collection was done exclusively within one academic term.

Also, the post-test of questionnaires and the science achievement test were administered just before the end of second term examinations week, during which all the pupils and teachers were expected to be in school.

According to Johnson and Onwuegbuzie (2004), mixed methods research is formally defined as the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study. Johnson and Turner (2003) have argued that the fundamental principle of mixed methods research is that multiple kinds of data should be collected with different strategies and methods in ways that reflect complementary strengths and non-overlapping weaknesses, allowing a mixed methods research to provide insights not possible when only qualitative or quantitative data are collected. Consequently, this study which sought to improve performance of JHS pupils in the Adaklu District employed a mixed method design, incorporating both quantitative and qualitative techniques.

**Population**

The accessible population for the study was all public Junior High School (JHS) science teachers in the Adaklu District of the Volta Region, comprising of twenty-one males and four females. Eighteen out of the 25 teachers involved in the study were professionally trained. Also, the population was made of 2 First Degree holders, 2 HND holders, 18 Diploma in Basic Education holders and 3 Teachers‟ Certificate „A‟ holders.

## Sample and Sampling Procedure

Five out of the 25 junior high schools in the District were selected for the study. One school was randomly selected from each of the Waya, Kalakpa, Ablornu, Ahunda and Abuadi educational circuits of the District to have representation of all the educational circuits in the study. A total of 25 JHS science teachers in the District constituted the study sample. The sample was composed of 21 males and 4 females. Of the sample, seventeen representing 68% fell below 30years with none above 50years. Also, 5 of the teachers have taught between 1 and 2 years, 18 have taught between 3 and 5 years while 2 of them have taught between 6 and 10 years. The sample was a blend of professionally trained and untrained teachers with different academic qualifications including Bachelor Degree, Diploma and Higher National Diploma.

## Instruments

Six instruments; two questionnaires, structured lesson observation check list, semi-structured interview, science achievement test and pupils‟ concept maps were sources of data for the study.

## Teachers' Questionnaire

Teachers‟ questionnaire (Appendix A) was divided into two parts. Part I contained seven (7) items used to gather information on the academic and professional background of teachers while Part II containing twenty-nine (29) items, classified under four sub-sections was used to gather information on perceived difficulties of teachers, their knowledge of concept mapping, their attitudes towards concept mapping, their interest in science, the approaches they employed in teaching science as well as their self-efficacy beliefs about science teaching. This questionnaire was developed based on literature that there is a significant positive relationship between teachers‟ academic and professional training and their attitudes towards teaching as well as their work output (Ashton & Crocker, 1987).

It is common knowledge that some individuals with various levels of education, including those with no professional qualification have been employed as teachers. This suggests that a large number of teachers teaching integrated science at the basic school levels are likely not to be professionally trained (Antwi, 1992). It is therefore not out of place that the study tried to determine whether the teachers in this study had undergone professional teacher training, any in-service training or even had any science knowledge background. Teacher qualification is tied to student achievement (Greenwald, Hedges, & Laine, 1996). Therefore, teacher capacity becomes critical for school improvement efforts. This questionnaire was also to find out teachers‟ knowledge of concept mapping before the intervention and their attitudes towards concept mapping after the intervention.

**Pupils' Questionnaire**

The pupils‟ questionnaire (Appendix B) was designed for the pupils and it is also of two parts. Part I consists of three (3) items on the background of the pupils with Part II consisting of nineteen (19) items under three headings and used to gather information on the interest of the pupils in science, their learning difficulties and their participation in integrated science lessons. This was also based on an assumption that one important aspect of teaching is to bring about a change in the attitudes of learners.

The questionnaires comprised of five point likert-type scales. Each item consists of a statement followed by five options with weightings which range from 1 to 5: strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree (1) for positive statements and a reverse scoring of strongly agree (1), agree (2), neutral (3), disagree (4) and strongly disagree (5) for all negative statements to provide consistency in a positive direction. For each item, respondents were required to indicate their responses by marking/ticking the appropriate column or box against the option selected. The likert-type scale appears to be the most popular method of attitude scale construction according to Lehmann and Mehren (1991). This is due to the fact that likert-type scale is easier to construct and score than the Thurston or Guttmann scales. Furthermore, the likert-type scale produces more homogeneous scales; allows the subjects to indicate the degree or intensity of feelings and permits spread of variance.

**Lesson Observation Check List**

A structured lesson observation check list, (Appendix C) was used for gathering data on teachers" use of Concept Mapping instructional approach and pupils" participation in science lessons involving concept mapping. This instrument considered the frequency, variation and effective use of concept maps by the teachers as well as the frequency and quality of questions pupils asked and also responded to, during integrated science lessons. This instrument was meant to complement both teachers" and pupils" questionnaires in collecting data on their attitudes towards concept mapping in the teaching and learning of science. The lesson observation checklist consists of thirteen (13) teachers" activities and eleven (11) pupils" activities. Each activity on the lesson observation checklist is followed by four options indicating the extent to which the activity has been performed. The frequencies of the activities were rated as: 5 or more times (Very often), 3 to 4 times (Often), 1 to 2 times (Few times) and zero (Never). For analysis, the options were given scores from 1 to 4 with very often (4), often (3), few times (2) and never (1) for positive activities and a reverse scores of very often (1), often (2), few times (3) and never (4) for all negative activities to provide consistency in a positive direction. For capturing classroom interactions, the researcher sat in classrooms in the best possible positions to hear and see both teachers and pupils. Any time an expected behaviour or activity was performed by the teachers or pupils, the researcher recorded it on appropriate data sheet, simultaneously assessing communication in the next period (Flanders, 1970).

The lesson observation check list was designed based on 'Flanders Interaction Analysis Category System' (FIACS) which has been found to be the most popular tool for capturing classroom interaction patterns. According to Shahi (2010), FIACS is found to be very useful tool to observe the classroom interaction pattern of those teachers who are teaching at primary and secondary school levels. The major features of this category system lie in the analysis of initiative and response which are the characteristics of interaction between two or more individuals (Flanders, 1970). Flanders interaction analysis also assumes that the teacher is a very influential authority in the classroom, because teacher talks and what he says determines to a large extent the reactions of the students.

**Science Achievement Test (SAT)**

The science achievement test instrument comprising objective test items and essay type items was used to measure pupils‟ academic achievement in science (Appendix D). There were ten (10) objective items consisting of multiple choice and completion type items while the essay part consisted of three (3) major items with sub questions.

According to Ausubel, Novak and Hanesian cited in Esiobu and Soyibo (1995), a test must be at the comprehension level and beyond in order to ascertain meaningful learning in a learner. However, the aim of this study was not to measure meaningful verbal learning per se, but the extent to which learners have explicit understanding of the contents taught. This was supposed to be reflected in the quality of answers supplied by pupils to the test items. The science achievement test instrument therefore consists of varied items covering knowledge, understanding and application domains of the profile dimensions and they were constructed by the researcher with reference to the JHS integrated science syllabus, textbooks and past West African Examination Council"s integrated science question papers.

**Pupils' Constructed Concept Maps**

At the end of five weeks of lesson observation, pupils were requested to construct concept maps individually based on three of the topics treated during the study. The topics included: Composition and functions of blood; Structure and functions of the human heart; Factors that affect the process of photosynthesis. The pupils" constructed maps were used to ascertain pupils" understanding of the relationships that exist between various concepts under the topics considered in the study. The instruction for the construction of these concept maps is presented in Appendix E while samples of the maps constructed by pupils are attached as Appendix F. Reliability and validity of concept maps as assessment tools are integrally related to the concept map task and to the scoring system used (Ruiz-Primo & Shavelson, 1996).

The traditional method of concept map scoring was proposed by Novak and Gowin (1984). Their method was based on the components and structure of the concept map.

This system assigns points for valid propositions, levels of hierarchy, branching, pattern, crosslinks and specific examples. The number of hierarchical levels addresses the degree of subsumption, the number of branching indicates progressive differentiation, and the number of cross-links indicates the degree of integration of knowledge. This scoring technique has proven to be time-consuming but it does give a great deal of information about the creator‟s knowledge structure. In this study, concept maps constructed by the pupils were scored by evaluating the separate propositions on the maps with emphasis on whether the most important concepts from the topics were depicted and as to whether the links among them were scientifically acceptable. This method of scoring concept maps was used based on its strength which lies in the fact that it is simple to use, less time consuming and the scores for maps are easily defended (McClure, Sonak & Suen, 1999).

**Semi-Structured Interview Guide**

A semi-structured interview guide (Appendix G) was used to find out the opinions of teachers and pupils on the concept mapping approach to the teaching and learning process. The major areas of the interview were put into themes (interest in concept mapping; pupils‟ participation in lessons; pupils‟ performance/achievements in class and construction of concept maps) to determine the perception of teachers and pupils about the concept map approach to teaching and learning.

**Validity of the Instruments**

Content validity is defined as the extent to which a research instrument adequately samples the research domain of interest when attempting to measure phenomena while face validity refers to the degree to which a test appears to measure what it purports to measure (Carmines & Zeller, 1979; Waltz, Strickland, & Lenz cited in Wynd, Schmidt, &

Schaefer, 2003). The content and face validity of research instruments are very vital for the success of any study and one of the means of achieving these is by expert judgment (Lomask, Jacobson & Hafner, 1995). The research instruments were therefore subjected to inspection and scrutiny by two supervisors and two experienced science teachers who are also WAEC examiners for their judgment on the correctness of content, representativeness of the items in relation to concepts involved in the topics considered in this study and the language appropriateness with respect to the level of the respondents. The formula used for calculating the content validity is indicated in Appendix H. For the teachers‟ questionnaire, 35 items out of 40 were rated relevant and this gives a validity index of 0.88. For the pupils‟ questionnaire, 21 out of a total of 25 items were rated relevant and this gives a validity index of 0.84. For the science achievement test, 19 out of a total of 22 items were rated relevant resulting in a validity index of 0.86. Also, 22 out of 24 items on the lesson observation checklist were rated relevant, giving this instrument a validity index of 0.92. All the four items in the semi-structured interview were rated relevant and this gives the instrument a validity index of 1.00. The validity indices above indicate that the instruments were valid and this is consistent with Amin (2005), who was of the view that the acceptable average index for instrument validity should be 0.7 and above.

**Pilot Testing**

The reliability of a research instrument concerns the extent to which the instrument yields the same results on repeated trials (Carmines & Zeller, 1979). The science achievement test instrument and pupils‟ questionnaire were pilot-tested with a total of 42 pupils comprising 25 boys and 17 girls in two schools from two separate circuits of the District to determine the reliability of the instruments. The pilot testing was done with JHS 3 pupils because it was believed that they were in a higher class and would have already treated the topics considered in the study. The schools for the pilot testing were selected from the District of the study in order to ensure that the respondents in the pilot testing had similar characteristics as the main research subjects. This pilot testing was conducted to establish not only the reliability of the research instrument, but also to identify defective items to help correct any ambiguities that might be detected and to get an idea of the expected response rate before administering them to the actual participants of the study. The data collected from pupils" questionnaire was entered into SPSS and the instrument reliability was determined to be 0.76 using the Cronbach alpha method. The Cronbach alpha method was used because it is used when measures have multiple-scored items such as perception and attitudinal scales (Payne & Payne, 2005). The reliability of the science achievement test was determined to be 0.89 using the Split-Halves reliability approach in SPSS. This approach was used in order to minimize the time and cost of using the test-retest method. The formula for the split-halves method according to Carmines and Zeller (1979) is known as the Spearman-Brown prophecy formula and it is stated in Appendix H. Item difficulty and discrimination indices of the science achievement test instrument were also determined after the pilot testing in order to exclude items that were perceived not to be very appropriate for the research subjects. The procedure followed by Ajaja and Eravwoke (2010) in a similar study was adopted. The formulae for calculating the difficulty and discrimination indices of items are stated in Appendix H. Items with difficulty levels of 25% to 75% and discrimination level up to 20% were accepted. One essay item whose difficulty level fell below 25% was removed and replaced. This is in conformity with the studies conducted by Aggarwal (1986) and Saravanavel (2011).

### Data Collection Procedure

Data collection was done in three phases; pre-intervention, intervention and post-intervention phases. Prior to the collection of data, the researcher visited the selected schools and met with the headmasters and the science teachers to explain to them the rationale for the study. Subsequently, the researcher paid familiarization visit to the selected classes with permission from the headmasters concerned. Also, the researcher, through the District Education Directorate, sent letters (Appendix I) to all junior high schools in the District to invite the science teachers to the intended workshop on concept mapping after having discussions on it with the District Director of Education.

### The Pre- Intervention Phase

During the pre- intervention data collection phase, the questionnaires for teachers and pupils were administered to the respondents directly and supervised by the researcher in order to prevent the respondents from comparing responses. The respondents were encouraged to do independent work and to direct any question to the researcher for clarification. They were also assured of confidentiality and inspired to be very frank in their responses. After the completion of the questionnaires, they were collected and edited to see if some were not completed so that they could be eliminated.

### The Intervention Phase

The intervention phase of the study started with a training workshop on Concept Mapping for all the JHS integrated science teachers in the District. This was in line with

Okebukola (2006), who in a study with 48 biology, 36 chemistry, 24 physics and 33 mathematics teachers, found that those who had been trained in and had used concept mapping showed a largely favourable attitude towards learning the technique and using it in teaching science rather than mathematics. On the first day of the workshop, the participating teachers were briefed on the rationale for organizing the workshop after which they were introduced to the theories underlying concept mapping. The participants were then made to observe and discuss samples of concept maps on some selected JHS integrated science topics, with the researcher as the facilitator for the discussions. The sample concept maps (Appendix J) on the “Circulatory system and Photosynthesis” were constructed by the researcher on a computer and projected on a screen for participants to observe. During the discussions, participants were asked to:

1. list the sub-topics that were covered in each of the sample concept maps with reference to the JHS integrated science syllabus
2. state some lesson objectives for the sub topics listed
3. describe how the various maps could be used to achieve the objectives stated and
4. construct some test items that could be used to test whether the set objectives have been achieved.

Following the discussions, the participants were then taken through the stages of concept map construction as prescribed by Novak and Canas (2008). The following steps were discussed:

1. Brainstorming Stage: This is where a domain of knowledge is identified and the area of the knowledge to be mapped is defined with reference to focus questions

that clearly specify the problems or issues the concept map is expected to resolve or address.

2. Organizing Stage: This is the stage where the key concepts that apply to the defined domain of knowledge are identified and the lists are clearly written so that they can be read easily. Usually 15 to 25 concepts will suffice. The lists are ranked to create groups and sub-groups of related items to emphasize hierarchies from most general and most inclusive concepts at the top of the list to the less general and most specific concepts at the bottom of the list. Some concepts will fall into multiple groupings and this will become important in the linking stage.
3. Layout Stage: This is where preliminary concept maps are constructed. The concepts are arranged so that they represent the collective understanding of the interrelationships and interconnections between and among groupings.
4. Linking Phase: This is where lines with arrows are used to connect and show the relationship between connected items. A word or short phrase is written by each arrow to specify the relationship. Many arrows can originate or terminate on particularly important concepts.
5. Revising Stage: This is where the draft concept map is carefully examined, sections may be rearranged and items may be removed or combined to simplify the map. In group work, any aspect of the map where opinions differ should be discussed. The Rubber Sheet Analogy states that concept positions on a map can continuously change, while always maintaining the same relationship with the other ideas on the map.

6. Finalizing the Concept Map: This is the stage where the concept map is converted into a permanent form that others can view and discuss after individuals or a group has agreed on an arrangement of items that convey their understanding.
7. Evaluating Concept Maps: This is where accuracy and thoroughness, organization, appearance as well as creativity within the map are scrutinized.

With the above guidelines, the participants were then put into five groups and asked to construct concept maps on some selected JHS integrated science topics of their choice. A4 sheets were provided to the groups to facilitate their work. The participants however came to the workshop with their own pencils, erasers and rulers for the mapping. While the participants were working in groups, the researcher went round to provide assistance to any group that had difficulty with the construction of the maps. Some of the maps constructed by the teachers are attached as Appendix K.

The group work approach was based on the fact that the teachers were expected to have their pupils construct some concept maps in groups and hence the need for them to go through the construction by themselves in groups so as to have first-hand experience to be able to predict some of the problems their pupils were likely to encounter during group construction of concept maps. It was also based on the fact that group interactions help learners to make sense of new inputs by relating it to their prior experiences and by collaborating through dialogue with others to co-construct shared understanding (Novak, 1998).

At the completion of the mapping, each group was given the chance to present their map on a black board for review by all participants. The group secretaries led the drawing of the maps on the board with group members providing information to them. During the review, the hierarchical arrangement of concepts and propositions were discussed as to whether they were valid or not. Some adjustments were proposed and made to some of the groups" concept maps and the final agreed concept maps were copied by the participating teachers for reference purposes as they were expected to adopt and/or modify the maps for use in teaching the topics concerned.

The teachers needed to acquire the knowledge about concept mapping because both the structure and quality of concept maps reflect the credibility and validity of learners" understandings and it is the quality and structure expressed through concept maps during the process of concept mapping that provide the windows into learners" understanding (Mintzes, Wandersee, & Novak, 2001). Pictures from the workshop are attached as Appendix L.

Two weeks after the workshop, the researcher started visiting the selected schools for the lessons observation as the teachers began incorporating concept mapping into their instructional approaches. The researcher allowed a two-week interval for the teachers to do more practice on concept mapping for the mastery of it and to factor it into their lesson plans before commencement of the lesson observation because according to Berry and Chew (2008**),** students who constructed only one map showed stable performance; students who constructed two or more maps showed an increase in performance over time and students who generated more maps also generated more sophisticated maps. The structured lesson observation check list was then used by the researcher during the science lessons to gather information on pupils" participation during integrated science lessons. The instrument also provides information on the performance of the teacher in the classroom.

For capturing classroom interactions, the researcher sat in classrooms in the best possible positions to hear and see both teachers and pupils. Any time an expected behaviour or activity was performed by the teachers or pupils, the researcher recorded it on appropriate data sheet, simultaneously assessing communication in the next period (Flanders, 1970). The lesson observations were done in the selected schools over a period of five weeks. A total of ten lessons were observed in each school, two per week and some of the sub topics treated under the main topics included: explanation of photosynthesis, factors necessary for photosynthesis, importance of photosynthesis to plants and animals, parts of the human circulatory system and their functions, composition and functions of blood, causes and prevention of high and low blood pressures. Observations made on pupils and teachers during lessons were scaled for analysis.

**The Post- Intervention Phase**

On the last day of observation, the semi-structured interview was administered to the science teachers and some selected pupils. The purpose of the interview was to solicit the views of the teachers and pupils concerning the teaching approach. All the twenty-five (25) JHS science teachers who took part in the workshop on concept mapping and fifteen (15) pupils randomly sampled from the selected schools were interviewed. The responses of the respondents were recorded manually on paper and read to them to confirm if their responses were rightly captured. The responses were classified for analysis.

At the end of the five weeks of observation, pupils were requested to construct some concept maps individually based on three of the topics taught. The topics were: Composition and functions of blood; Structure and functions of the human heart; Factors that affect the process of photosynthesis. This was done to ascertain the extent to which pupils could construct concept maps individually. These concept maps were scored by evaluating the separate propositions identified on the maps with emphasis on whether the most important concepts from the topics were depicted and as to whether the links among them were scientifically acceptable. The scores were recorded and compared with the science achievement test scores to determine if the pupils could transfer the knowledge acquired through concept mapping into writing essay type examinations testing similar concepts. The maps were scored by the science teachers using scoring rubrics (Appendix M) constructed by the researcher.

The science achievement test was subsequently administered to the pupils. The answer scripts of the respondents were collected and scored and the scores recorded for analysis. To ensure objectivity in the scoring, the researcher developed a scoring rubric otherwise referred to as marking scheme (Appendix N). The averages of continuous assessment test scores obtained by the pupils in the first term and early part of the second term of the academic year were retrieved from the cumulative record registers of the various classes and compared with the scores from the science achievement test during data analysis. This was done to determine whether there was a significant impact of concept mapping approach on the academic performance of the pupils since the continuous assessment scores were obtained at the time that concept mapping was not used in teaching the pupils but the science achievement test scores were obtained by the same pupils after the intervention. The data collection process ended with the post testing of questionnaires for both teachers and pupils.

## Data Analysis

After the completion of the questionnaires, they were collected and edited to see if some were not completed so that they could be eliminated. The responses from the questionnaires were then scaled for analysis. The data obtained from the two questionnaires, science achievement test, pupils‟ concept maps and the lesson observation check list were separately entered into SPSS 20.00 version for analysis.

