UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF CONCEPT MAPPING STRATEGY ON STUDENTS' ACHIEVEMENT IN THE TEACHING AND LEARNING OF CIRCULATORY SYSTEM

ABDULAI ISSAKA

MASTER OF PHILOSOPHY

2021

UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF CONCEPT MAPPING STRATEGY ON STUDENTS' ACHIEVEMENT IN THE TEACHING AND LEARNING OF CIRCULATORY SYSTEM

ABDULAI ISSAKA
(8170130004)

A thesis in the Department of Science Education, Faculty of Science Education, submitted to the School of Graduate Studies, in partial fulfilment

of the requirements for the award of the degree of Master of Philosophy (Science Education) in the University of Education, Winneba.

JULY, 2021

DECLARATION

STUDENT'S DECLARATION

I, ABDULAI ISSAKA, 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 that it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:……………………………….

DATE: ……………………………………..

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines on supervision of thesis laid down by the University of Education, Winneba.

PROF. YAW AMEYAW (PhD)

(SUPERVISOR)

SIGNATURE:……………………………….

DATE: ……………………………………..

DEDICATION

This study is dedicated to my lovely family for their support and patience during the period of the research work. I thank you very much.

ACKNOWLEDGEMENTS

I express my heartfelt thanks to God Almighty for providing me with guidance, good health and direction throughout this work.

I would like to express my deepest appreciation to my supervisor, Prof. Yaw Ameyaw, for his guidance.

My special thanks are extended to Mr. Ibrahim Mohammed the Vice Principal of Gbewaa College of Education for his support. I also thank my colleague staff members and students of Gbewaa College of Education who assisted me and participated voluntarily in carrying out this research.

Finally, while I appreciate the contribution of others that have not been mentioned in this research work, I take responsibility for any short coming.

TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

Table **Page**

LIST OF FIGURES

ABSTRACT

This study investigated the effects of concept mapping teaching strategies, (concept identifying, proposition identifying, student generated) on Colleges of Education students' achievement on circulatory system. Five research questions and four null hypotheses guided the study. The study was a non-equivalent quasi-experimental design involving one treatment group and one control group. The Sample of the study comprised of 95 first year integrated science students purposively drawn from two Colleges of Education in the Northern part of Ghana. Fifty students from Gbewaa College of Education consisting of 28 males and 22 females as the experimental group and 45 students from Bagabaga College of Education made up of 25 males and 20 females as the control group. Two instruments: Circulatory System Achievement Tests (CSAT) and a structured questionnaire on effectiveness of concept mapping developed by the researcher were used for data collection. Concept maps were assessed using a scoring instrument created by Lomask, Baron, Greig and Harrison (1992). The validity and reliability of these instruments were established. The items on the questionnaire were subjected to item analysis while construct validity analysis was established for CSAT. The reliability of the instruments was established using Pearson's test – retest correlation co-efficiency before it was administered. Means, Standard Deviation, Analysis of variance (ANOVA) and t-Test were used to analyse and interpret data obtained. The study, among others showed that concept mapping instructional strategies significantly enhanced students' interest in science. The findings further revealed that the use of concept mapping instructional strategies in teaching was most effective way of improving students' performance in the teaching and learning of circulatory system in Integrated Science. In conclusion, the control group had a higher pre-test mean score as compared to the experimental group. However, the experimental group had a higher post-test mean score as compared to the control group due to the treatment. Finally, the findings recommended that Science tutors should use concept mapping teaching strategy to improve their students understanding in difficult topics such as the excretory system.

CHAPTER ONE

INTRODUCTION

1.0. Overview

This chapter describes the background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, null hypothesis and significance of the study. The chapter also includes, limitations, delimitations, operational definition of terms, abbreviations and organization of the chapters.