## Quantitative Data

Descriptive statistics was used to organize data obtained from the questionnaires, the continuous assessment scores, science achievement test scores and the structured lesson observation. The data was organized into mean scores, standard deviations, ranges, frequencies and percentages. Inferential statistical analysis was employed to investigate the hypothesized relationship between the teaching method (Concept Mapping) and pupils‟ academic performance. This was discussed with reference to the science achievement test scores and the continuous assessment test scores for first term and early part of the second term. Paired t-test was used to compare the academic performance of the pupils before and after the intervention while Pearson correlation (r) was used to determine the relationship between pupils‟ concept map scores and their science achievement test scores. A t-test analysis was carried out to determine the statistical significance of the difference in the pretest and posttest mean attitudes scores of both teachers and pupils.

**Qualitative Data**

Thematic content analysis was used to analyse data from the semi-structured interview and the lesson observation check list as well as some responses of teachers‟ and pupils‟ to the questionnaires. By this, the major areas of the questionnaires and the interview were put into themes to determine the perception of teachers and pupils about the concept map approach to teaching and learning and their responses were subjected to narrative description.

**Ethical Issues**

It is of paramount importance that educational researchers respect the rights, privacy, dignity and sensitivities of their research populations and also the integrity of the institutions within which the research occurs (Smith, 2003). The researcher sought the consent of the teachers involved in the study in order to include pictures from the concept mapping workshop in the research report. This was necessary because the research report was going to become a public document and the privacy of those teachers ought to be respected. Also, the researcher met with the District Director of Education and the Head teachers of the selected schools before the start of the study to seek permission for the use of the selected schools and to ensure that they completely understand the purpose of the study. Furthermore, the integrated science teachers were briefed on the methods to be used in the study and the demands placed on them as participants (Best & Kahn, 2006).

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## Overview

In this chapter, the results from the study are presented and discussed in relation to the stated hypotheses and research questions. The purpose of this study was to investigate the effect of JHS science teachers" use of concept mapping on the participation of their pupils in integrated science lessons and to further determine if any significant relationship existed between concept mapping as a teaching approach and pupils" academic performance in integrated science.

## Research Question 1:

**To what extent will a workshop on concept mapping equip Junior High School integrated science teachers in Adaklu District with knowledge and skills of concept mapping?**

Teachers" questionnaire was used to collect data to answer the research question 1, which sought to find out the extent to which a workshop on concept mapping will equip JHS science teachers in Adaklu District with the knowledge and skills of concept mapping. Table 1 presents the responses of the teachers to the questionnaire before intervention.

**Table 1:**
***Results of Teachers' Questionnaire on Knowledge and Use of Concept Mapping Before Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I have knowledge of concept mapping | 0 (0) | 2 (8) | 11 (44) | 8 (32) | 4 (16) |
| I have been using Concept maps to teach | 0 (0) | 1 (4) | 4 (16) | 9 (36) | 11 (44) |
| Concept maps are not too difficult to construct and use | 0 (0) | 0 (0) | 20 (80) | 3 (12) | 2 (8) |
| Concept maps can help me to better explain concepts to the understanding of my pupils | 0 (0) | 2 (8) | 20 (80) | 3 (12) | 0 (0) |
| Concept maps help me to organize my lesson activities | 0 (0) | 2 (8) | 19 (76) | 2 (8) | 2 (8) |
| Concept maps help me to diagnose and identify the misconceptions in the minds of the pupils | 1 (4) | 1 (4) | 15 (60) | 6 (24) | 2 (8) |
| Concept maps can help individuals to learn on their own | 2 (8) | 2 (8) | 17 (68) | 3 (12) | 1 (4) |

**SA = strongly agree** **D = disagree** **n = number of teachers** **A = agree**

**SD = strongly disagree** **(%) = percentage** **N = neutral**

Results from Table 1 show that only two out of 25, representing 8% of the JHS science teachers of the study sample had knowledge of Concept Mapping before the intervention. Also, the results show that only one of the two who had knowledge of concept mapping was actually using it to teach. More than half of the respondents (15) representing 60% of the teachers responded neutral to items on concept mapping.

**Table 2:**
***Results of Teachers' Questionnaire on Knowledge and Use of Concept Mapping After Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I have knowledge of concept mapping | 11 (44.0) | 14 (56.0) | 0 (0) | 0 (0) | 0 (0) |
| I have been using Concept maps to teach | 10 (40.0) | 15 (60) | 0 (0) | 0 (0) | 0 (0) |
| Concept maps are not too difficult to construct and use | 8 (32.0) | 10 (40.0) | 4 (16.0) | 3 (12.0) | 0 (0) |
| Concept maps can help me to better explain concepts to the understanding of my pupils | 10 (40.0) | 13 (52.0) | 2 (8.0) | 0 (0) | 0 (0) |
| Concept maps help me to organize my lesson activities | 14 (56.0) | 11 (44.0) | 0 (0) | 0 (0) | 0 (0) |
| Concept maps help me to diagnose and identify the misconceptions in the minds of the pupils | 12 (48.0) | 13 (52.0) | 0 (0) | 0 (0) | 0 (0) |
| Concept maps can help individuals to learn on their own | 13 (52.0) | 11 (44.0) | 1(4.0) | 0 (0) | 0 (0) |

**SA = strongly agree D = disagree n = number of teachers A = agree**

**SD = strongly disagree (%) = percentage N = neutral**

Results from Table 2 show that, all the teachers involved in the study (100%), in one way or the other used concept mapping approach in teaching after they have been exposed to the approach. On the item which reads „Concept Maps are not too difficult to construct", 18 of the teachers representing 72% responded positively while 3 of them representing 12% responded negatively and 4 representing 16% were neutral. Also, on the item which reads „Concept mapping helps me to better explain concepts to the understanding of my pupils", 23 of the study sample representing 92% responded in the affirmative, 2 representing 8% were neutral in their response while there was no disagreement. Furthermore, as shown in Table 2, all 25 teachers of the study sample indicated that concept mapping helps them to organize their lesson activities while there was no disagreement on the item. Again, there was 100 per cent affirmation from the teachers that they use concept mapping to diagnose and identify misconception in the minds of their pupils.

In comparing results from Table 1 with those from Table 2, it was clearly noticed that the workshop on concept mapping had greatly equipped the JHS integrated science teachers with knowledge and skills of concept mapping. For instance, while the results in Table 1 indicates that only two out of the 25 teachers had knowledge and skills of concept mapping before the workshop, the results in Table 2 show that all the teachers had acquired knowledge and skills of the teaching approach after the workshop. A careful look at the results from Tables 1 and 2 reveals that an average of 15 representing 60% of the study sample responded neutrally to the items on concept mapping before the workshop but this number reduced after the workshop to an average of 2 representing 8%. It can be deduced from this results that because most of the teachers had no knowledge of concept mapping before the workshop, they could neither agree nor disagree with the items on concept mapping and hence were neutral. However, after the workshop, they gained enough knowledge on the teaching approach such that they were better informed to either agree or disagree with the statements. This led to the reduction in the number that responded neutrally to the items. The results from Tables 1and 2 also indicates that an average of two out of the 25 teachers responded positively to the items before the workshop but this number increased to twenty-four out of 25 after the workshop. This also confirms that the teachers had gained a lot of knowledge on concept mapping at the workshop because most of the items were true statements about concept mapping and individuals with knowledge about the approach would give positive responses.

The quality of maps constructed by the teachers at the workshop, samples of which are attached as Appendix K is a further proof that the workshop had to a large extent equipped the JHS integrated science teachers in Adaklu District with the knowledge and skills of concept mapping. Again, results from the lesson observation on teachers as presented in Table 3 show that the teachers were using the approach in teaching their pupils after the workshop on concept mapping. The results indicate that the teachers demonstrated varied use of the teaching approach such as using it to introduce lessons, using it as a scaffold to support concept explanation and also as assessment tool.

**Table 3:**
***Results on Teachers' Activities from Lesson Observations in all the Five Schools***

| ACTIVITY | Very often | Often | Few times | Never |
|---|---|---|---|---|
| Introduces lesson with concept map | 1 | 1 | 3 | 0 |
| Asks questions on material shown: concept maps, drawings, models, charts etc. | 2 | 2 | 1 | 0 |
| Asks questions involving critical thinking. | 0 | 2 | 3 | 0 |
| Presents subject matter coherently with regards to continuity and relevance. | 2 | 2 | 1 | 0 |
| Concepts presentation during lesson development supported by concept maps. | 2 | 1 | 2 | 0 |
| Presents irrelevant contents /subject matter. | 0 | 0 | 2 | 3 |
| Teaching approach embedded with self-questioning. | 0 | 2 | 2 | 1 |
| Dictates the subject matter from the note book or text book. | 0 | 0 | 2 | 3 |

**Table 3 (Continued)**

| ACTIVITY | Very often | Often | Few times | Never |
|---|---|---|---|---|
| Gives directions which pupils are expected to comply with. | 0 | 2 | 3 | 0 |
| Visits and interacts with groups | 0 | 1 | 3 | 1 |
| Accepts and clarifies the feeling and questions of pupils in a non- threatening manner. | 2 | 2 | 1 | 0 |
| Praises or encourages pupil"s action or behaviour; (nodding of head or saying "Um hm" or "go on" are included). | 1 | 1 | 2 | 1 |
| Accepts, clarifies and builds on or develops ideas suggested by a pupil. | 1 | 2 | 2 | 0 |

**Research Question 2:**

**What is the attitude of Junior High School integrated science teachers in Adaklu District towards concept mapping before and after the workshop on concept mapping?**

To determine the attitude of the teachers towards concept mapping, the mean scores for the twenty-five teachers were determined using their responses to six of the items of the Teachers" questionnaire which have direct bearing on attitude towards concept mapping. The six items were:

1. I have been using concept mapping approach to teach
2. Concept maps are not too difficult to construct and use
3. Concept maps can help me to better explain concepts to the understanding of my pupils

4. Concept maps help me to organize my lesson activities
5. Concept maps help me to diagnose misconceptions in the minds of my pupils
6. Concept maps can help individuals to learn on their own.

A mean score of 3 to 5 was considered positive while a mean score of less than 3 indicated a negative attitude. The grand total mean and standard deviation for the twenty-five teachers were calculated to determine whether there was generally positive attitude of teachers towards concept mapping. The mean scores of teachers on attitude towards concept mapping before and after the workshop are presented in Tables 4 and 5 respectively.

**Table 4:**
***Mean Score of Teachers on Attitude towards Concept Mapping before Workshop***

| TEACHER | MEAN | SD | TEACHER | MEAN | SD |
|---|---|---|---|---|---|
| T1 | 2.7 | 0.5 | T14 | 3.8 | 1.0 |
| T2 | 2.8 | 1.0 | T15 | 3.0 | 0.0 |
| T3 | 2.5 | 0.5 | T16 | 2.5 | 0.8 |
| T4 | 2.7 | 0.8 | T17 | 2.5 | 0.8 |
| T5 | 2.3 | 1.2 | T18 | 2.7 | 0.8 |
| T6 | 2.7 | 0.8 | T19 | 2.5 | 0.8 |
| T7 | 2.2 | 1.0 | T20 | 2.7 | 0.8 |
| T8 | 3.5 | 1.6 | T21 | 2.8 | 0.4 |
| T9 | 2.5 | 0.5 | T22 | 2.3 | 0.8 |
| T10 | 2.3 | 0.8 | T23 | 2.7 | 0.5 |
| T11 | 2.7 | 0.5 | T24 | 2.3 | 1.0 |
| T12 | 2.5 | 0.8 | T25 | 3.0 | 0.0 |
| T13 | 2.8 | 0.4 | | | |
| **Grand Total** | **Mean = 2.7** | **SD = 0.7** | **RANGE = 1.6** | | |

From Table 4, the grand total mean score for the teachers on attitude towards concept mapping before the workshop was 2.7 (SD = 0.7) and the range was 1.6. Four teachers had mean scores of 3 and above while twenty-one of them had mean scores of less than 3.

**Table 5:**
***Mean Score of Teachers on Attitude towards Concept Mapping after Workshop***

| TEACHER | MEAN | SD | TEACHER | MEAN | SD |
|---|---|---|---|---|---|
| T1 | 4.2 | 0.4 | T14 | 4.2 | 0.4 |
| T2 | 4.8 | 0.4 | T15 | 4.2 | 0.8 |
| T3 | 4.2 | 0.8 | T16 | 4.5 | 0.5 |
| T4 | 4.8 | 0.4 | T17 | 4.8 | 0.4 |
| T5 | 4.0 | 0.0 | T18 | 4.3 | 0.5 |
| T6 | 4.8 | 0.4 | T19 | 4.0 | 1.1 |
| T7 | 5.0 | 0.0 | T20 | 4.5 | 0.5 |
| T8 | 3.7 | 0.8 | T21 | 4.2 | 0.8 |
| T9 | 4.5 | 0.5 | T22 | 4.5 | 0.5 |
| T10 | 4.0 | 1.0 | T23 | 4.5 | 0.5 |
| T11 | 4.0 | 1.1 | T24 | 4.3 | 0.5 |
| T12 | 4.5 | 0.5 | T25 | 4.0 | 0.9 |
| T13 | 4.5 | 0.5 | | | |
| **Grand Total** | **Mean = 4.4** | | **SD = 0.6** | | **RANGE = 1.3** |

The results from Table 5 show that the grand total mean score for the teachers on attitude towards concept mapping after the workshop was 4.4 (SD = 0.6) and the range was 1.3. All the twenty-five teachers had mean scores above 3.

A comparison of results from Tables 4 and 5 revealed that JHS integrated science teachers in Adaklu District showed negative attitude towards concept mapping before the workshop but developed a positive attitude towards the teaching method after they had been exposed to the approach at the workshop. This was evident in the fact that the grand total mean score for attitude before the workshop was 2.7 (SD = 0.7). This grand total mean score indicated a negative attitude as it was less than 3 on the attitude scale on which scores less than 3 were considered negative. Also, as many as twenty-one out of the 25 teachers representing 84% of the study sample had mean scores of less than 3 indicating that they showed negative attitudes towards concept mapping before the workshop. On the other hand, all the twenty-five teachers showed positive attitudes towards concept mapping after the workshop. This is based on the fact that all the teachers obtained mean scores above 3 in analyzing the responses they provided after the intervention. The grand total mean score for teachers‟ attitude towards concept mapping after the workshop was also 4.4 (SD = 0.6). The findings of the present study are in line with those of Okebukola (2006), who in a study with 48 biology, 36 chemistry, 24 physics and 33 mathematics teachers, found that those who had been trained in and had used concept mapping showed a largely favourable attitude towards learning the technique and using it in teaching science rather than mathematics. His report also indicated that both science and mathematics teachers expressed views favouring the approach in terms of its benefits in the areas of meaningful learning and reduction of anxiety levels.

Based on the above discussions, it can be concluded that JHS integrated science teachers in Adaklu district developed positive attitudes towards concept mapping after the workshop, hence the null hypothesis 1 which states „JHS integrated science teachers in Adaklu District will not show positive attitudes towards concept mapping‟, is rejected.

**Research Question 3:**

**What are the teaching and learning difficulties of JHS integrated science teachers and pupils in Adaklu District?**

Results from pretest of questionnaires on teachers‟ difficulties and that on pupils‟ learning difficulties were used to ascertain some of the perceived difficulties of teachers and pupils in teaching and learning of integrated science in Adaklu District. The responses of teachers and pupils are presented in Tables 6 and 7 respectively.

**Table 6:**
***Results of Teachers' Questionnaire on Teaching Difficulties before Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I was not a science student | 13 (52) | 2 (8) | 0 (0) | 6 (24) | 4 (16) |
| I have never attended any in-service training | 6 (24) | 12 (48) | 4 (16) | 1 (4) | 2 (8) |
| I teach some other subject(s) in addition to integrated science | 6 (24) | 8 (32) | 0 (0) | 6 (24) | 5 (20) |
| There are insufficient textbooks in the school for pupils | 4 (16) | 1 (4) | 0 (0) | 6 (24) | 14 (56) |
| There is no science laboratory for practical work in this school | 17 (68) | 8 (32) | 0 (0) | 0 (0) | 0 (0) |
| I don"t know how to improvise materials for practical work | 2 (8) | 7 (28) | 5 (20) | 8 (32) | 3 (12) |

**SA = strongly agree D = disagree n = number of pupils A = agree**
**SD = strongly disagree (%) = percentage N = neutral**

The results from Table 6 revealed that there were serious difficulties or challenges faced by the JHS science teachers in teaching and learning of science in terms of teachers" pre-service and in-service training as well as equipment and infrastructure. For instance, fifteen out of 25 of the teachers representing 60% of the study sample indicated that they were not science students during their pre-service training and eighteen of them representing 72% have never had any in-service training prior to this study. Also, nine (36%) of the teachers indicated that they lack the knowledge and skills of improvisation.

**Table 7:**
***Results of Pupils' Questionnaire on Learning Difficulties before Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| Our integrated science teacher only gives us notes without explaining the notes to us | 4 (3.9) | 27 (26.5) | 6 (5.9) | 37 (36.3) | 16(15.7) |
| I always find it difficult to understand what we are taught in integrated science | 5 (4.9) | 30 (29.4) | 10 (9.8) | 24 (23.5) | 33 (32.4) |
| I often find it difficult to remember what we are taught in integrated science | 7 (6.9) | 32 (31.4) | 11 (10.8) | 32 (31.4) | 20 (19.6) |
| It is difficult for me to relate one topic to the other in integrated science | 1 (1.0) | 30 (29.4) | 7 (6.9) | 29 (28.4) | 29 (28.4) |
| Scientific terms are too difficult to spell and pronounce | 3 (2.9) | 9 (8.8) | 0 (0) | 69 (67.6) | 21 (20.6) |
| I always score low marks in integrated science tests and exams | 17 (16.7) | 36 (35.3) | 0 (0) | 29 (28.4) | 20 (19.6) |
| I have no science textbook to read at home | 15 (14.7) | 23 (22.5) | 1 (1.0) | 2 (2.0) | 61 (59.8) |
| There is no science laboratory in this school for practical lessons | 88 (86.3) | 14 (13.7) | 0 (0) | 0 (0) | 0 (0) |
| We usually do not perform practical activities during integrated science lessons. | 81 (79.4) | 20 (19.6) | 0 (0) | 1 (1.0) | 0 (0) |

**SA = strongly agree D = disagree n = number of pupils A = agree**
**SD = strongly disagree (%) = percentage N = neutral**

It was noted from the results in Table 7 that JHS pupils in Adaklu District were not been given practical lessons in integrated science as indicated by one hundred and one (99%) of the 102 pupils who responded to their questionnaire. This is attributable to the fact that there are no science laboratories and science equipment in the schools and some of the teachers lack knowledge and skills of improvisation as indicated in Table 6. This situation can also partly be blamed on the fact that most of the teachers themselves lack the practical scientific knowledge because they were not taken through any rigorous practical activities during their pre-service training. This view point is in line with Showers (1990) who noted that when teacher education focuses on acquisition of theoretical knowledge only, it typically results in little skills and negligible transfer to classroom practice thus limiting successful learning. It was also suggested by Czemiak and Haney (1998) that, when science teachers are not adequately prepared in science, they may develop anxiety towards science teaching and learning, self-efficacy about science teaching and choice of instructional strategy. The results from Table 7 also revealed that thirty-eight out of the 102 pupils who answered indicated that they did not have any science text books to read at home.

It was even pathetic but worth noting from the interview of teachers that most of the pupils could not express their thoughts the least in English language and this made communication in the classrooms very difficult. This problem was however minimised after the workshop on concept mapping through teachers‟ use of the approach in teaching. This was based on the fact that concept mapping strategy helps in building pupils‟ confidence in language learning and improves their self-efficacy and expository writing accuracy (Nobahar, Tabrizi & Shaghaghi, 2013). This position is collaborated by results on pupils‟ participation in lessons by way of asking and answering of questions. Again, 100% of both teachers and pupils who responded to the questionnaires indicated that there were no science laboratories in their schools for practical work. These situations do not work well for effective teaching and learning of science in the schools.

**Research Question 4:**

**To what extent will the use of concept mapping by JHS integrated science teachers impact on their interest in teaching integrated science?**

Teachers‟ questionnaire was used to answer the research question 4 which sought to find out the teachers‟ interest in teaching science before and after the intervention. The responses of the teachers before and after the intervention are presented in Tables 8 and 9 respectively.

**Table 8:**
***Results of Teachers' Questionnaire on Interest in Teaching Science before Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I don‟t have interest in teaching science | 0 (0) | 3 (12) | 0 (0) | 13 (52) | 9 (36) |
| I would prefer teaching a different subject | 3 (12) | 4 (16) | 0 (0) | 10 (40) | 8 (32) |
| I do encourage pupils in my class to develop interest in science | 6 (24) | 12 (48) | 2 (8) | 5 (20) | 0 (0) |

**SA = strongly agree D = disagree n = number of teachers A = agree**

**SD = strongly disagree (%) = percentage N = neutral**

From Table 8, it is noted that three out of the 25 teachers representing 12% of the study sample did not have interest in teaching integrated science while 88% of them had interest in teaching science before the intervention. Also, before the intervention, seven of the teachers representing 28% of the study sample indicated their preference for other subjects. Again, five out of the 25 teachers were not encouraging their pupils to develop interest in the study of science while eighteen of the teachers representing 72% were whipping up interest in their pupils towards the study of science. The grand total mean score on interest for the 25 teachers was calculated and found to be 3.8 (SD = 1.0). The range for the mean score on interest was found to be 2. Fifteen of the teachers had scores above the grand total mean score while 10 of them scored below the grand total mean score.

**Table 9:**
***Results of Teachers' Questionnaire on Interest in teaching Science after Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I don‟t have interest in teaching science | 0 (0) | 0 (0) | 0 (0) | 9 (36.0) | 16 (64.0) |
| I would prefer teaching a different subject | 0 (0) | 3 (12.0) | 4 (16.0) | 11 (44.0) | 7 (28.0) |
| I do encourage pupils in my class to develop interest in science | 11 (44) | 12 (48) | 2 (8.0) | 0 (0) | 0 (0) |

**SA = strongly agree D = disagree n = number of teachers A = agree**

**SD = strongly disagree (%) = percentage N = neutral**

Results from Table 9 indicate that all the 25 teachers (100%) of the study sample had shown interest in teaching science after the intervention. Also, 3 of the teachers representing 12% of the study sample indicated that they would prefer teaching other subjects. Again, twenty-three out of the 25 teachers representing 92% of the study sample indicated that they did encourage their pupils to develop interest in the study of science after the workshop on concept mapping. The grand total mean score on interest for the 25 teachers was calculated and found to be 4.3 (SD = 0.7). The range for the mean score on interest was also determined to be 1.7. Nine of the teachers had scores above the grand total mean score while eight of them scored below the grand total mean score.

In comparing results from Tables 8 and 9, it can be concluded that the workshop on concept mapping has to a large extent improved the interest of the JHS integrated science teachers in Adaklu District towards the teaching of science. This is consistent with the findings of Meteku (2010) who found that students who were taught using concept mapping method showed improved attitudes towards Biology as a subject. From the results it was noticed that the posttest grand total mean score of teachers 4.3 (SD =0.7) is greater than the pre-test grand total mean score of 3.8 (SD = 1.0). It was also noted that while only 22 of the teachers (88%) of the study sample were interested in teaching integrated science before the intervention, all the teachers developed interest in teaching science after they have been exposed to the concept mapping approach. Again, before the concept mapping workshop was organized, seven of the teachers (28%) indicated that they would prefer teaching other subjects. This number however reduced to three (12%) after the intervention. A careful examination of data on the teachers showed that the three teachers who, even though developed interest in the teaching of science still prefer teaching other subjects were those who did not study pure science but were teaching integrated science due to various circumstances. The results again point to the fact that when teachers are more interested in teaching their subjects, they will encourage their pupils to study the subject. For instance, when only 88% of the teachers were interested in teaching science before the intervention, only 72% of them were encouraging their pupils to develop interest in science but when all the teachers developed interest in teaching science after the concept mapping workshop, the number that did whip up interest in their pupils towards the study of science also increased to 92%. The findings of the present study are in line with the finding of Okonkwo (2011) and Imoko (2005), who had earlier found that students exposed to concept mapping demonstrated a greater interest in learning concepts than those exposed to lecture method.

**Research Question 5:**

**To what extent will the use of concept mapping by JHS integrated science teachers improve their self-efficacy beliefs about teaching science?**

Pretest and posttest results on teachers‟ self-efficacy beliefs about science teaching were used to answer the research question which sought to determine the extent to which the use of concept mapping approach by the integrated science teachers can improve their self-efficacy beliefs about teaching science. The results of the pretest are presented in Table 10 while that of the posttest are presented in Table 11.

**Table 10:**
***Results of Teachers' Questionnaire on Teachers' Self Efficacy Beliefs before Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| Science is too difficult to teach | 11 (44) | 6 (24) | 2 (8) | 5 (20) | 1 (4) |
| I have difficulty explaining most concepts to the understanding of the pupils | 8 (32) | 8 (32) | 1 (4) | 7 (28) | 1 (4) |
| I very often ask some friends to explain some topics to me before I go to teach them | 2 (8) | 8 (32) | 0 (0) | 9 (36) | 6 (24) |
| I use pupil centred approaches in teaching my lessons | 2 (8) | 9 (36) | 11 (44) | 3 (12) | 0 (0) |
| I don‟t take my pupils through experiments | 1 (4) | 7 (28) | 3 (12) | 5 (20) | 9 (36) |
| I often allow pupils to ask questions in my class | 14 (56) | 8 (32) | 2 (8) | 0 (0) | 1 (4) |
| I distribute questions well in class | 11 (44) | 12 (48) | 0 (0) | 2 (8) | 0 (0) |
| I often give assignments and class exercises to my pupils | 3 (12) | 7 (28) | 3 (12) | 10 (40) | 2 (8) |
| I promptly mark the assignments I give to my pupils | 2 (8) | 6 (24) | 9 (36) | 8 (32) | 0 (0) |
| I am regular at school | 18 (72) | 5 (20) | 0 (0) | 0 (0) | 2 (8) |
| I always prepare my lesson notes before teaching | 10 (40) | 9 (36) | 4 (16) | 2 (8) | 0 (0) |

**Table 10 (Continued)**

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I have cordial relationship with pupils in my class | 15 (60) | 10 (40) | 0 (0) | 0 (0) | 0 (0) |
| The pupils I teach usually perform well in integrated science at BECE | 1 (4) | 7 (28) | 11 (44) | 6 (24) | 0 (0) |
| I am satisfied with my work output | 3(12) | 12 (48) | 8 (32) | 2 (8) | 0 (0) |

**SA = strongly agree D = disagree n = number of teachers A = agree**
**SD = strongly disagree (%) = percentage N = neutral**

From Table 10, it can be noticed that before the workshop on concept mapping, seventeen out of 25 of the teachers representing 68% of the study sample were of the view that science was too difficult to teach but six of them representing 24% were not in agreement with that position. Sixteen of the teachers representing 64% had difficulty explaining most concepts to the understanding of their pupils and ten of the teachers representing 40% indicated that they often consulted friends to explain topics to them before they go to teach. The results also showed that fifteen out of the 25 teachers representing 60% of the study sample were satisfied with their work output.

**Table 11:**
***Results of Teachers' Questionnaire on Teachers' Self Efficacy Beliefs after Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| Science is too difficult to teach | 0 (0) | 4 (16.0) | 1 (4.0) | 12 (48.0) | 8 (32.0) |
| I have difficulty explaining most concepts to the understanding of the pupils | 0 (0) | 3 (12.0) | 4 (16.0) | 11 (44.0) | 7 (28.0) |
| I very often ask some friends to explain some topics to me before I go to teach them | 0 (0) | 4 (16.0) | 2 (8.0) | 11 (44.0) | 8 (32.0) |

**Table 11 (Continued)**

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I use pupil centred approaches in teaching my lessons | 12 (48.0) | 13 (52.0) | 0 (0) | 0 (0) | 0 (0) |
| I don't take my pupils through experiments | 0 (0) | 8 (32.0) | 0 (0) | 10 (40.0) | 7 (28.0) |
| I often allow pupils to ask questions in my class | 14 (56.0) | 11 (44.0) | 0 (0) | 0 (0) | 0 (0) |
| I distribute questions well in class | 11 (44.0) | 12 (48.0) | 0 (0) | 2 (8.0) | 0 (0) |
| I often give assignments and class exercises to my pupils | 16 (64.0) | 9 (36.0) | 0 (0) | 0 (0) | 0 (0) |
| I promptly mark the assignments I give to my pupils | 11 (44.0) | 10 (40.0) | 4 (16.0) | 0 (0) | 0 (0) |
| I am regular at school | 18 (72.0) | 5 (20.0) | 0 (0) | 0 (0) | 2(8.0) |
| I always prepare my lesson notes before Teaching my lessons | 11 (44.0) | 11 (44.0) | 2 (8.0) | 1 (4.0) | 0 (0) |
| I have cordial relationship with pupils in my class | 15 (60.0) | 10 (40.0) | 0 (0) | 0 (0) | 0 (0) |
| The pupils I teach usually perform well in integrated science at BECE | 1 (4.0) | 7 (28.0) | 11 (44.0) | 6 (24.0) | 0 (0) |
| I am satisfied with my work output | 6 (24.0) | 16 (64.0) | 1 (4.0) | 2 (8.0) | 0 (0) |

**SA = strongly agree D = disagree n = number of teachers A = agree**
**SD = strongly disagree (%) = percentage N = neutral**

Results from Table 11 revealed that the number of teachers who felt that science was too difficult to teach after the workshop on concept mapping were four out of 25, representing 16% of the study sample while twenty of them representing 80% believed otherwise. Also, three of the teachers representing 12% had difficulty explaining most concepts to the understanding of their pupils. Again, four of the teachers representing

16% indicated that they often consulted friends to explain topics to them before they go to teach. As many as twenty-two out of the 25 teachers representing 88% of the study sample indicated that they were satisfied with their work output.

The results from Tables 10 and 11 provide evidence to the fact that the workshop on concept mapping and the subsequent use of the teaching approach by the JHS integrated science teachers had improved their self-efficacy beliefs in teaching science. For instance, out of the 25 teachers of the study sample, the number who believed that science was not too difficult to teach rose from six (24%) before the intervention to twenty (80%) after exposure to the teaching approach. Also, as many as sixteen (64%) of the teachers had difficulties explaining concepts to the understanding of their pupils before the concept mapping workshop but this number reduced to three (12%). This was supported by results from post-test of teachers‟ questionnaires on knowledge and use of concept mapping where all the twenty-five teachers indicated that concept mapping helped them to organize their lesson activities and twenty-three of them further disclosed that concept mapping helped them to better explain concepts to the understanding of their pupils. After the teachers had been exposed to the teaching approach, 22 of them representing 88% indicated satisfaction in their work output as compared to fifteen (60%) before the workshop. The results suggest that before the concept mapping workshop, most of the integrated science teachers worked under pressure due to lack of appropriate methodologies to get concepts explained to the best understanding of their pupils. This position is supported by Czemiak and Haney (1998) who were of the view that when science teachers are not adequately prepared in science, they may develop anxiety towards science teaching and learning, self-efficacy about science teaching and choice of instructional strategy.

**Research Question 6:**

**To what extent will the use of concept mapping by JHS integrated science teachers improve the interest of their pupils in the study of integrated science?**

Results from pretest and posttest of pupils" questionnaires were used to ascertain the extent to which concept mapping approach can help to increase the interest of pupils in the study of integrated science.

**Table 12:**
***Results of Pupils' Questionnaire on Pupils' Interest in the Study of Integrated Science before Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| Integrated science classes are interesting | 23 (22.5) | 52 (51.0) | 10 (9.8) | 17 (16.7) | 0 (0) |
| I like integrated science more than other subjects | 3 (2.9) | 45 (44.1) | 4 (3.9) | 31 (30.4) | 9 (8.8) |
| I fear integrated science so much | 6 (5.9) | 25 (24.5) | 7 (6.9) | 38 (37.3) | 26 (25.5) |
| I like the way my integrated science teacher teaches us | 22 (21.6) | 29 (28.4) | 12 (11.8) | 21 (20.6) | 4 (3.9) |

**SA = strongly agree D = disagree n = number of pupils A = agree**
**SD = strongly disagree (%) = percentage N = neutral**

From Table 12, the pre-test results on pupils" interest in the study of science show that seventy-five (73.5%) of the pupils saw integrated science classes as interesting while seventeen (16.7%) felt otherwise. On an item that sought to find out if pupils liked integrated science more than other subjects, forty-eight (47%) of the pupils responded in the affirmative while forty (39.2%) disagreed. Thirty-one (30.4%) of the pupils agreed that they feared integrated science. Fifty-one (50%) of the pupils who took part in the study indicated that they liked the way their science teachers were teaching them while twenty-five (24.5%) did not like their teachers" way of teaching them.

**Table 13:**
***Results of Pupils' Questionnaire on Pupils' Interest in the Study of Integrated Science after Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| Integrated science classes are interesting | 45 (44.1) | 51 (50.1) | 3 (2.9) | 3 (2.9) | 0 (0) |
| I like integrated science more than other subjects | 24 (23.5) | 62 (60.8) | 0 (0) | 16 (15.7) | 0 (0) |
| I fear integrated science so much | 0 (0) | 24 (23.5) | 0 (0) | 41 (40.2) | 37 (36.3) |
| I like the way my integrated science teacher teaches us | 56 (54.9) | 38 (37.3) | 0 (0) | 1 (1.0) | 0 (0) |

**SA = strongly agree D = disagree n = number of pupils A = agree**
**SD = strongly disagree (%) = percentage N = neutral**

The results in Table 13 shows that ninety-six (94.1%) of the pupils thought that integrated science classes were interesting while three (2.9%) disagreed. Also, eighty-six (84.3%) liked integrated science more than other subjects. The number of respondents who indicated their fear for integrated science was twenty-four (23.5%). Ninety-four (92.2%) of the pupils indicated that they liked the way their integrated science teachers were teaching them while one person indicated dislike for the teachers" way of teaching.

Analysis of results from Tables 12 and 13 show that pupils" interest in the study of integrated science increased as they were introduced to concept mapping. For instance, the number of pupils who saw integrated science classes as interesting before the intervention increased from 75 to 96 after the intervention. Also, the number of respondents who showed that they liked integrated science as a subject more than other subjects increased from 48 to 86. Furthermore, while only 51 of the pupils liked their teachers" way of teaching before the concept mapping workshop was organized for their teachers, 94 of them developed interest in the way their teachers taught them after the workshop. On the other hand, while 25 of the pupils disliked their teachers" way of teaching before the workshop, only one of the pupils showed dislike for the teacher"s way of teaching. Again, those who indicated fear for integrated science reduced from 31 before the intervention to 24 after the intervention. These findings are in conformity with the findings of Abimbola (1997), who showed that concept mapping generally had positive effect on students" attitude when used as an instructional tool.

The increased interest of the pupils in the study of integrated science can be based on the fact that the concept mapping approach which is learner centred offered more opportunities to the pupils to interact with their mates than previously. Most pupils have the tendency of working in groups than doing independent work and hence enjoyed lessons involving concept mapping than the traditional expository approach that was previously used in teaching them. This position is in line with Anamuah-Mensah, Otuka and Ngman-Wara (1996), who reported that students preferred concept mapping as a teaching approach to the traditional method of teaching. The increased interest can also be attributed to the fact that the concept mapping approach used in teaching them after the workshop enhanced their understanding of what they were taught and also helped in improving their academic performance. This position conforms to that of Freeman (2004), who was of the view that when pupils hold discussions during construction of concept maps, the presentation of the concepts by pupils to their mates brings a greater conceptual clarity for themselves.

It is an undeniable fact that the excitements and satisfaction that pupils get when they perform well in class exercises, tests, take home assignments and examinations in particular subjects urge them to develop interest in those subjects. Working in groups can help learners to provide more accurate answers to questions than working individually and independently because during discussions among peers, learners become aware of their misconceptions (Freeman, 2004).

**Research Question 7:**

**To what extent will the use of concept mapping by JHS integrated science teachers improve pupils' participation in integrated science lessons?**

Responses from pre-test and posttest of pupils‟ questionnaire on participation, observations made during science lessons as well as the interviews of teachers were analysed to determine the effect of concept mapping on pupils‟ participation in integrated science lessons. Pupils‟ responses to questionnaire before and after intervention are presented in Tables 14 and 15 respectively.

**Table 14:**
***Results of Pupils' Questionnaire on Pupils' Participation in Integrated Science Lessons before Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I often have the opportunity to interact with my class mates during integrated science lessons | 40 (39.2) | 29 (28.4) | 10 (9.8) | 18 (17.6) | 3 (2.9) |
| I ask a lot of questions during integrated science lessons | 36 (35.3) | 20 (19.6) | 4 (3.9) | 35 (34.3) | 7 (6.9) |
| I usually answer questions in class when called by the teacher | 36 (35.3) | 29 (28.4) | 5 (4.9) | 25 (24.5) | 5 (4.9) |
| I often do not pay attention in integrated science class | 0 (0) | 1 (1.0) | 16 (15.7) | 5 (4.9) | 77 (75.5) |
| I often sleep in integrated science class | 0 (0) | 7 (6.9) | 3 (2.9) | 15 (14.7) | 77(75.5) |
| I often read other subjects during integrated science lessons | 0(0) | 0(0) | 8(7.8) | 21(20.6) | 69(67.6) |

**SA = strongly agree D = disagree n = number of pupils A = agree**
**SD = strongly disagree (%) = percentage N = neutral**

From Table 14, it had been noted that sixty-nine of the pupils involved in the study representing 67.6% indicated that they often had opportunities to interact with mates during science lessons before the concept mapping intervention. For an item that states „I ask a lot of questions during integrated science lessons", fifty-six pupils representing 54.9% of the respondents were in agreement during the pre-intervention test. Also, in the pre-intervention test, sixty-five (63.7%) of respondents to the pupils" questionnaire indicated that they answered questions in class. It was noted from the pre-test results that seven of the respondents (6.9%) indicated that they often slept in integrated science class.

**Table 15:**
***Results of Pupils' Questionnaire on Participation in Integrated Science Lessons after Intervention***

| ITEM | SA n(%) | A n(%) | N n(%) | DA n(%) | SD n(%) |
|---|---|---|---|---|---|
| I often have the opportunity to interact with my class mates during integrated science lessons. | 62 (60.8) | 40 (39.2) | 0 (0) | 0 (0) | 0 (0) |
| I ask a lot of questions during integrated science lessons | 41 (40.2) | 18 (17.6) | 1 (1.0) | 41 (40.2) | 1 (1.0) |
| I usually answer questions in class when called by the teacher | 41 (40.2) | 39 (38.2) | 1 (1.0) | 20 (19.6) | 1 (1.0) |
| I often do not pay attention in integrated science class. | 0 (0) | 1 (1.0) | 14 (13.7) | 5 (4.9) | 82 (80.4) |
| I often sleep in integrated science class. | 0 (0) | 0 (0) | 0 (0) | 17 (16.7) | 85 (83.3) |
| I often read other subjects during integrated science lessons. | 0 (0) | 0 (0) | 0 (0) | 24 (23.5) | 78 (76.5) |

**SA = strongly agree D = disagree n = number of pupils A = agree**
**SD = strongly disagree (%) = percentage N = neutral**

From Table 15, it can be noticed that all the respondents in the posttest of the questionnaires on pupils‟ participation representing 100% indicated that they interacted with mates during science lessons. Fifty-nine of the respondents (57.8%) indicated that they asked a lot of questions during integrated science lessons. Again, eighty (78.4%) of the pupils indicated that they answered questions in class. None of the respondents in the posttest agreed to the statement that suggested they slept during integrated science lessons.

It was observed from Tables 14 and 15 that pupils‟ participation in integrated science lessons improved from beginning to the end of the study. In other words, pupils‟ participation in integrated science lessons improved after the concept mapping workshop for the science teachers. For instance, before the concept mapping workshop, only sixty-nine out of the 102 pupils had opportunities to interact with mates during integrated science lessons but the posttest results showed that all the respondents had such opportunities after the workshop. This can be explained on the basis that during some of the lessons, pupils were put in small groups and asked to construct concept maps and such activities required dialogue and consensus building among the individuals. This is in line with the study conducted by Anamuah-Mensah, Otuka and Ngman-Wara (1996), in which the study samples commented that the discussions between teacher and students and among students themselves during concept mapping class promoted friendliness and cooperation among them and above all understanding of the concept.

The results also show that more of the pupils (59) representing 57.8% asked questions during integrated science lessons after the workshop for their teachers as compared to the 56 of them representing 54.9% who did before the workshop. Similarly, more pupils were involved in answering of questions after the workshop than before. The numbers for pretest and posttest results on answering of questions are 65 and 80 respectively. This is attributable to the fact that concept mapping helped the pupils to have better understanding and therefore they were in the position to supply answers to the questions asked. This position is supported by Freeman (2004) who contended that during construction of concept maps in groups, pupils hold discussions in which presentation of the concepts by pupils to their mates brings a greater conceptual clarity for themselves. In addition, while seven of the pupils agreed that they did sleep in class before the workshop, none of them indicated during the posttest that they slept during integrated science lessons. This observation could mean that the pupils who used to sleep in class did so because they were not actively involved in the teaching and learning process due to the expository approach that was being used.

Analysis of items under participation in the questionnaire was done to determine the mean scores for participation of pupils in integrated science lessons in each of the five schools and paired sample t-test was performed to ascertain the significance of the mean differences. The result of the t-test is presented in Tables 16 to 21.

**Table 16:**
***Results of Paired Sample t-test for Mean Scores on Pupils' Participation in Integrated Science Lessons before and after Intervention (School 'A') Using Questionnaire***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| Before Intervention | 26 | 4.03 | 0.63 | 4.47 | $7.38839\times10^{-5}$* |
| After Intervention | 26 | 4.42 | 0.46 | | |

* Significant at P < .05 Tabulated t=1.71

From Table 16, pre intervention (M= 4.03, SD=0.63) and post intervention (M=4.42, SD= 0.46) showed significant improvement in pupils" participation from school „A".