1.1 Background to the Study

One of the fundamental focuses of science education is to teach students scientific concepts because they are the building blocks of scientific knowledge (Smith, Disessa, & Roschelle, 1993). Students experience difficulty learning science concepts due the plethora of rules and principles it encompasses (Ueckert & Newsome, 2008). Because students lack an understanding of these rules and principles, they always struggle to understand the scientific information. Moreover, these rules and principles are often presented to students as isolated ideas or concepts. Assessment of first-year students' performance at Gbewaa College of Education revealed that the concepts of the circulatory system were difficult for students. This came to light when students could not answer questions on the concepts of the circulatory system when a test was conducted. Further discussion and analysis of the problem from fellow science teachers and science examiners revealed that other colleges are not an exception. This has led to poor performance of students in science at the Colleges of Education in Ghana. Chief Examiner's report, (Institute of Education, University of Cape Coast 2017) attributes the low performance to student's failure to grasp properly the fundamental concepts in science.

Another contributing factor to poor achievement in science concepts is the use of inappropriate strategies of teaching by teachers. Common methods of teaching employed over the years are the traditional or lecture method of teaching, inquiry method, collaborative method etc.

Also, students frequently enter the science classroom with previously established conceptions that are different from scientifically accepted ones (Thompson & Logue, 2007). These kinds of conceptions are generally reported as alternative conceptions or misconceptions. These students experience difficulty replacing the erroneous scientific information with true scientific facts. Lastly, to understand multifaceted science topics, students must have a well-established foundation of prior science learning (Buntting, Coll, & Campbell, 2006). Since science is a subject that builds on itself, if students fail to acquire basic science content, they will likely struggle with the more complex scientific concepts that follow.

Additionally, there are many other factors contributing to the low science achievement among colleges of education students. One of the factors affecting students‘ science achievement is the pedagogical approaches used by some teachers. Some science instructors still hold traditional teacher-directed teaching philosophies that place the learner in a passive learning role. In these teacher-directed classrooms, students do not actively participate in the acquisition of scientific knowledge by engaging in meaningful learning (Hill, 2005). Ausubel (1968) described meaningful learning as the establishment of non-arbitrary relations among concepts in the learner‘s mind. Meaningful learning is achieved if learners are provided the opportunity to relate new information to ideas they already know, and to do so learners need to be placed in active rather than passive learning roles (Ausubel, 1968).

Unfortunately, students oftentimes are expected to learn through rote memorization. This type of learning disempowers learners because they do not actively make connections to their prior knowledge (BouJaoude & Attieh, 2008). In addition, information learned by rote memorization is frequently forgotten. Hence, it is important for students to engage in scientific learning that facilitates meaningful learning.

There are various learning strategies that are used in science classrooms to attempt to help students overcome some of the difficulties of learning science. Learning strategies are activities that students employ to improve their learning of new information (Liu, 2009). Harrison, Andrews, and Saklofske (2003) suggested that students who use learning strategies during academic tasks work more effectively than students who do not use learning strategies. Some of the learning strategies used in science classrooms that engage students in the learning process include: underlining, note taking, discussing with co-learners, and outlining (Hilbert & Renkl, 2008). Although the learning strategies mentioned above are currently being used by teachers to assist students with the acquisition of science content, they may not be encouraging the connection of prior knowledge with new knowledge to enhance meaningful learning (Hilbert & Renkl, 2008). In view of this concept mapping strategy is one of learning strategies that connects the prior knowledge of learners to new knowledge or skills to be developed and also encourages active participation of learners. Concept mapping is a learning strategy that promotes meaningful learning by requiring students to show the interrelatedness of a group of concepts and integrating new knowledge with pre-existing knowledge (Plotnick, 2001). There are four types of concept maps: (1) teacher generated, (2) student generated, (3) concept identifying, and (4) proposition identifying. Teacher generated concept maps are created entirely by the teacher and given to the students as a study tool (Lim et al., 2009). In contrast, student generated concept maps are created entirely by the students (Harpaz, Balik, & Ehrenfeld, 2004; Novak & Gowin, 1984). Concept identifying concept maps are partially completed concept maps that students complete by finding the correct concepts to place in the nodes (Wang & Dwyer, 2006). Similarly, proposition identifying concept maps are also partially completed maps, however rather than finding the correct concepts to place in the nodes, students complete them by providing linking word(s) between concepts in order to create propositions or node-link networks (Wang & Dwyer, 2006).