**Table 17:**
***Results of Paired Sample t-test for Mean Scores on Pupils' Participation in Integrated Science Lessons before and after Intervention (School 'B') Using Questionnaire***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| Before Intervention | 22 | 4.18 | 0.62 | 4.00 | 0.0003* |
| After Intervention | 22 | 4.45 | 0.47 | | |

* Significant at P < .05 Tabulated t=1.72

From Table 17, pre-intervention (M= 4.18, SD=0.62) and post intervention (M=4.45, SD= 0.47) showed significant improvement in pupils" participation from school „B".

**Table 18:**
***Results of Paired Sample t-test for Mean Scores on Pupils' Participation in Integrated Science Lessons before and after Intervention (School 'C') Using Questionnaire***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| Before Intervention | 15 | 3.88 | 0.63 | 4.36 | 0.0003* |
| After Intervention | 15 | 4.23 | 0.50 | | |

* Significant at P < .05 Tabulated t=1.76

From Table 18, pre intervention (M= 3.88, SD=0.63) and post intervention (M=4.23, SD= 0.50) showed significant improvement in pupils‟ participation from school „C‟.

**Table 19:**
***Results of Paired Sample t-test for Mean Scores on Pupils' Participation in Integrated Science Lessons before and after Intervention (School 'D') Using Questionnaire***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| Before Intervention | 23 | 4.19 | 0.50 | 4.57 | $7.51654 \times 10^{-5}$* |
| After Intervention | 23 | 4.39 | 0.46 | | |

* Significant at P < .05 Tabulated t=1.72

From Table 19, pre intervention (M= 4.19, SD=0.50) and post intervention (M=4.39, SD= 0.46) showed significant improvement in pupils‟ participation from school „D‟.

**Table 20:**
***Results of Paired Sample t-test for Mean Scores on Pupils' Participation in Integrated Science Lessons before and after Intervention (School 'E') Using Questionnaire***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| Before Intervention | 16 | 4.29 | 0.45 | 2.61 | 0.01* |
| After Intervention | 16 | 4.44 | 0.47 | | |

* Significant at P < .05 Tabulated t=1.75

From Table 20, pre intervention (M= 4.29, SD=0.45) and post intervention (M=4.44, SD= 0.47) showed significant improvement in pupils‟ participation from school „E‟.

**Table 21:**
***Results of Paired Sample t-test for Mean Scores on Pupils' Participation in Integrated Science Lessons before and after Intervention (All Schools) Using Questionnaire***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| Before Intervention | 102 | 4.12 | 0.58 | 8.528 | $8.13636\times10^{-14}$* |
| After Intervention | 102 | 4.40 | 0.46 | | |

* Significant at P < .05 Tabulated t=1.66

From Table 21, pre intervention (M= 4.12, SD=0.58) and post intervention (M=4.40, SD= 0.46) showed there was significant improvement in pupils‟ participation generally in all the five schools. This improvement in pupils‟ participation can be attributed to the concept mapping approach. This position is collaborated by data obtained on pupils‟ participation from the lesson observation check list as presented in Table 22.

**Table 22:**
***Results on Pupils' Activities from Lesson Observations in all the Five Schools***

| ACTIVITY | Very often | Often | Few times | Never |
|---|---|---|---|---|
| Carry out instructions given by the teacher. | 2 | 1 | 2 | 0 |
| Interact with mates during construction of concept maps. | 2 | 3 | 0 | 0 |
| Eager to present concept map on the board | 2 | 1 | 1 | 1 |
| Presents concept map on the board alone or with group members | 0 | 3 | 2 | 0 |
| Answers questions asked by teacher. Freedom to express own ideas is limited. | 2 | 2 | 1 | 0 |
| Answers questions asked by mates. | 1 | 3 | 1 | 0 |
| Suggests some concepts to be mapped | 0 | 1 | 2 | 2 |
| Playful during group activities. | 0 | 0 | 4 | 1 |
| Sleeps during class discussions. | 0 | 0 | 1 | 4 |

**Table 22 (Continued)**

| ACTIVITY | Very often | Often | Few times | Never |
|---|---|---|---|---|
| Asks thoughtful questions when concept map is Used; Freedom to develop opinions and line of thought not restricted. | 0 | 1 | 3 | 1 |

Analysis of data obtained on ten items relating to pupils‟ activities from the lesson observation checklist was done to determine the mean score for participation of pupils from each of the schools. A mean score of 3.1 to 4.0 was considered as high, 2.1 to 3.0 was considered moderate while 2 and below was considered low in terms of pupils‟ participation. The analysis showed that the mean participation scores for pupils in schools A, B, C, D and E were 3.33, 2.78, 2.89, 2.78 and 2.78 respectively. A grand total mean participation score of 2.91 (SD = 0.24) was calculated for pupils from the five schools. These results indicate that in general, there was moderate level of pupils‟ participation based on data from the lesson observation check list.

This position was further supported by answers provided by some teachers and pupils during the interview section of the study held on 26th and 27th of March, 2015. Answers provided by both teachers and pupils to questions posed to them by the researcher during the interview showed that the concept mapping approach generally had positive effect on teachers and pupils. When a teacher was asked by the researcher, „How did you see the performance of your pupils in lessons involving concept mapping?‟, the teacher answered that, "The introduction of concept mapping has improved the level of participation of pupils in my lessons such that even those who don‟t normally answer any question in class are now beginning to answer questions and not only that but also providing right answers". When a pupil was asked whether he saw concept mapping interesting, he said "Yes. Once something makes you get vivid understanding about a topic, you would like it". Another pupil also answered "Yes. It is very good; it is easy for presenting answers to questions and when we use it for our teacher, he gives us good marks". It seems that pupils developed interest in concept mapping because it was helping them to get clearer understanding of what was being taught and also helping them to score better marks in tests than before. The results of this current study are in line with the findings of Cheema and Mirza (2013) who found that concept mapping provided opportunity for active involvement of students in their learning process and hence enhanced their thinking ability while cross questioning and thinking for seeking solutions.

From the results analysis above, it is quite clear that the use of concept mapping significantly improved pupils" participation in integrated science lessons, hence the null hypothesis 2 which states „The use of concept mapping by JHS science teachers in Adaklu District will not significantly improve their pupils" participation in integrated science lessons", is rejected.

**Research Question 8:**

**To what extent will the use of concept mapping by JHS integrated science teachers impact on academic performance of their pupils?**

To analyse the effect of concept mapping on pupils" academic performance, continuous assessment scores of pupils from first term and early part of second term when concept mapping was not introduced were compared with their science achievement test scores which were obtained after the exposure of both teachers and pupils to concept mapping. The results are presented in Tables 23 to 25.

**Table 23:**
***Results of Paired Sample t-tests for Mean First Term Continuous Assessment Scores and Second Term Continuous Assessment Scores of Pupils from All Five Schools***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| First Term C. A | 102 | 36.02 | 8.49 | 1.65 | 0.05 |
| Second Term C. A | 102 | 37.04 | 8.78 | | |

Not Significant at $P \leq .05$ Tabulated t = 1.66

From Table 23, the mean difference of 1.02 between first term continuous assessment scores and second term continuous assessment scores was not significant at t (101) = 1.65, p = 0.05 at 95% confidence interval.

**Table 24:**
***Results of Paired Sample t-tests for Mean First Term Continuous Assessment Scores and Science Achievement Test Scores of Pupils from All Five Schools***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| First Term C. A | 102 | 36.02 | 8.49 | 9.83 | $1.09\times10^{-16}$** |
| SAT | 102 | 42.96 | 8.30 | | |

**Significant at $P \leq .05$ Tabulated t = 1.66

The results from Table 24 showed that the mean difference of 6.94 between first term continuous assessment scores and the science achievement test scores, was very significant at t (101) = 9.83, p = $1.09\times10^{-16}$ at 95% confidence interval.

**Table 25:**
***Results of Paired Sample t-tests for Mean Second Term Continuous Assessment Scores and Science Achievement Test Scores of Pupils from All Five Schools***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| Second Term C. A | 102 | 37.04 | 8.78 | 9.92 | $6.76\times10^{17}$** |
| SAT | 102 | 42.96 | 8.30 | | |

**Significant at $P \leq .05$ Tabulated t= 1.66

From Table 25, it was observed that the mean difference of 5.92 between second term continuous assessment scores and the science achievement test scores was very significant at t (101) = 9.92, p = $6.76\times10^{-17}$ at 95% confidence interval.

A careful analysis of results from Tables 23 to 25 reveals that between first and second terms" continuous assessment scores, when concept mapping approach was not used in the teaching and learning process, the mean difference was not significant. However, comparing the science achievement test scores (which were obtained after the use of concept mapping in the teaching and learning process) with either of the two sets of continuous assessment scores, the mean differences were very significant. The significant improvement in performance can therefore be attributed to the concept mapping approach. This result is consistent with the findings of Berry and Chew (2008) who discovered that lower performing students who participated in constructing concept maps improved their exam performance such that they were indistinguishable from stronger students who did not participate in the concept map construction. They also found that, for initially better performing students who participated in concept map construction, the difference between their exam performance and that of lower performing students who did not participate in the map construction increased. The findings of the present study are also in line with those of Karakuyu (2010) who found that using concept mapping approach in instruction was more effective than traditional instruction in improving physics achievement of the participating students.

Based on the above analysis, the null hypothesis 3 which states „There will be no significant improvement in pupils‟ academic performance in integrated science when taught through concept mapping‟, is rejected.

**Research Question 9:**

**Is there Correlation between Pupils' Concept Map Scores and Science Achievement Test Scores?**

Pupils‟ concept map scores and science achievement test scores (Appendix O) were compared to see if pupils were performing similarly in map construction and writing of text structured examinations (multiple choice and essay items). This was done using, frequencies, percentages, bar charts, paired sample t-test and Pearson correlation coefficient.

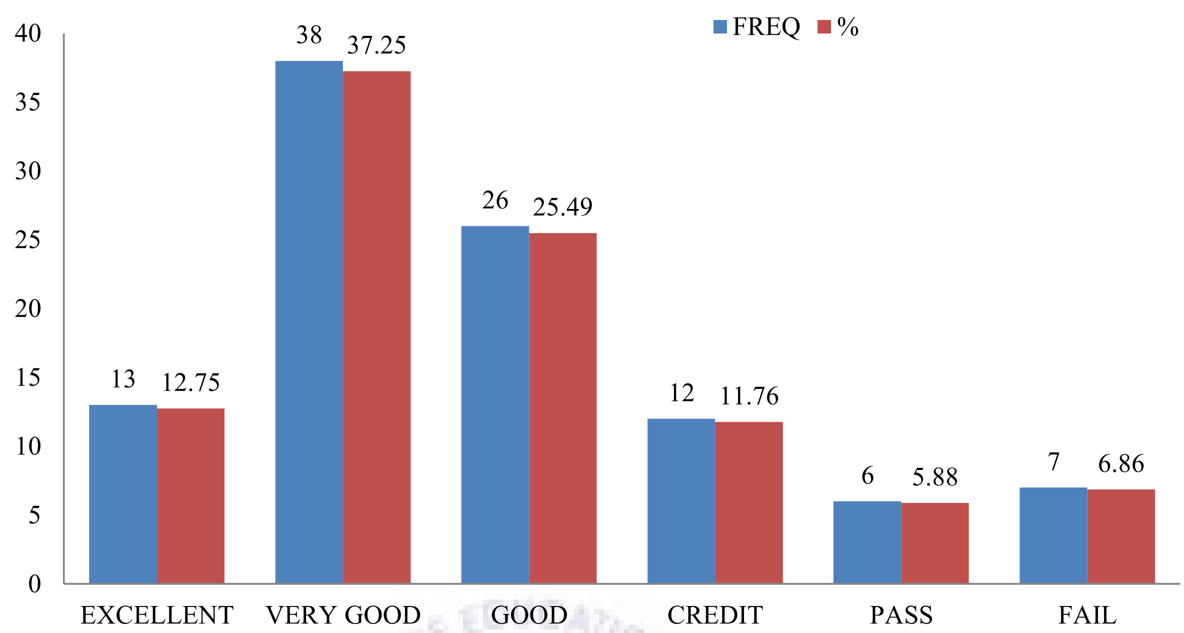


***Figure 1*:**
**A bar chart showing the quality of Concept Maps constructed by pupils from all five schools**

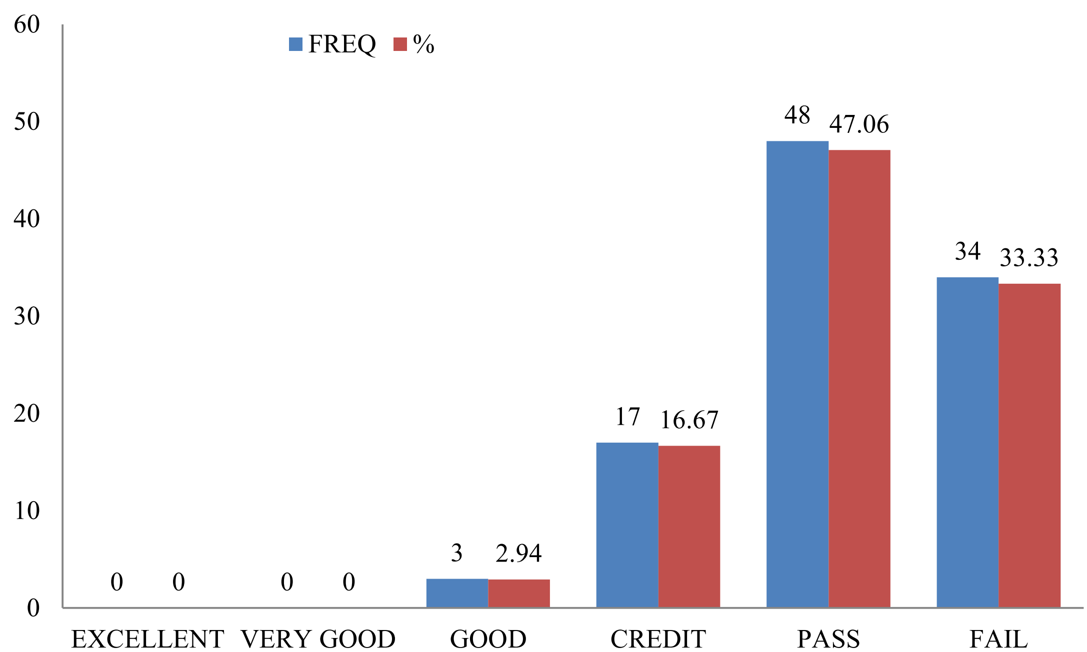


***Figure 2*:**

**A bar chart showing the rating of Science Achievement Test scores of pupils from all five schools**

From Figures 1 and 2, it has been observed that the pupils performed better in concept map construction than in the science achievement test. For instance, thirteen pupils representing 12.75% performed excellently and thirty-eight (37.25%) obtained very good scores in map construction while there was no excellent nor very good scores recorded in science achievement test. Also, twenty-six (25.49%) of the pupils had good concept map scores as compared to three (2.94%) in the science achievement test. Again, only seven, representing 6.86% of the pupils failed in concept map construction compared with thirty-four (33.33%) in the science achievement test. Paired sample t-test was performed to determine the significance of the mean difference between concept map scores and science achievement test scores. The results are presented in Table 23.

**Table 26:**
***Results of Paired Sample t-test for Mean Concept Map Scores and Science Achievement Test Scores***

| Variable | N | Mean | SD | t | p |
|---|---|---|---|---|---|
| **C'Map Scores** | 102 | 65.15 | 13.26 | 16.30 | $2.399\times10^{-30}$ ** |
| **SAT Scores** | 102 | 42.96 | 8.30 | | |

**Significant at P ≤ .05 Tabulated t=1.66

The results of the t-test between concept map scores and science achievement test scores showed that the concept map mean score (M=65.15 and SD= 13.26) was significantly higher than the science achievement test mean score (M=42.96, SD=8.30). The difference in mean scores is attributable to the fact that the pupils generally had difficulty expressing their thoughts in English language. Since the science achievement test contained essay type of items compared to the concept mapping items where both the concepts and the linking phrases were provided for the pupils to just join them to form propositions, it was more difficult for them to answer the science achievement test questions than the concept mapping questions. This position was supported by answers provided by some of the teachers during the interview section of the study. For instance, on a question which read, „How did you find the academic performance of your pupils in Integrated Science after being exposed to concept mapping?", a teacher said "Concept mapping has helped improved the academic performance of my pupils". "This is because whenever I used it as a scaffold, it helped the pupils to understand the concepts being taught easier and better and even in class exercises, it helped a lot of the pupils who were scoring very low marks to now score at least pass marks". This position is consistent with the findings of Appaw (2011) who found that when concept mapping was used as an instructional strategy in teaching photosynthesis and internal respiration, students easily grasped the concepts. Another teacher said "My greatest problem with the pupils I teach is that about 95% of them cannot read, write or speak English to any appreciable level and so classroom communication is difficult". "However, with the introduction of concept mapping, a lot of them are even beginning to construct good sentences because they read the propositions from the maps displayed to guide them".

**Table 27:**
***Results of Correlation between Concept Map Scores and Science Achievement Test Scores of Pupils from All Five Schools***

| | | Science Achievement |
|---|---|---|
| **Concept Map** | Pearson correlation (r) | 0.25 |
| | Sig. (Two tailed) | 0.01** |
| | N | 102 |

** Significant at $P \leq .05$

According to Cohen (1988), the strength of correlation of r = 0.10 to 0.29 is small, r = 0.30 to 0.49 is medium and r = 0.50 to 1.0 is large. The results from Table 27 have shown that there was generally a small or weak but significant positive correlation between pupils" concept map scores and science achievement test scores r (101) = 0.25, p = 0.01 at 95% confidence interval. These results are in conformity with the findings of Schau and Mattern (1997) who found that posttest scores of graduate students in introductory statistic correlated significantly with final course grades. The findings of the current study show that the pupils were generally performing quite similar on the concept map items and essay items designed to measure similar content. The $r^2$ which is the coefficient of determination was computed and found to be 0.06. This was multiplied by 100% to obtain 6% shared variance. Analysis of data on individual schools however revealed that there was mixed correlation among the five schools. The results are presented in Tables 28 to 32.

**Table 28:**
***Results of Correlation between Concept Map Scores and Science Achievement Test Scores of Pupils from School 'A'***

| | | Science Achievement |
|---|---|---|
| **Concept Map** | Pearson correlation (r) | 0.04 |
| | Sig. (Two-tailed) | 0.831 |
| | N | 26 |

Not Significant at P < .05

From Table 28, r (25) = 0.04, p = 0.83 show that there was low or weak positive correlation between pupils" concept map scores and science achievement test scores in school „A". This positive correlation was very insignificant at 95% confidence interval.

**Table 29:**
***Results of Correlation between Concept Map Scores and Science Achievement Test Scores of Pupils from School 'B'***

| | | Science Achievement |
|---|---|---|
| **Concept Map** | Pearson correlation (r) | 0.17 |
| | Sig. (Two tailed) | 0.462 |
| | N | 22 |

Not Significant at P < .05

From Table 29, r (21) = 0.17, p = 0.46 show that there was low or weak positive correlation between pupils‟ concept map scores and science achievement test scores in school „B‟. The correlation was not significant at 95% confidence interval.

**Table 30:**
***Results of Correlation between Concept Map Scores and Science Achievement Test Scores of Pupils from School 'C'***

| | | Science Achievement |
|---|---|---|
| **Concept Map** | Pearson correlation (r) | 0.59 |
| | Sig. (Two tailed) | 0.02* |
| | N | 15 |

* Significant at P < .05

**Table 31:**
***Results of Correlation between Concept Map Scores and Science Achievement Test Scores of Pupils from School 'D'***

| | | Science Achievement |
|---|---|---|
| **Concept Map** | Pearson correlation (r) | 0.50 |
| | Sig. (Two tailed) | 0.015* |
| | N | 23 |

* Significant at P < .05

The results from Table 30 shows that in school C, the correlation coefficient r (14) = 0.59, p = 0.02. Results from Table 31 also reveals that in school „D", r (22) =0.50, p = 0.02. These results mean that there were strong positive correlation between pupils" concept map scores and science achievement test scores in schools „C" and „D". The positive correlations in these schools were also significant at 95% confidence interval.

**Table 32:**
***Results of Correlation between Concept Map Scores and Science Achievement Test Scores of Pupils from School 'E'***

| | | Science Achievement |
|---|---|---|
| **Concept Map** | Pearson correlation (r) | 0.33 |
| | Sig. (Two tailed) | 0.211 |
| | N | 16 |

Not Significant at P < .05

From Table 32, it was observed that in school „E", the correlation coefficient r (15) = 0.33, p = 0.21 indicating that there was moderate positive correlation between pupils" concept map scores and science achievement test scores in school „E". It was also observed that the correlation in this school was insignificant at 95% confidence interval.

The mixed correlation obtained in the results above suggests that some of the pupils who might have scored low in the science achievement test might have scored high in the concept map construction, and vice versa. This is in line with Novak, Gowin and Johansen (1983) who showed that concept mapping scores were not significantly related to students" science achievement test scores. This indicates that sometimes, pupils" concept map scores may not correlate with their achievement test scores. According to

Asan (2007), strong positive correlation provides evidence for the content validity of the concept map scores.

# CHAPTER FIVE

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### Overview

This is the concluding chapter of the study. It summarizes the study and presents the key findings of the research. Also, recommendations and suggestions for future research are made.

### Summary of the Study

The study sought to investigate the impact of JHS science teachers‟ use of concept mapping on the academic performance of their pupils in integrated science. The study employed the mixed method research design. It involved twenty-five (25) JHS science teachers, five (5) schools and one hundred and two (102) JHS 2 pupils from the Adaklu District of the Volta Region. The schools were selected using convenient sampling based on accessibility. Second year classes were used for the study because the topics under consideration are in the JHS 2 syllabus. There was pretest-posttest of pupils‟ and teachers‟ questionnaires. A two-day workshop on concept mapping was organized for all the JHS science teachers involved in the study soon after the pretest of the questionnaires. For the pretest, the inter-ratter reliability of teachers‟ questionnaire was determined to be 0.99 while that of pupils‟ questionnaire was 0.97. For the posttest, the inter-ratter reliability of teachers‟ questionnaire was 0.99 and that of pupils‟ questionnaire was also 0.99. A Cronbach alpha coefficient of reliability of 0.89 was determined for the science achievement test through pilot testing. Also, the inter-ratter reliability of pupils‟ concept map scores was found to be 0.97.

**Key Findings**

1. Results from pretest of the questionnaire indicate that most of the teachers had no knowledge of Concept Mapping and were therefore not using it as a teaching approach before this research study. However, results from the posttest of teachers‟ questionnaire showed that the teachers developed positive attitudes towards concept mapping after they had been exposed to the approach.
2. Analysis of data from the lesson observation checklist showed that the level of pupils‟ participation was moderate to high during the intervention. A comparison of pupils‟ pretest and posttest mean scores on participation indicated that there was a significant improvement in pupils‟ participation in integrated science lessons.
3. Comparison of pupils‟ continuous assessment scores and science achievement test scores revealed that there was generally a significant improvement in pupils‟ academic performance in integrated science owing to concept mapping approach.
4. Data analysis indicated that there was generally a significant positive correlation between pupils‟ concept map scores and science achievement test scores even though the pupils performed better in concept mapping than in writing essay type test.
5. It was noted through lesson observation and interviews of teachers and pupils that most of the JHS pupils could not express themselves fairly well in the English language; making classroom communication very difficult.

**Conclusion**

This study provides an insight into earlier research works conducted in concept mapping and the effect of the approach on learning. Based on the findings of the present study, it was concluded that concept mapping strategy has the ability to impact positively on pupils‟ participation in integrated science lessons, especially when they work in groups, helping to make pupils‟ learning more meaningful. It was also concluded that concept mapping is an effective tool in improving pupils‟ academic performance in integrated science. From this present study, the mixed positive correlation between pupils‟ concept map scores and science achievement test scores indicates that some of the pupils who obtained high scores in science achievement test are likely to score low in concept map construction.

Finally, the findings from this study show that both teachers and pupils developed positive perception about concept mapping and that the approach is capable of helping teachers and pupils to develop more positive attitudes towards the teaching and learning of integrated science.

**Recommendations**

1. Concept mapping should be adopted as a teaching method by the JHS integrated science teachers and other subject teachers in the Adaklu District because of its effectiveness in giving opportunity to pupils to see the links between concepts and its potential of improving upon the academic performance of pupils at the Basic Education Certificate Examination (BECE).
2. The training officer and the subject coordinators at the Adaklu District Education Office should incorporate concept mapping into their in-service training

programmes for teachers so that teachers in the District will be equipped with the knowledge and skills of concept mapping to effectively combine it with other methods in the teaching and learning process.

3. The Adaklu District Education Directorate should embark on reading crusades to help the pupils to be able to communicate fairly well during the teaching and learning process.

**Suggestions for Further Research**

1. The study may be replicated in other districts in the Volta Region of Ghana and the period for the intervention should be extended to cover a whole term so that more topics can be covered.
2. Future research should be carried out with two different groups at the same level. One group may be taught with concept mapping strategy and the other group with the Learning Cycle approach and compare their differential effects on pupils" academic performance.

# REFERENCES


Adlaon, R. B. (2012). Assessing effectiveness of concept map as instructional tool in high school biology. *Asia Pacific Journal of Research, 1* (24), 53-65. Retrieved on September 26, 2014 from www.apjor.com

Aggarwal, Y. P. (1986). Statistical Methods, Concepts, Applications and Computations. New Delhi: Sterling Publication. 275pp.

Aidman, E. V., & Egan, G. (1998). Academic assessment through computerized Concept mapping: Validating a method of implicit map reconstruction. *International Journal of Instructional Media, 25*, 277-294. Retrieved on December 6, 2013 from http://www.editlib.org/p/85426.

Ajaja, O. P. & Eravwoke, O. U. (2010). Effects of cooperative learning strategy on junior secondary school students‟ achievement in integrated science. *Electronic Journal of Science Education, 14* (1), 1–18. Retrieved on April 28, 2014 from http://www.academicjournals.org/IJSTER.

Ajaja, O. P. (2011). Concept mapping as a study skill: Effects on students‟ achievement in biology. *International Journal of Science and Technology Education Research*, *3* (1), 49–57. Retrieved on February 18, 2014 from http://www.academicjournals.org/IJSTER.

Amin, M. E, (2005). Social science research; Conception, Methodology and Analysis. Makerere University Press, Kampala. Retrieved on November 17, 2014 from www.ljemail.org/reference/ReferencesPapers.aspx

Ampiah, J. G. & Quartey, I. (2003). Concept mapping as a teaching and learning technique with senior secondary school students in Ghana. *Journal of Educational Development and Practice*, *1* (1), 19-43.

Anamuah-Mensah, J., Otuka, J., & Ngman-Wara, E. (1995). Introduction of concept mapping in junior secondary school using energy. *Journal of Science and Mathematics Education, 2*(1), 55-69.

Anamuah-Mensah, J., Otuka, J., & Ngman-Wara, E. (1996). Concept mapping as a teaching and learning technique: Ghana secondary school students‟ experience. *Journal of Practice in Education for Development, 1* (3), 11-16.

Anderson, O. R. (1992). Some interrelationships between constructivist models of learning and current neurobiological theory, with implications for science education. *Journal of Research in Science Teaching, 19* (10), 1037-1058. Retrieved on December 7, 2013 from http://shbieejournal.files.wordpress.com/20.

Antwi, M.K. (1992). *Education, Society and development in Ghana.* Accra: Unimax Publishers Ltd.

Appaw, E. L. (2011). Comparing concept mapping and traditional methods in teaching some selected topics in biology at the senior high school level in Ghana. Retrieved on June 25, 2014 from *ir.ucc.edu.gh › ... › Department of Science and Mathematics Education*.

Ary, D., Jacobs, L. C. & Razavieh, A. (2002). *Introduction to research in education.* (6th ed.). Belmont: Wadsworth Group.

Asan, A. (2007). Concept mapping in science class: A case study of fifth grade students. *Education Technology and Society, 10* (1), 186-195.

Ashton P. & Crocker, L. (1987). Systematic Study of Planned Variations: The essential focus of teacher education reform. *Journal of Teacher Education*, *38*, 2-8. Retrieved on August 27, 2013 from https://books.google.com.gh/books?isbn

Asiegbor, I. K. (2014). S*trategies for improving the performance of BECE candidates in Adaklu District*. A paper presented by the District Director of Education at a stakeholders meeting on August 21, 2014 in the Adaklu District Assembly Conference Hall.

Ausubel, D. P. (1963). *The psychology of meaningful verbal learning*. New York: Grune and Stratton. Retrieved on November 27, 2013 from http://itls.usu.edu/~mimi/courses/6260/theorists/ausubel/.

Baumgartner, T. A., Strog, C. H. & Hensley, L. D. (2002). Conducting and reading research in health and human performance. New York: McGraw-Hill. 432pp.

Bello, G. & Abimbola, I. O. (1997). Gender influence on biology students‟ concept mapping ability and achievement in evolution. *Journal of Science Teaching and Learning, 3* (1&2), 8-17. Retrieved on December 2, 2013 from http://www.unilorin.edu.ng/index.php/en/publication-faculty-of-education/1564-.

Bennett, J. (2003). Teaching and Learning Science. A Guide to Recent Research and Its Applications, London: Continuum. Retrieved on November 22, 2014 from http://books.google.com/books?isbn=1317551524

Berry, J. W. & Chew, S. L. (2008). Improving learning through interventions of student-generated questions and concept maps. *Teaching of Psychology, 35* (4), 305-312.

Best, J. W. & Kahn, J. W. (2006). Ethical issues in conducting research. New Delhi: Sage Publications. Retrieved on January 14, 2015 from https://www.sagepub.com/sites/default/

Borich, G. D. (2004). *Effective Teaching Methods* (5th ed.) New Jersey: Merrill, Prentice Hall.

Bunting, C., Coll, R. K. & Campbell, A. (2006). Students view of concept mapping used in introductory tertiary biology classes. *International Journal of Science and Mathematics Education, 4*, 641- 668.

Carmines, E. G. & Zeller, R. A. (1979). *Reliability and validity assessment*. Beverly Hills, California: Sage Publications.

Cheema, A. B. & Mirza, M. S. (2013). Effect of Concept Mapping On Students‟ Academic Achievement. *Journal of Research and Reflections in Education, 7* (2), 125 -132. Retrieved on March 12, 2015 from http://www.ue.edu.pk/jrre

Clark, I. F. & James, P. R. (2004). Using concept maps to plan an introductory structural geology course. *Journal of Geoscience Education, 52* (3), 224–230.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences.* (2nd ed.) Hillsdale, NJ: Erlbaum. 590pp. Retrieved on November 12, 2014 from http://coeweb.gsu.edu/coshima/.../One-Way%20BG%20ANOVA_modified.

Coll, R. K., France, B., & Taylor, I. (2005). The role of models and analogies in science: Implications from research. *International Journal of Science Education, 27*(2), 183-198.

Correia, P.R.M. (2012). The use of concept maps for knowledge management: from classrooms to research labs. Springer –Verlag. Retrieved on December 3, 2014 from http://www.each.usp.br/cmapping/.

Crandell, T. L., Naomi, A. & Soderston, C. (1996). Empirical evaluation of concept mapping: A job performance aid for writers. *Technical Communication, 43*, 157-158. Retrieved on December 13, 2013 from http://www.docstoc.com/docs/

Crowl, T. K., Kaminsky, S. & Podel, D. M. (1997). *Educational psychology: Windows on teaching*. Chicago: Brown and Benchmark Publishers. Retrieved on December 2, 2013 http://www.sciencedirect.com/science/article/pii/S1877042814036982

Curriculum Research and Development Division, (2007). Teaching Syllabus for Integrated Science (Junior High School). Accra: MESS. 60pp.

Curriculum Research and Development Division, (2012). Teaching Syllabus for Integrated Science (Junior High School). Accra: MoE. 49pp.

Czemiak, C. M. & Haney, J. J. (1998). The effect of collaborative concept mapping on elementary pre-service teachers‟ anxiety, efficacy and achievement in physical science. *Journal of Science Teacher Education, 9* (4), 303 – 320.

Dorough, D. K. & Rye, J. A. (1997). Mapping for understanding-using concept maps as windows to students‟ minds. *The Science Teacher, 64* (1), 36-41. Retrieved on December 8, 2013 from www.citejournal.org/vol7/iss1/.

Edmondson, K. M. (1994). Concept maps and the development of cases for problem-based learning. *Academic Medicine, 69* (2), 108–110. Retrieved on October 18, 2014 from https://books.google.com.gh/books?isbn=1930608934

Edmondson, K. M. (1995). Concept mapping for the development of medical curriculum. *Journal of Research in Science Teaching, 32* (7), 777–793.

Eshiet, I. (1987). Remedy for students poor performance in science, interment of local scientific experience in curriculum implementation to motivate learning. *Journal of the STAN, Vol. 125*, p. 2.

Esiobu, O. G. & Soyibo, K. (1995). Effects of concept mapping and vee mapping under three learning modes on students‟ cognitive achievement in ecology and genetic. *Journal of Research in Science Teaching, 32* (9), 971-995.

Flanders, N. A. (1970). Analysing Teaching Behaviour: Addition Wesley. *Bilingual Journal of Humanities & Social Sciences, 1*. Retrieved on May 31, 2014 from www.shodh.net.

Fobih, D. A., Akyeampong, K., & Koomson, A. K. (1999). *Ghana primary school development: final evaluation of project performance report.* Accra: MoE.

Freeman, L. A. (2004).The power and benefits of concept mapping: Measuring use, usefulness, ease of use, and satisfaction. *International Journal of Science Education, 26* (2), 151-169.

Good, T. & Brophy, J. (2000). *Looking in Classrooms* (8th ed.). New York: Addison Wesley Longman.

Greenwald, R., Hedges, L. & Laine, R. (1996). The effect of school resources on student achievement. *Review of Educational Research*, *66* (3), 361-396. Retrieved on August 13, 2014 from http://ejlts.ucdavis.

Imoko, B. I. (2005). Effect of concept mapping on students" achievement and interest in trigonometry *unpublished Ph.D Thesis*, University of Nigeria, Nsukka. Retrieved on June 17, 2015 from http://stemstates.org/assets/files/244_Effect%20of%20

Johnson, R. B. & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*, 14–26.

Johnson, R. B. & Turner, L. A. (2003). Data collection strategies in mixed methods research. In A.Tashakkori, and C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research,* pp. 297–319. Thousand Oaks, CA: Sage.

Karakuyu, Y. (2010). The effect of concept mapping on attitude and achievement in a physics course. *International Journal of the Physical Sciences, 5* (6), 724-737.

Karpicke, J. D. & Roediger, H. L. (2007). Expanding retrieval practice promotes short-term retention, but equally spaced retrieval enhances long-term retention. *Journal of Experimental Psychology: Learning, Memory and Cognition, 33,* pp. 704–719.

Kaya, O. S., Dogan, A. & Kilic, Z. (2005). University students" attitude towards chemistry laboratory: Effects of argumentative discourse accompanied by concept mapping. *Journal of Experimental Education, 25* (2), 201-213. Retrieved on December 10, 2013 from http://www.osmannafizkaya.com/yayinlar.html.

Kochhar, S.K. (1985*). Method and Technique of Teaching*. New Delhi: Sterling Publishers Ltd.

Lambiotte, J. & Dansereau, D. (1991). Effects of Knowledge Maps and Prior Knowledge on Recall of science lecture content. *Journal of Experimental Education*, *60*, pp. 189-201.

Lehmann, I. J. & Mehrens, A. (1991*). Measurement and Education in Education and Psychology*. Philadelphia: Harcourt Brace Publishers.

Lomask, M. S., Jacobson, L., & Hafner, L. P. (1995). The development and validation of an assessment of safety awareness of science teachers using interactive video disc technology. *Journal of Science Education, 79* (5), 519-534.

Macnamara, J. (1982). *Names for things: A study of human learning*. Cambridge, MA: M. I. T. Press. Retrieved on December 7, 2013 from http://books.google.com.gh/.

Markham, K. & Mintzes, J. (1994). The concept map as a research and evaluation tool: Further evidence of validity. *Journal of Research in Science Teaching*, *31* (1), 91-101.

Martin, B. L., Mintzes, J. J. & Clavijo, I. E. (2000). Restructuring knowledge in Biology: cognitive processes and metacognitive reflections. *International Journal of Science Education*, *22* (3), 303-323. Retrieved on November 2, 2013 from http://scholar.google.com/citations?user=li8h-6IAAAAJ&hl=en.

McAleese, R. (1999). Concept mapping: A critical review. *Innovations in Education and Teaching,* 36 (4), 351-360.

McClure, J. R., Sonak, B. & Suen, H. K. (1999). Concept map assessment of classroom learning: Reliability, validity and logistical practicality. *Journal of Research in Science Teaching, 36* (4), 475-492.

Meteku, C. (2010). The effect of concept mapping on students‟ achievement and attitudes towards biology. Unpublished M Phil. Thesis, *Department of Science and Mathematics Education,* University of Cape Coast.

Mintzes, J.J., Wandersee, J.H., & Novak, J.D. (2001). Assessing understanding in biology. *Journal of Biological Education*, *35* (3), 119-124.

Nesbit, J. C. & Adesope, O. O. (2006). Learning with concept and knowledge maps: A meta-analysis. *Review of Educational Research, 76,* pp. 413–448.

Nicoll, G., Francisco, J. & Nakhleh, M. (2001). A three-tier system for assessing concept map links: A methodological study. *International Journal of Science Education, 23* (8), 863-875.

Nobahar, B., Tabrizi, A. R. N. & Shaghaghi, M. (2013). The Effect of Concept Mapping on Iranian Intermediate EFL Learners' Self-efficacy and Expository Writing Accuracy. *Theory and Practice in Language Studies*, *3* (11), 2117-2127. Retrieved on February 18, 2015 from https://ojs.academypublisher.com

Novak, J. D. (1990b). Concept mapping: A useful tool for science education. *Journal of Research in Science Teaching, 27* (10), 937-949.

Novak, J. D. (1991). *Clarify with concept maps: A tool for students and teachers alike. The Science Teacher 58*, pp. 45-49. Retrieved on November 26, 2013 from www.hbcse.tifr.res.in/episteme/episteme-1/.

Novak, J. D. (1998). *Learning, creating and using knowledge: Concept maps as facilitative tools in schools and corporations.* Mahwah, NJ: Lawrence Eribaum Associates. Retrieved on November 26, 2013 from http://cmap.ihmc.us/docs/Origins.html .

Novak, J. D. (1998). Meta-cognitive strategies to help students learn how to learn. *National Association for Research in Science Teaching Newsletter, 29* (3), 59-74. Retrieved from on November 28, 2013 from http://www.narst.org/publications/.

Novak, J. D. (2002). Meaningful learning: The essential factor for conceptual change in limited or appropriate propositional hierarchies leading to empowerment of learners. *Science Education, 86* (4), 548-571.

Novak, J. D., & Canas, A. J. (2008). *The theory underlying concept maps and how to construct and use them.* Technical report IHMC Cmap tools 2006-01 Rev 01-2008 Institute of Human and Machine Cognition, Florida.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn*. New York: Cambridge University Press. Retrieved on December 3, 2014 from http://www.ihmc.us/groups/jnovak/

Novak, J. D., Gowin, D. B., & Johansen, G. T. (1983). The use of concept mapping and knowledge vee mapping with junior high school science students. *Science Education, 67* (5), 625-645.

Novak, J. D. & Musonda, D. (1991). A twelve-year longitudinal study of science concept learning. *American Educational Research Journal. 28*, pp. 117-153.

Nowell, A., Masini, B. & Quinn, D. W. (2001). *Learning from home while comparing abroad: Mathematics achievement in TIMSS and the first in the world schools*. TIMSS report, 2001.

OʽDonnell, A. M., Dansereau, D. F. & Hall, R. H. (2002) Knowledge maps as scaffolds for cognitive processing. *Educational Psychology Review 14*, pp. 71–86. Retrieved on October 18, 2014 from https://books.google.com.gh/books?isbn=1599049937

Okebukola, A. P. (2006). Attitude of teachers towards concept mapping and vee diagramming as meta-learning tools in science and mathematics *Journal of Educational Research, 34* (3), 201-213.

Okonkwo, I. G. A. (2011). Using concept mapping to teach separation of mixtures in SS1 in Ojokuku G.O. Amadi, E.O, Mfon E. Udo and Onwukwe E.O. *STAN chemistry panel workshop series* 7, pp. 79-82. Zaria, Max Chin Multimedia.

Payne, G., & Payne, J. J. (2005). *Key Concept in Social Research*. London: Sage Publications.

Pearsall, N. R., Skipper, J. & Mintzes, J. (1997). Knowledge restructuring in the life sciences: a longitudinal study of conceptual change in biology. *Science Education, 81* (2), 193-215. Retrieved on September 28, 2014 from https://books.google.com.gh/books?isbn=0857245155

Roth, W. M. & Roychoudhury, A. (1993). The concept map as a tool for the collaborative construction of knowledge: A microanalysis of high school physics students. *Journal of Research in Science Teaching*, *30* (5), 503-534. Retrieved on June 28, 2014 from https://books.google.com.gh/books?isbn=0080575331

Ruiz-Primo, M. and Shavelson, R. (1996). Problems and issues in the use of concept maps in science assessment. *Journal of Research in Science Teaching*, *33* (6), 569-600.