Additionally, concept mapping learning strategy is effective in learning science concepts, hence, the researcher used concept mapping strategy for the study to enriched student‘s achievement on the circulatory system in Gbewaa College of education. Students recall prior knowledge and determine if and how the new information learned is relevant to their previous understanding of a given topic. The concept mapping learning strategy is effective because it enables students to make visual connections between information, thus helping them better understand the subject (Aidman & Egan, 1998). In terms of effectiveness, concept mapping strategy is preferred to the aforementioned learning techniques. According to Ameyaw as cited in Ameyaw (2015) concept mapping strategy encourages students to represent their vision on how a knowledge domain of a concept is structured and foster reflection of how nodes are interrelated. A concept map is and essential teaching strategy for teaching and learning of concepts that students perceived to be difficult and that teachers should adopt it as a teaching strategy and also encourage their students to make use of it in their studies (Ameyaw, 2015)

Furthermore, the concept mapping learning strategy is beneficial in understanding students' misconceptions of the structure of circulatory system. Students were made to generate concept maps on the structure of the circulatory system revealing their level of understanding. Teacher and students analysed the concept maps generated, identify deficiencies, allowed teacher, to address the deficiencies before students attempted to build scientific knowledge based on accurate information.

1.2. Statement of the Problem

The study was to investigate the effect of concept mapping strategy on students' achievement in the circulatory system which formed part of the integrated science curriculum for colleges of education. It has been recognised by various researchers of science curriculum at various levels of education that, "scientific concept taught in abstract terms forces students to resort to rote learning without understanding" (Felder, 1993). Observation and experience with the first-year students' performance at Gbewaa College of Education over the years revealed that the concepts of the circulatory system were difficult for students. This came to light when students could not answer questions on the concepts of the circulatory system when a test was conducted. This has led to poor performance of students in science at the Colleges of Education in Ghana. Chief Examiner's report, (Institute of Education, University of Cape Coast 2017) attributes the low performance to student's failure to grasp properly the fundamental concepts in science and teacher's failure to communicate the fundamental concept via the appropriate method of teaching the circulatory system. Further discussion and analysis of the problem from fellow science teachers and science examiners revealed that the major contributing factor is the use of inappropriate strategies of teaching the circulatory system by science teachers. Common methods of teaching employed over the years in teaching the circulatory system are the traditional or lecture method of teaching, inquiry method, collaborative method etc.

These methods even with the addition of charts and improvised teaching and learning materials are unable to properly explain concepts of the circulatory system.

To overcome some of the difficulties teachers and students face under this method as suggested by Ogunkola (2011) and Ameyaw (2015), is to use concept mapping strategy to enhance presentation and to captivate and sustain students. Also, adopt reasonable and adjustable pace that balances content coverage and student understanding. However, in this research, all the four types of concept maps were used. The concept identifying concept maps, the proposition identifying concept maps, the student generated concept maps and the teacher generated concept map (expert concept map) were used to enhanced students‘ achievement on the circulatory system in Gbewaa College of Education in the Upper East Region of Ghana.

Many studies have investigated the influence of gender on achievement of students and the reports are conflicting. While Danmole and Adeoye (2004) and Aiyedun (2000) reported that gender has no significant influence on achievement, Ifeakor (2005) and Mari (2002) reported males‘ superiority over females in terms of achievement based on concept mapping. However, Ekwueme and Umoiyang (2004) as cited by Georgina (2012) reported female superiority over males in achievement and interest. These contradictory evidences necessitate a further investigation on the effect of gender on students‘ achievement in circulatory system using concept mapping strategy.

1.3. Purpose of the Study

The purpose of the study was to determine the effect of concept mapping strategy on students' achievement in the teaching and learning of the human circulatory system in Gbewaa College of Education.