Saravanavel, P. (2011). Research Methodology. New Delhi: Kitab Mahal Publishers.

Schau, C. & Mattern, N. (1997). Use of map techniques in teaching applied statistics courses. *The American Statistician, 51* (2), 171-175.

Schiefele, U. & Csikszentmihalyi, M. (1995). Motivation and ability as factors in mathematics experience and achievement. *Journal of Research in Mathematics Education, 266* (2), 163-181. Retrieved on March 2, 2014 from http://jwilson.coe.uga.edu/EMAT7050/Students .

Shahi, R. S. (2010). Observation and analysis of classroom teaching at tertiary level. *Bilingual journal of Humanities & Social Sciences, 1*, (1), 1- 4.

Shepard, R. N. (1967). Recognition memory for words, sentences, and pictures. *Journal of Verbal Learning and Verbal Behaviour*, *6*, pp. 156-163.

Showers B (1990). Aiming for superior room instruction for all children; *A comprehensive state development model remedial and special education, 11*, pp. 35- 39.

Shulman, L. S. (1987). Knowledge and Teaching: Foundations of the new reform. *Harvard Education Review, 57*, 1-22. Retrieved on March 2, 2014 from https://www.ets.org/s/educator_licensure/ckt_handout.pdf

Simon, J. (2009). Curriculum changes using concept maps. *Accounting Education: an international journal, 19* (3), 301–307. UK: Taylor & Francis group.

Sizmur, S. & Osborne, J. (1997) Learning processes and collaborative concept mapping. *International Journal of Science Education*, *19* (10), 1117-1135.

Smith, D. (2003). Five principles for research ethics. *American Psychology Association*, *34* (1), 3. Retrieved on January 22, 2015 from www.apa.org>...>January2003

Taber, K. S. (1995). Development of students‟ understanding: A case study of stability and liability in cognitive structure. *Research in Science and Technology Education, 13* (1), 89-99. Retrieved on November 29, 2014 from http://etd.lib.metu.edu.tr/upload/3/12609912/index.pdf.

Trochim, W. (2000). *The Research method of knowledge base* (3rd ed.). Cincinnati: Atomic Dog Publishing.

Trowbridge, L. W. & Bybee, R. W. (1996). Teaching secondary school science: Strategies for developing scientific literacy. New Jersey: Prentice Hall Inc. Retrieved on August 29, 2014 from www.world-education center.org/index.php/cjes/article/.../7.3.9/168.

Wallace, J. & Mintzes, J. (1990). The concept map as a research tool: Exploring conceptual change in biology. *Journal of Research in Science Teaching, 27* (10), 1033-1052.

West African Examination Council (2002). *Chief examiners' report.* Accra: WAEC Press.

West African Examination Council (2005). *Chief examiners' report*. Accra: WAEC Press.

Wilkes, L., Cooper, K., Lewin, J. & Batts, J. (1999). Concept mapping: Promoting science learning in BN learners in Australia. *Journal of Continuing Education in Nursing, 30*, pp. 37-44. Retrieved on December 13, 2013 from http://books.google.com.gh/books.

Winther, A. A. & Volk, T. L. (1994). Comparing achievement of inner-city high school students in traditional VS. STS based chemistry courses. *Journal of Chemistry Education, 71* (6), 501-505. Retrieved on December 13, 2013 from http://www.ejmste.com/032006/full.pdf.

Wood, E. M. (2007). The effect of constructivist approach on students‟ achievement in Chemistry. Unpublished M Phil. Thesis, *Department of Science and Mathematics Education,* University of Cape Coast.

Woolnough, B. E. (1994). „Why students choose physics or reject it‟. *Physics Education*, *29*, pp. 368-374. Retrieved on December 14, 2013 from http://www.iop.org/education/teacher/support/girls.

Wynd, C. A., Schmidt, B. & Schaefer, M. A. (2003). Two Quantitative Approaches for Estimating Content Validity. *Western Journal of Nursing Research, 25* (5), 508-518.

Zittle, F. J. Jr. (2002). The effect of Web-based concept mapping on analogical transfer. Unpublished Dissertation, University of New Mexico. *Dissertation Abstracts International Section A: Humanities & Social Sciences University Microfilms International, 62* (11-A), 3695.

# APPENDICES

## APPENDIX A

QUESTIONNAIRE ON TEACHERS" BACKGROUND, DIFFICULTIES AND APPROACHES TO THE TEACHING OF INTEGRATED SCIENCE

This questionnaire is to help an M.Phil. student in the Department of Science Education of the University of Education, Winneba to find out JHS science teachers" background, difficulties, knowledge of concept mapping and approaches to the teaching of Integrated Science.

You will be contributing immensely to this study by responding to the questionnaire as frankly as possible. You are assured of confidential treatment of your responses.

Please tick [√] in the appropriate box the response that best corresponds to your choice concerning each of the following statements below:

PART I

1. Sex Male [ ] Female [ ]
2. Age in years Below 30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ]
3. Professional status Professional [ ] Nonprofessional [ ]
4. Years of teaching experience 1-2Yrs[ ] 3-5Yrs[ ] 6-10Yrs [ ] above 10Yrs [ ]
5. Highest level of education SHS [ ] „O" level [ ] „A" level [ ] Post sec. [ ]
   Diploma [ ] HND [ ] First degree [ ] Masters [ ]
6. Were you a science student during your school days? Yes [ ] No [ ]

7. Which of the following elective science subject(s) did you study at school?

   Physics [ ]    Chemistry [ ]    Biology [ ]    Elective Maths [ ]

PART II

Use the following key to select the responses to items in the table:

Strongly agree = SA;    Agree = A;    Neutral = N;    Disagree = D;

Strongly disagree = SD

| No. | ITEM | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | **A. Interest**<br>I don"t have interest in teaching science | | | | | |
| 2 | I would prefer teaching a different subject | | | | | |
| 3 | I do encourage pupils in my class to develop interest in science | | | | | |
| 1 | **B. Perceived Difficulties**<br>I have never attended any in-service training in integrated science | | | | | |
| 2 | I teach some other subject(s) in addition to integrated science | | | | | |
| 3 | There are insufficient textbooks in the school for pupils | | | | | |
| 4 | There is no science laboratory for practical work in this school | | | | | |
| 5 | I don"t know how to improvise science materials for practical work | | | | | |
| 1 | C. **Knowledge and Perception about Concept Mapping**<br>I have adequate knowledge of concept mapping | | | | | |

| No. | ITEM | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 2 | I have been using Concept maps to teach | | | | | |
| 3 | Concept maps are not too difficult to construct and use | | | | | |
| 4 | Concept maps help me to explain concepts to my pupils | | | | | |
| 5 | Concept maps help me to organize my lesson activities | | | | | |
| 6 | Concept mapping helps me to diagnose and identify the misconceptions in the minds of the pupils I teach | | | | | |
| 7 | Concept maps can help individuals to learn on their own | | | | | |
| 1 | **D. Self-efficacy**<br>Science is too difficult to teach | | | | | |
| 2 | I have difficulty explaining most concepts to the understanding of my pupils | | | | | |
| 3 | I very often ask some friends to explain some topics to me before I go to teach them | | | | | |
| 4 | I use pupil-centred approaches in teaching my lessons | | | | | |
| 5 | I don"t take my pupils through experiments | | | | | |
| 6 | I often allow pupils to ask questions in my class | | | | | |
| 7 | I distribute questions well in class | | | | | |
| 8 | I often give assignments and class exercises to my pupils | | | | | |
| 9 | I promptly mark the assignments I give to my pupils | | | | | |
| 10 | I am regular at school | | | | | |
| 11 | I always prepare my lesson notes before teaching | | | | | |
| 12 | I have cordial relationship with pupils in my class | | | | | |

| No. | ITEM | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 13 | The pupils I teach usually perform well in integrated science at BECE | | | | | |
| 14 | I am satisfied with my work output | | | | | |

# APPENDIX B

## QUESTIONNAIRE ON PUPILS‟ LEARNING DIFFICULTIES, INTEREST AND PARTICIPATION IN INTEGRATED SCIENCE LESSONS

This questionnaire is to help an M. Phil. student in the Department of Science Education of the University of Education, Winneba to find out the learning difficulties of JHS pupils as well as their interest and participation in integrated science lessons.

You will be contributing immensely to this study by responding to the questionnaire as frankly as possible. You are assured of confidential treatment of your responses.

Please, tick [√] in the appropriate box the response that best corresponds to your choice concerning each of the following statements below:

PART I

Sex Male [ ] Female [ ]

Age in years <12 [ ] 12-14 [ ] 15-17 [ ] 18 ≥ [ ]

Have you ever repeated any class? Yes [ ] No [ ]

PART II

Use the following key to select the responses to items in the table:

Strongly agree = SA; Agree = A; Neutral = N; Disagree = D;

Strongly disagree = SD

| No. | ITEM | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| | **A. Interest in the study of Integrated Science** | | | | | |
| 1 | Integrated science classes are interesting | | | | | |
| 2 | I like integrated science more than other subjects | | | | | |
| 3 | I fear integrated science so much | | | | | |
| 4 | I like the way my integrated science teacher teaches us | | | | | |
| | **B. Learning Difficulties** | | | | | |
| 1 | Our science teacher gives us notes but does not explain the notes to us | | | | | |
| 2 | I always find it difficult to understand what we are taught in integrated science | | | | | |
| 3 | I often find it difficult to remember what we are taught in integrated science | | | | | |
| 4 | It is difficult for me to relate science topics to each other | | | | | |
| 5 | Scientific terms are too difficult to spell and pronounce | | | | | |
| 6 | I always score low marks in integrated science tests and exams | | | | | |
| 7 | I have no science textbook to read at home | | | | | |
| 8 | There is no science laboratory in this school for practical lessons | | | | | |

| No. | ITEM | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 9 | We usually do not perform practical activities during integrated science lessons | | | | | |
| 1 | **C. Participation in Integrated Science Lessons**<br>I often have the opportunity to interact with my class mates during integrated science lessons | | | | | |
| 2 | I ask a lot of questions during integrated science lessons | | | | | |
| 3 | I usually answer questions in class when called by the teacher | | | | | |
| 4 | I often do not pay attention in integrated science class | | | | | |
| 5 | I often sleep in integrated science class | | | | | |
| 6 | I often read other subjects during integrated science lessons | | | | | |

# APPENDIX C

LESSON OBSERVATION CHECKLIST

TOPIC: DATE:

CLASS: DURATION:

| ACTIVITIES | | No. | DESCRIPTION OF ACTIVITY | RATING OF TEACHERS' AND PUPILS' ACTIVITIES DURING LESSONS | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Very often** | **Often** | **Few times** | **Never** |
| TEACHER ACTIVITY | INITIATION | 1 | Introduces lesson with concept map (prepared in advance or to be done by pupils) | | | | |
| | | 2 | Asks questions on material shown: concept maps, drawings, models, charts etc. | | | | |
| | | 3 | Asks questions involving critical thinking. | | | | |
| | | 4 | Presents subject matter coherently with regards to continuity and relevance. | | | | |
| | | 5 | Concepts presentation during lesson development supported by C‟Maps. | | | | |
| | | 6 | Presents irrelevant content / subject matter. | | | | |
| | | 7 | Teaching approach embedded with self-questioning. | | | | |
| | | 8 | Dictates the subject matter from the note book or text book. | | | | |
| | | 9 | Gives directions which pupils are expected to comply with. | | | | |
| | | 10 | Visits and interacts with groups | | | | |
| | RESPONSE | 11 | Accepts and clarifies the feeling (positive or negative) and questions of a pupil in a non- threatening manner. | | | | |
| | | 12 | Praises or encourages pupil‟s action or behaviour. Nodding of head or saying "Um hm?" or "go on" are included. | | | | |
| | | 13 | Accepts, clarifies and builds on or develops ideas suggested by a pupil. | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PUPILS ACTIVITY | RESPONSE | 14 | Carry out directives / instructions, given by teacher | | | | |
| | | 15 | Interact with mates during construction of concept maps. | | | | |
| | | 16 | Eager to present concept map on the board | | | | |
| | | 17 | Presents concept map on the board alone or with group members | | | | |
| | | 18 | Answers questions asked by teacher. Freedom to express own ideas is limited. | | | | |
| | | 19 | Answers questions asked by mates. | | | | |
| | | 20 | Suggests some concepts to be mapped | | | | |
| | | 21 | Playful during group activities | | | | |
| | | 22 | Sleeps during class discussions | | | | |
| | INITIATION | 23 | Asks thoughtful questions when concept map is used. Freedom to develop opinions and line of thought not restricted. | | | | |
| SILENCE / IDLING | | 24 | Pauses and short periods of silence during which communication cannot be established by the observer. | | | | |

**SCORING KEY:**

| **Frequency of Activity** | **5 and above** | **3 to 4** | **1 to 2** | **0** |
|---|---|---|---|---|
| **Rating** | **Very often** | **Often** | **Few times** | **Never** |

# APPENDIX D

SCIENCE ACHIEVEMENT TEST (SAT)

DURATION: 1HOUR, 15MINUTES

This test paper consists of two sections: A and B. You are expected to answer all questions from both sections. Section A is allocated a total of 10marks while section B is allocated a total of 40marks.

---

## SECTION A

1. The raw materials for photosynthesis are

   A. carbon dioxide and chlorophyll B. oxygen and carbon dioxide

   C. water and carbon dioxide D. chlorophyll and water

2. The pores (holes) in leaves which allow for gaseous exchange during photosynthesis are called ……………..

3. The energy needed for photosynthesis is supplied by……………….

4. The following factors which affect photosynthesis are classified as external except

   A. water B. chlorophyll C. sunlight D. carbon dioxide

5. Complete the chemical equation below for the process of photosynthesis

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6\ldots\ldots.$$

6. Where in the body is oxygen deposited in the blood?

   A. heart　　B. liver　　C. lungs　　D. intestines

7. The human heart is divided into ………. main chambers.

   A. 2　　B. 4　　C. 6　　D. 8

8. All the following are diseases of the circulatory system except

   A. leukaemia　　B. asthma　　C. piles　　D. varicose vein

9. Which structure prevents oxygenated blood and deoxygenated blood from mixing up in the heart?

10. The substance responsible for the red colour of blood is called ……………

**SECTION B**

1. a) Explain briefly how plants obtain the raw materials needed for photosynthesis.

   b) Explain the effect of total darkness on plants.

   c) State two importance of photosynthesis. [15 marks]

2. a) In an experiment to test for the presence of starch in a green leaf, the following activities were performed. Rearrange the steps in the activities to form the correct order of the experiment.

(i) The leaf was boiled in water for about 5-10 minutes.

(ii) The leaf was put in a petri dish.

(iii) The leaf was dipped in hot water for about 5-10 seconds.

# APPENDIX E

INSTRUCTIONS FOR PUPILS‟ CONCEPT MAPS CONSTRUCTION

1. Using the sets of concepts and the linking words in the table below, construct a concept map on the topic: Composition and functions of blood.

| CONCEPTS | LINKING WORDS / PHRASES |
|---|---|
| BLOOD, FLUID, GLUCOSE, DISEASES, $O_2$, BLOOD CLOTTING, WBC, $CO_2$, MUSCLES, PLATELETES, TISSUES, RBC, PLASMA, FOOD NUTRIENTS, CELLS | such as, called, help in, transport, to, contains, which fight, and, which are classified as, can prevent, from |

2. Using the sets of concepts and the linking words in the table below, construct a concept map on the topic: The Structure and Functions of the Human Heart.

| CONCEPTS | LINKING WORDS |
|---|---|
| HUMAN HEART, VENTRICLES, LEFT HALF, SEPTUM, VALVES, 2 LOWER CHAMBERS, OXYGENATED, 2 UPPER CHAMBERS, ATRIA, RIGHT HALF, BLOOD, DEOXYGENATED | receives and pumps, are separated by, contains, called, which may be, or, is divided into, in the, and |

3. Using the sets of concepts and the linking words in the table below, construct a concept map on the topic: Factors that Affect the Process of Photosynthesis.

| CONCEPTS | LINKING WORDS |
|---|---|
| PHOTOSYNTHESIS, ROOTS, SUN, $CO_2$, OSMOSIS, DIFFUSION, LIGHT, SOIL, CHLOROPHILL, WATER, ATMOSPHERE, LEAVES | requires, which is obtained through, which is contained in, which enters, which is provided by the, which is transported to, which is obtained from, which is absorbed by |

# APPENDIX F

## SAMPLES OF PUPILS" CONSTRUCTED CONCEPT MAPS

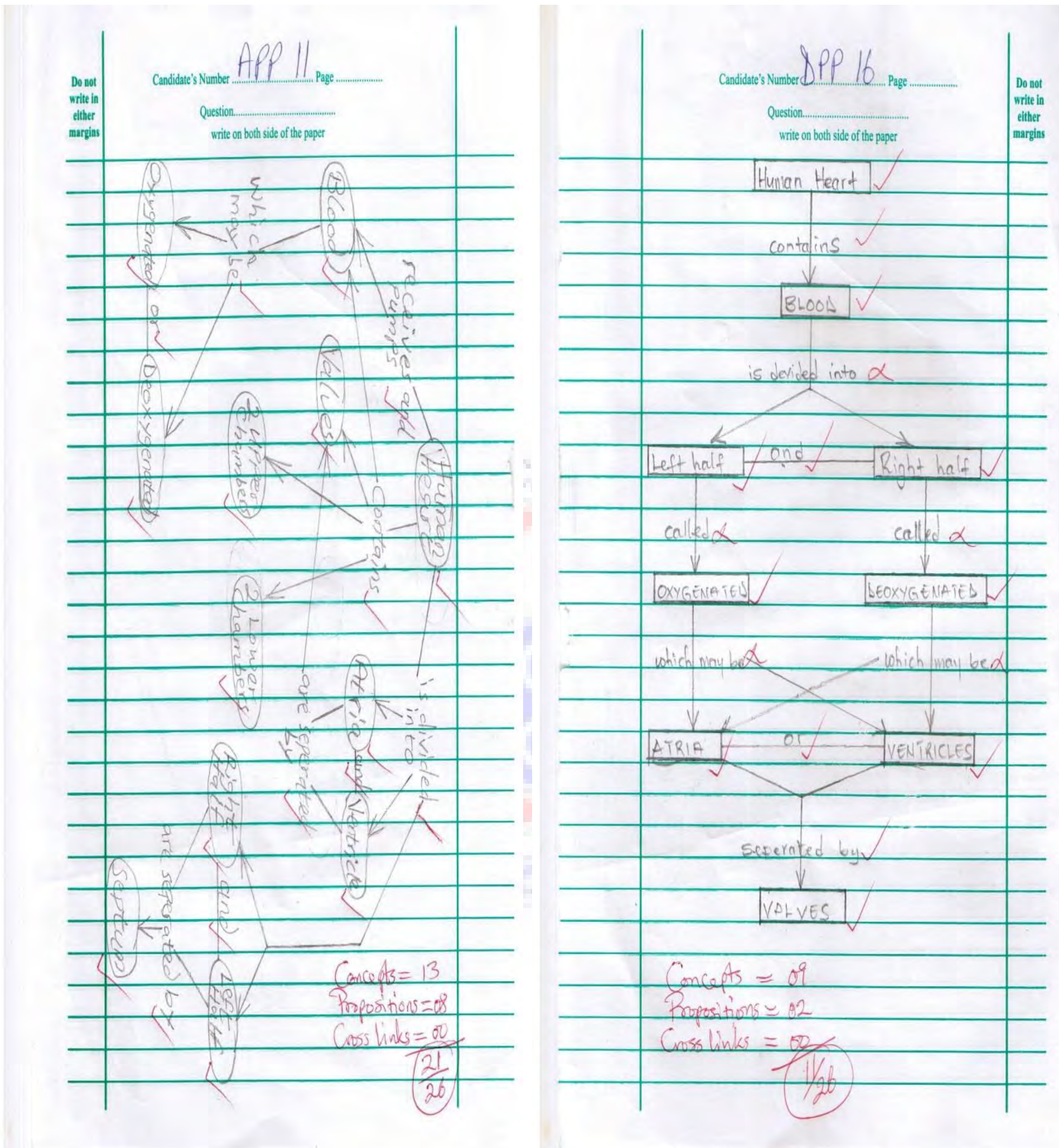


Fig. 3: (a) Fig. 3: (b)

**Fig. 3: Pupils' constructed concept maps on parts of human heart and their functions;**

**(a) from school 'A' and (b) from school 'D'**

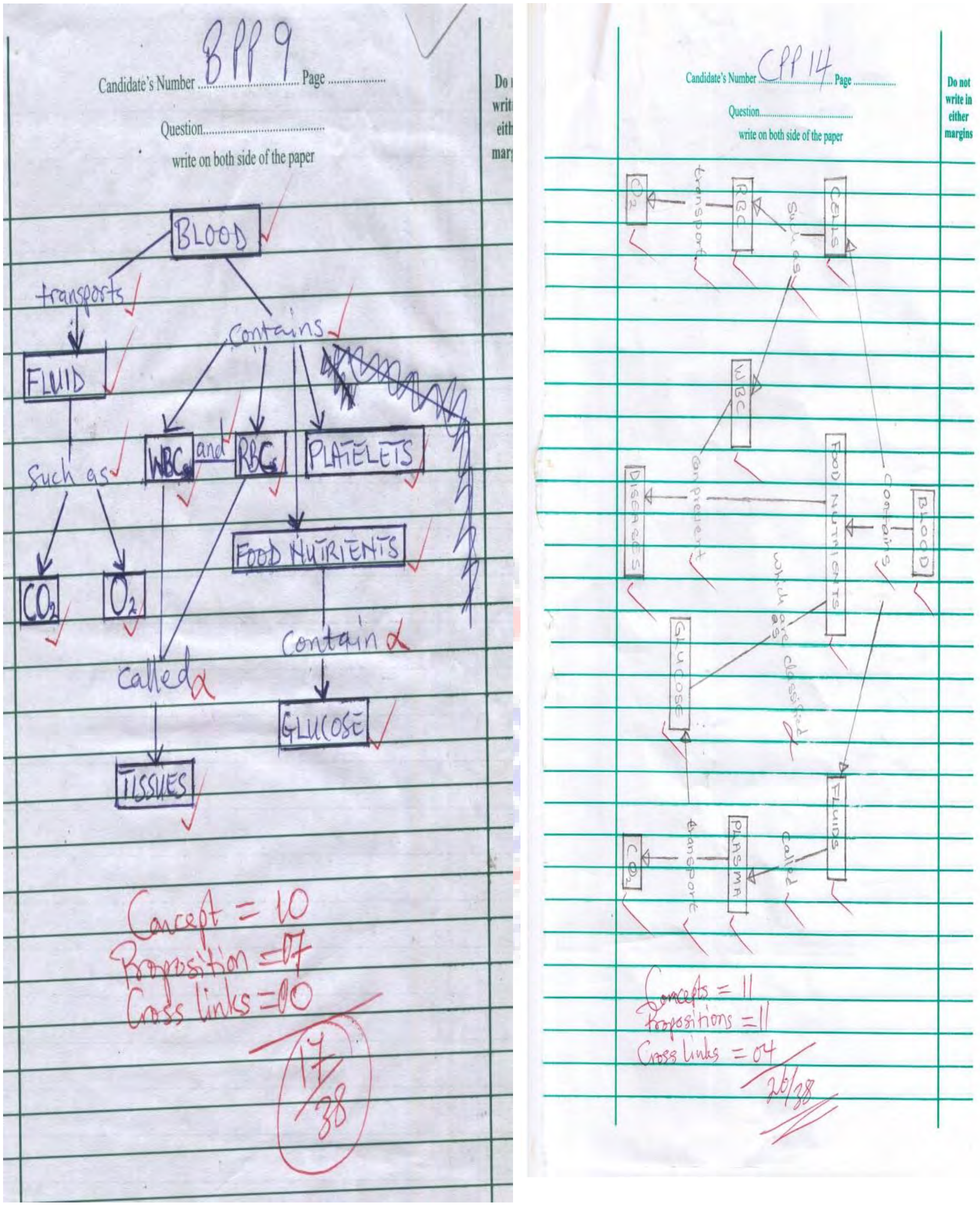


Fig. 4: (a) Fig. 4: (b)

**Fig. 4: Pupils' constructed concept maps on composition and functions of blood; (a) from school 'B' and (b) from school 'C'**

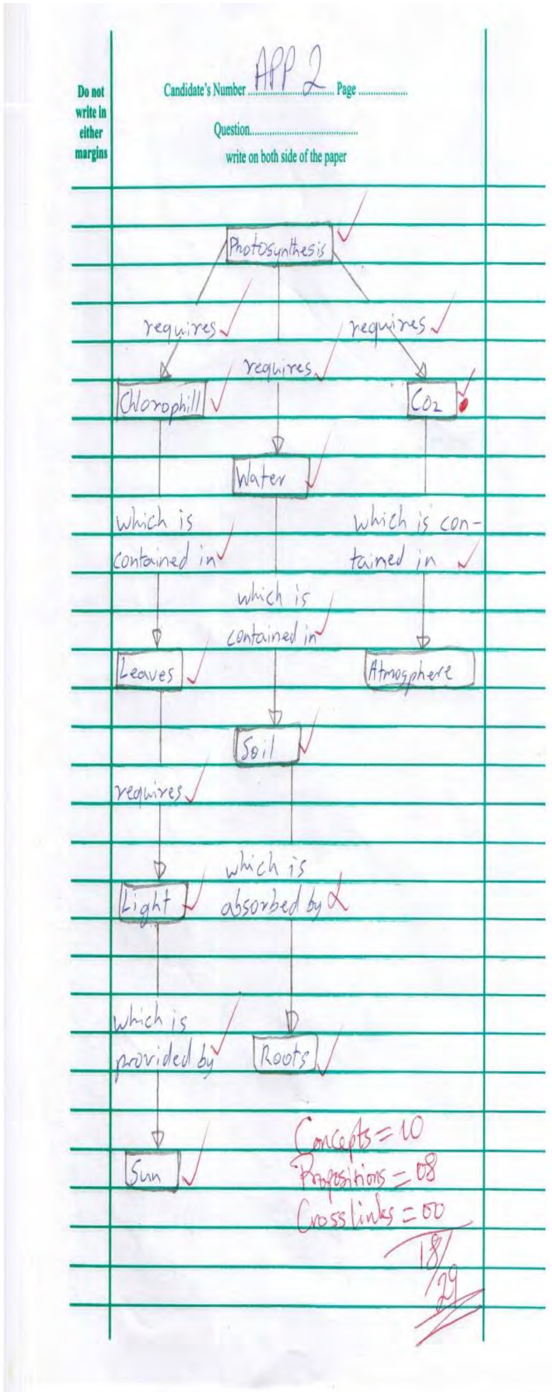


**Fig. 5: (a)**

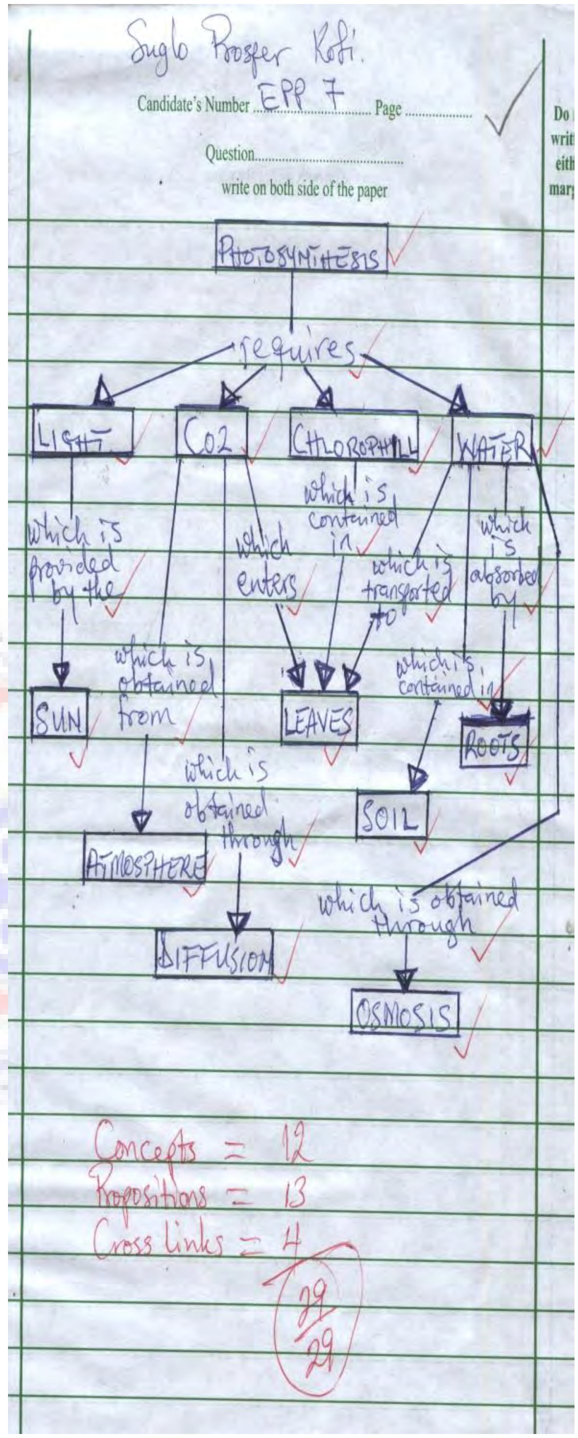


**Fig. 5: (b)**

**Fig.5: Pupils' Constructed Concept Maps on Factors that Affect Photosynthesis; (a) from school 'A' and (b) from school 'E'**

# APPENDIX G

## SEMI-STRUCTURED INTERVIEW ON CONCEPT MAPPING

1. Did you find teaching and learning with concept mapping interesting?

2. How did you see the performance of your pupils in lessons involving concept mapping?

3. How did you find the academic performance of your pupils in Integrated Science after being exposed to concept mapping?

4. What did you like and/or dislike about the construction of concept maps?

# APPENDIX H

## FORMULA SHEET FOR ITEM ANALYSIS

1. Formula for determining content validity of instruments:

$$\text{Content Validity Index (CVI)} = \frac{\text{No of items rated relevant}}{\text{Total No of items}}$$

2. Spearman-Brown prophecy formula for determining reliability of instruments:

$$\text{Reliability coefficient} = \frac{2 \times \text{split-half correlation}}{1 + \text{split-half correlation}}$$

3. Formula for determining difficulty level of items:

$$\text{Item Difficulty Index} = \frac{\text{Number of pupils who answered the item correctly}}{\text{The total number of pupils}}$$

4. Formula for determining discrimination level of items:

$$\text{Item Discrimination Index} = \frac{\mathbf{N_u - N_L}}{\mathbf{N}}$$

where; $\mathbf{N_u}$ represents the number of pupils from the upper performing group who answered the item correctly, $\mathbf{N_L}$ represents the number of pupils from the lower performing group who answered the item correctly and **N** represents the total number of pupils in the upper or lower performing groups.

# APPENDIX I

## A LETTER INVITING TEACHERS TO CONCEPT MAPPING WORKSHOP

ADAKLU DISTRICT EDUCATION OFFICE
BOX MW 451
HO
2ND FEBRUARY 2015

DISTRIBUTION:
ALL HEADTEACHERS OF JHS
ADAKLU DISTRICT

**A TWO-DAY TRAINING WORKSHOP FOR JHS SCIENCE TEACHERS IN THE ADAKLU DISTRICT**

As part of efforts to improve the performance of pupils in the BECE through effective teaching and learning, you are requested to send your Integrated Science Teacher to a Two-Day Training Workshop.

**VENUE:** Adaklu Goefe D/A JHS

**DATE :** 11th - 12th February 2015.

**TIME:** 9:30am – 2:30pm Daily.

The participants are expected to come along with pencil, ruler, eraser and an exercise book.

All heads are to ensure that their science teachers attend without fail.

Yours faithfully,

**Samuel A. Dorfe.**
**(D. D. Adm. & Fin.)**

**Cc:**

**A. D. Supervision**
**All Circuit Supervisors**

# APPENDIX J

## RESEARCHER CONSTRUCTED CONCEPT MAPS

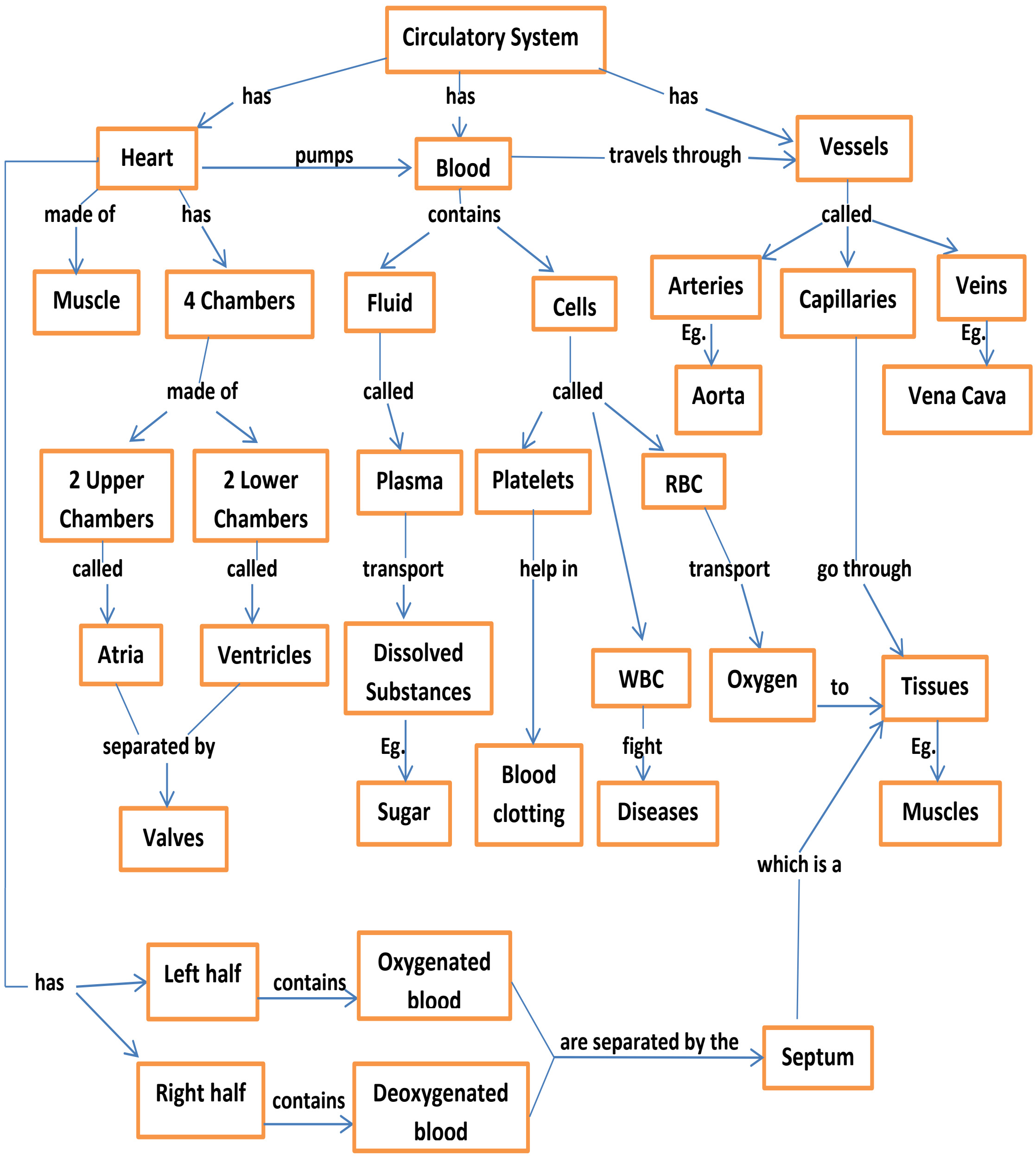


**Fig. 6: A Concept Map on the Human Circulatory System**

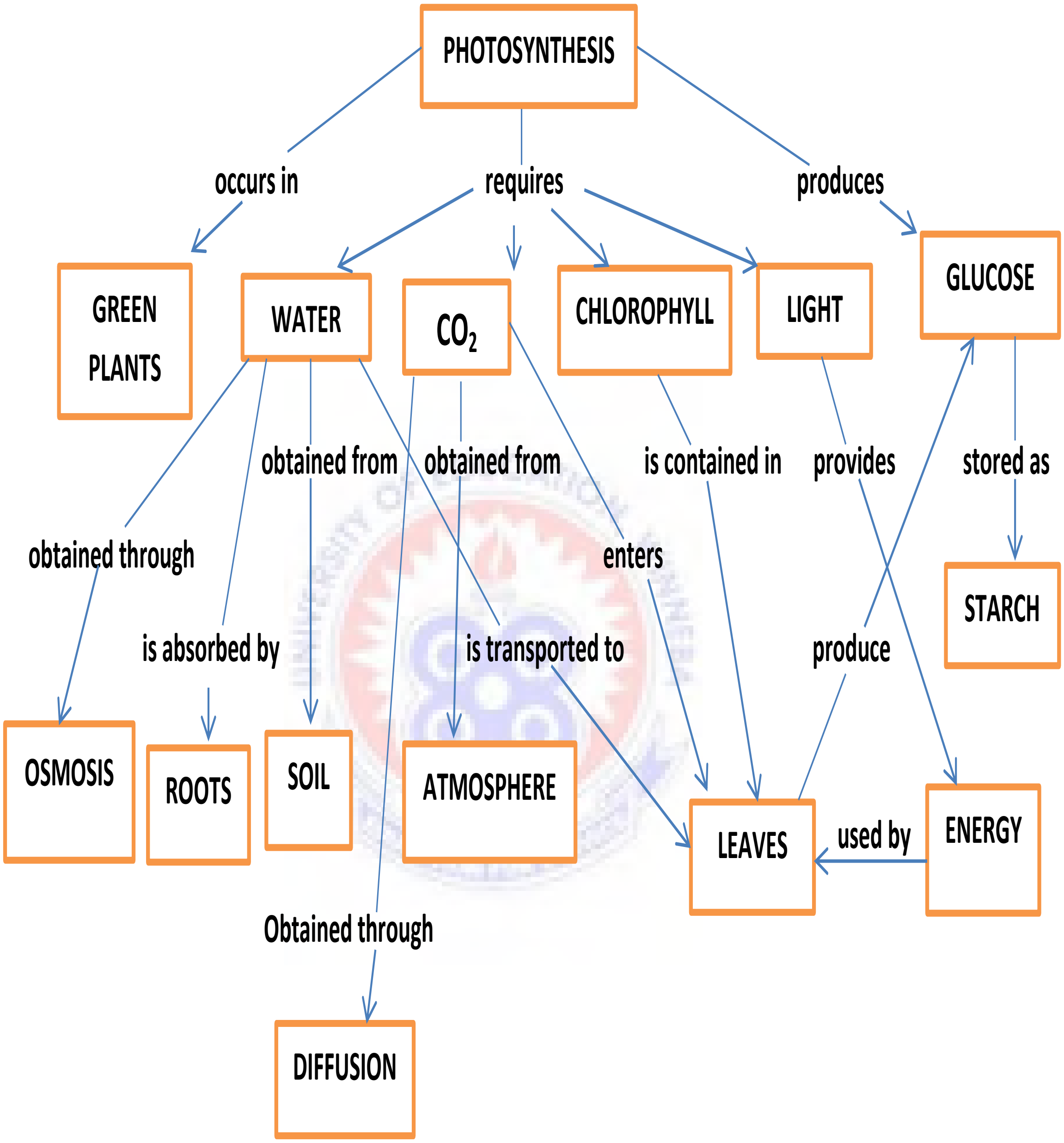


**Fig. 7: A Concept Map on Photosynthesis**

# APPENDIX K

SAMPLES OF MAPS CONSTRUCTED BY TEACHERS AT THE WORKSHOP

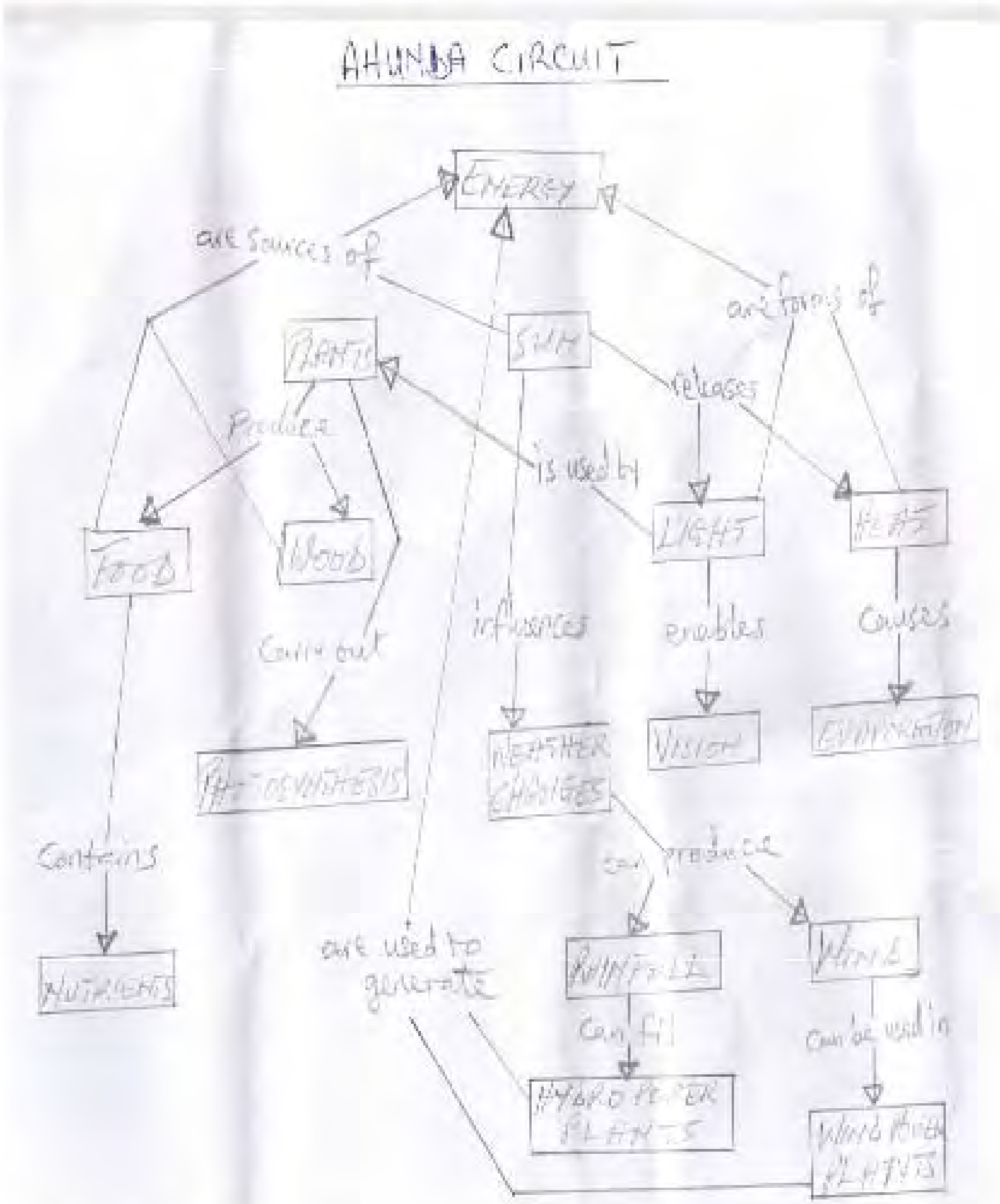


**Fig. 8: A Concept Map on Energy constructed by a group of workshop participants**

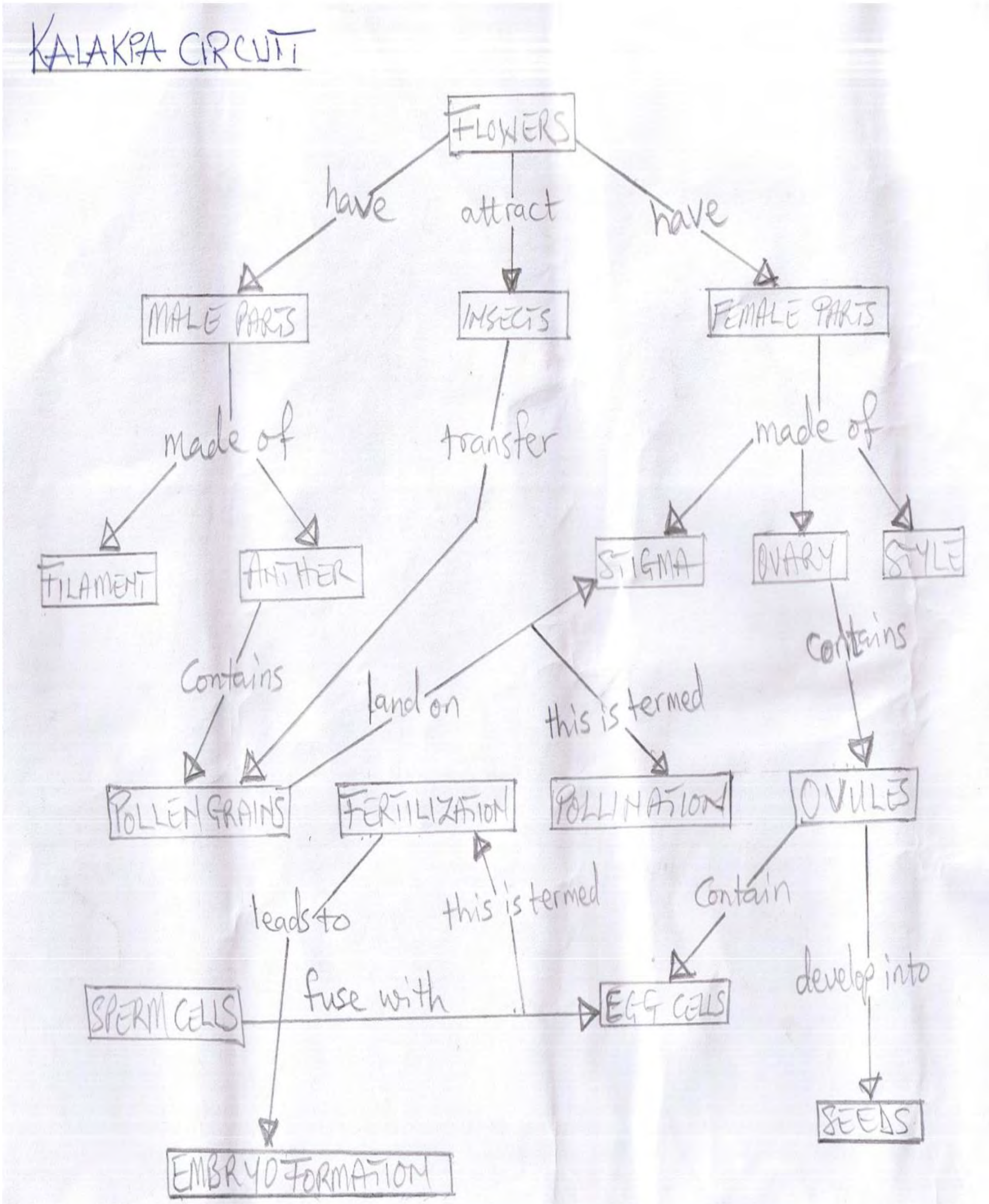


**Fig. 9: A Concept Map on Sexual Reproduction in Plants constructed by a group of workshop participants**

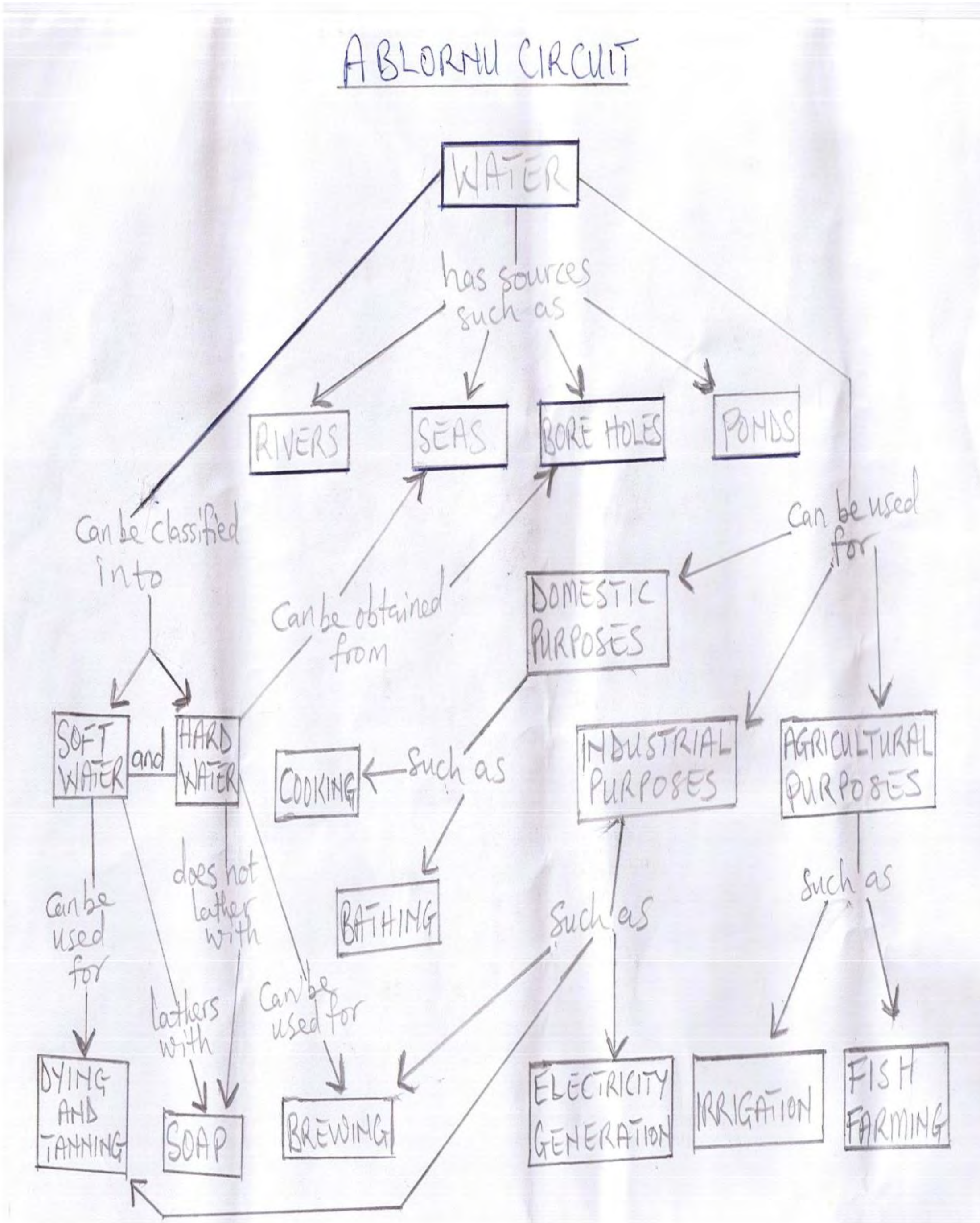


**Fig. 10: A Concept Map on Sources, Classification and Uses of Water constructed by a group of workshop participants**

# APPENDIX L

PICTURES FROM CONCEPT MAPPING WORKSHOP FOR JHS SCIENCE TEACHERS

**Fig. 11: Pictures showing participants interacting in groups during the preparation of Concept Maps at the concept mapping workshop**

**Fig. 12: Pictures showing teachers discussing group drafted Concept Maps with the workshop facilitator (Researcher)**

**Fig. 13: Pictures showing some participants presenting their group Concept Maps on a black board for review during the workshop**

**Fig. 14: Group photograph of participants at the end of the Concept Mapping workshop**

# APPENDIX M

## SCORING RUBRICS FOR PUPILS' CONSTRUCTED CONCEPT MAPS

**Points to score**

1. Concepts: Score 1 point for each concept that is connected to at least one other concept by a proposition.
2. Propositions: Score 1 point for each meaningful valid proposition.
3. Crosslink: Score 2 points for each appropriate crosslink.

**Penalty**

Score zero (0) for the following:

1. Concepts not placed in a box or circle.
2. Omitted concepts
3. Linking phrases placed in a box or circle.
4. Linking lines not labelled.
5. Invalid propositions.

1. Concept map on composition and functions of blood.

Concepts…………………………… 1×15=15

Propositions………………………… 1×15=15

Crosslink…………………………… 2×4=8

Sub-Total…………………………… 38 Points

2. Concept map on the structure and functions of the human heart.

Concepts………………………….. 1×12=12

Propositions……………………… 1×10=10

Crosslink………………………… 2×2=4

Sub-Total………………………… 26 Points

3. Concept map on factors that affect the process of photosynthesis.

Concepts…………………………… 1×12=12

Propositions…………………………1×13=13

Crosslink…………………………… 2×2=4

Sub-Total…………………………… 29 Points

**Grand Total = 93 Points**

# APPENDIX N

SCIENCE ACHIEVEMENT TEST (SAT) MARKING SCHEME

## SECTION A

1. C
2. Stomata
3. Sun (light)
4. B
5. $6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$
6. C
7. B
8. B
9. Septum
10. Haemoglobin

10×1 = 10

**SUB TOTAL = 10 MARKS**

## SECTION B

1a) Explanation of how plants obtain the raw materials needed for photosynthesis

i. **Water** [1mark] is obtained from the soil [1mark] by the roots [1mark] through osmosis [1mark] and transported to leaves [1mark]

ii. **Carbon dioxide** [1mark] is obtained from the atmosphere [1mark] by leaves [1mark] through diffusion [1mark].

b) Effects of Total darkness on Plants

It prevents plants from getting light [1mark] for photosynthesis [1mark] leading to improper / reduction in growth and development of the plant. [2marks].

c) Importance of Photosynthesis to Animals

- It provides food for animals in the ecosystem
- It deposits oxygen in the atmosphere for animals‟ use in respiration
- It removes excess carbon dioxide from the atmosphere
- It helps in the water cycle which results in rainfall to provide water for animals

[Any 2×1 = 2marks]

**SUB TOTAL = 15 MARKS**

2a) Correct order of activities

i. The leaf was boiled in water for about 5-10 minutes

vi. The leaf was boiled in alcohol for about 5 minutes

v. The leaf was washed in cold water.

iii. The leaf was dipped in hot water for about 5-10 seconds.

ii. The leaf was put in a petri dish

iv. About three drops of iodine solution was added to the leaf

[6×1 = 6marks]

b) i. Reason for boiling the leaf

To decolourise the leaf / to remove chlorophyll from the leaf [2marks]

ii. Expected observation

The leaf will turn blue-black when the iodine solution is added to it [2 marks]

**SUB TOTAL = 10 MARKS**

3a) (i) Left ventricle

(ii) Right atrium

(iii) Right ventricle

(iv) Left atrium

(v) Septum [5×1 = 5marks]

b) ( i) Three main components of the circulatory system

– Heart

– Blood vessels

– Blood [3×1 = 3marks]

(ii) Three functions of blood

- It transports dissolved substances to and from body parts
- It regulates / controls body temperature
- It prevents pathogens from invading the body by clotting when there is a cut
- It fights disease causing organisms by producing antibodies
- It helps to bring about erection in the process of reproduction

[Any 3×1 = 3marks]

C) Two causes of Hypertension

- Smoking
- Drinking of alcohol
- Lack of exercise
- Obesity
- Eating of fatty foods
- Depression / Stress
- Hereditary [Any 2×1 = 2marks]

d) <u>Explanation of what is likely to happen to a person with small number of Red Blood Cells</u>

The person will become anaemic [1mark] and will have reduced capacity to transport oxygen [1mark] in the circulatory system.

**SUB TOTAL = 15 MARKS**

GRAND TOTAL = 10 + 15 + 10 + 15

**= 50 MARKS**

# APPENDIX O

**Pupils' Concept Map Scores and Science Achievement Test Scores**

| PUPIL | C'Map Score | (100%) | SAT Score | (100%) |
|---|---|---|---|---|
| APP1 | 21 | 23 | 23 | 46 |
| APP2 | 46 | 50 | 24 | 48 |
| APP3 | 61 | 66 | 23 | 46 |
| APP4 | 65 | 70 | 24 | 48 |
| APP5 | 56 | 60 | 22 | 44 |
| APP6 | 67 | 72 | 21 | 42 |
| APP7 | 56 | 60 | 23 | 46 |
| APP8 | 45 | 48 | 27 | 54 |
| APP9 | 56 | 60 | 20 | 40 |
| APP10 | 50 | 54 | 28 | 56 |
| APP11 | 72 | 77 | 25 | 50 |
| APP12 | 67 | 72 | 23 | 46 |
| APP13 | 29 | 31 | 14 | 28 |
| APP14 | 56 | 60 | 27 | 54 |
| APP15 | 78 | 84 | 20 | 40 |
| APP16 | 66 | 71 | 17 | 34 |
| APP17 | 46 | 49 | 18 | 36 |
| APP18 | 56 | 60 | 17 | 34 |
| APP19 | 67 | 72 | 22 | 44 |
| APP20 | 82 | 88 | 26 | 52 |
| APP21 | 77 | 83 | 20 | 40 |
| APP22 | 35 | 38 | 29 | 58 |
| APP23 | 61 | 66 | 19 | 38 |
| APP24 | 54 | 58 | 19 | 38 |
| APP25 | 58 | 62 | 24 | 48 |
| APP26 | 71 | 76 | 18 | 36 |
| BPP1 | 65 | 70 | 34 | 68 |
| BPP2 | 56 | 60 | 21 | 42 |
| BPP3 | 71 | 76 | 28 | 56 |
| BPP4 | 67 | 72 | 26 | 52 |
| BPP5 | 70 | 75 | 23 | 46 |
| BPP6 | 66 | 71 | 28 | 56 |
| BPP7 | 50 | 54 | 23 | 46 |
| BPP8 | 35 | 38 | 24 | 48 |
| BPP9 | 61 | 66 | 20 | 40 |
| BPP10 | 77 | 83 | 56 | 56 |
| BPP11 | 82 | 88 | 20 | 40 |
| BPP12 | 67 | 72 | 31 | 62 |
| BPP13 | 56 | 60 | 24 | 48 |
| BPP14 | 46 | 49 | 22 | 44 |
| BPP15 | 71 | 76 | 21 | 42 |
| BPP16 | 65 | 70 | 24 | 48 |
| BPP17 | 50 | 54 | 18 | 36 |
| BPP18 | 65 | 70 | 23 | 46 |
| BPP19 | 77 | 83 | 20 | 40 |
| BPP20 | 70 | 75 | 23 | 46 |
| BPP21 | 56 | 60 | 23 | 46 |

| PUPIL | C'Map Score | (100%) | SAT Score | (100%) |
|---|---|---|---|---|
| BPP22 | 67 | 72 | 25 | 50 |
| CPP1 | 50 | 54 | 17 | 34 |
| CPP2 | 61 | 66 | 22 | 44 |
| CPP3 | 56 | 60 | 18 | 36 |
| CPP4 | 67 | 72 | 23 | 46 |
| CPP5 | 46 | 49 | 19 | 38 |
| CPP6 | 56 | 60 | 24 | 48 |
| CPP7 | 50 | 54 | 20 | 40 |
| CPP8 | 67 | 72 | 23 | 46 |
| CPP9 | 35 | 38 | 15 | 30 |
| CPP10 | 56 | 60 | 19 | 38 |
| CPP11 | 61 | 66 | 19 | 38 |
| CPP12 | 67 | 72 | 20 | 40 |
| CPP13 | 70 | 75 | 18 | 36 |
| CPP14 | 65 | 70 | 24 | 48 |
| CPP15 | 56 | 60 | 18 | 36 |
| DPP1 | 65 | 70 | 15 | 30 |
| DPP2 | 35 | 38 | 14 | 28 |
| DPP3 | 80 | 86 | 26 | 52 |
| DPP4 | 50 | 54 | 22 | 44 |
| DPP5 | 56 | 60 | 15 | 30 |
| DPP6 | 67 | 72 | 20 | 40 |
| DPP7 | 48 | 52 | 18 | 36 |
| DPP8 | 66 | 71 | 19 | 38 |
| DPP9 | 46 | 49 | 13 | 26 |
| DPP10 | 71 | 76 | 14 | 28 |
| DPP11 | 67 | 72 | 21 | 42 |
| DPP12 | 56 | 60 | 25 | 50 |
| DPP13 | 70 | 75 | 23 | 46 |
| DPP14 | 48 | 52 | 18 | 36 |
| DPP15 | 58 | 62 | 22 | 44 |
| DPP16 | 46 | 49 | 12 | 24 |
| DPP17 | 70 | 75 | 19 | 38 |
| DPP18 | 67 | 72 | 17 | 34 |
| DPP19 | 77 | 83 | 19 | 38 |
| DPP20 | 78 | 84 | 23 | 46 |
| DPP21 | 56 | 60 | 20 | 40 |
| DPP22 | 50 | 54 | 13 | 26 |
| DPP23 | 66 | 71 | 17 | 34 |
| EPP1 | 66 | 71 | 23 | 46 |
| EPP2 | 67 | 72 | 19 | 38 |
| EPP3 | 77 | 83 | 25 | 50 |
| EPP4 | 78 | 84 | 26 | 52 |
| EPP5 | 56 | 60 | 27 | 54 |
| EPP6 | 65 | 70 | 20 | 40 |
| EPP7 | 82 | 88 | 26 | 52 |
| EPP8 | 72 | 77 | 24 | 48 |
| EPP9 | 56 | 60 | 17 | 34 |
| EPP10 | 50 | 54 | 18 | 36 |
| EPP11 | 56 | 60 | 19 | 38 |
| EPP12 | 70 | 75 | 30 | 60 |
| EPP13 | 35 | 38 | 24 | 48 |
| EPP14 | 80 | 86 | 21 | 42 |

| PUPIL | C'Map Score | (100%) | SAT Score | (100%) |
|---|---|---|---|---|
| EPP15 | 61 | 66 | 22 | 44 |
| EPP16 | 67 | 72 | 24 | 48 |