1.4. Research Questions

The research questions for the study were:

1. What is the difference in achievement between the experimental and the control groups mean scores before using concept map strategy in teaching circulatory system in Gbewaa College of Education?
2. What is the difference in achievement between the experimental and the control groups mean scores after using concept map strategy in teaching circulatory system in Gbewaa College of Education?
3. What is the difference in achievement between the experimental male and experimental female groups mean scores after using concept map strategy in teaching circulatory system in Gbewaa College of Education?
4. What is the difference in the experimental group students' concept maps mean scores among the low achievers, average achievers and high achievers groups after using concept map strategy in teaching circulatory system in Gbewaa College of Education?
5. What are the perceptions of the experimental group on the effect of concept mapping strategy on the teaching and learning of the circulatory system in Gbewaa College of Education?

1.5. Null Hypotheses

The null hypotheses were:

1. There is no significant difference in achievement between the experimental and control groups mean scores before using concept map strategy in teaching circulatory system in Gbewaa College of Education.
2. There is no significant difference in achievement between the experimental and the control groups mean scores after using concept map strategy in teaching circulatory system in Gbewaa College of Education.
3. There is no significant difference in achievement between the experimental male and experimental female groups mean scores after using concept map strategy in teaching circulatory system in Gbewaa College of Education.
4. There is no statistical significant difference in the experimental group students' concept maps mean scores among the low achievers, average achievers and high achievers groups after using concept map strategy in teaching circulatory system in Gbewaa College of Education.

1.6. Significance of the Study

The study will enhance the achievement of students of Colleges of Education on the human circulatory system. Also, the study would contribute to the pre-existing concept mapping literature by demonstrating that the concept mapping strategy assist in raising students' achievement on the human circulatory system in Gbewaa College of Education. Moreover, the study would contribute to the limited research related to the use of concept mapping as a teaching strategy in colleges of education in Ghana. The study is expected to provide insight to science tutors on teaching other challenging concepts in Colleges of Education. The findings of the study could be used as bases to conduct research on gender differences in achievement by other college science tutors.

1.7. Delimitation

For meaningful deduction to be made on the impact of concept mapping in understanding of science, all topics in the syllabus would have been treated with the strategy but due to inadequate resource, this study covered only the circulatory system which students find difficult to understand

The study was restricted to only first year science students of Gbewaa College of Education in Pusiga district in the Upper East Region of Ghana where the students find it difficult to answer questions on the circulatory system. Purposively sample was used which limit the scope of generalisation.

1.8. Limitation

The findings may not be generalised due to the location. The timing of the data collection when students were preparing for the mid and end of semester exams was also a limiting factor; students were finding it difficult to cooperate due to tiredness. Also, there may be possibility of bias due to human nature since the researcher taught both the control and the experimental groups. The researcher was not also able to find out further why the male students in the experimental group achieved better than female students in the experimental group.

1.9. Definition of Terms

The following terms were used in the study:

Cognitive Structure: A learner‘s overall memorial structure or integrated body of knowledge (Ausubel, 1963b).

Concept: A perceived regularity (or pattern) in events or objects, or records of events or objects, designated by a label (Novak, 2004).

Concept Map: two or more dimensional diagrams that consist of concepts or nodes linked by labelled lines to show relationships between and among those concepts (Wang & Dwyer, 2004).

Concept Identifying Concept Map: Partially completed map that students fill in the nodes to complete (Wang & Dwyer, 2006).

Cross-link: A line depicting the relationships between concepts in different segments of a concept map (Novak, Gowin, & Johansen, 1983)

Teacher Trainee: A student pursuing a teaching course in a college of education in Ghana

Derivative Subsumption: The learning of new examples that are illustrative of an established concept or previously learned idea (Ausubel, Novak, & Hanesian, 1978).

Discovery Learning: When individuals are required to internalize the information presented by rearranging it and integrating it with existing cognitive structure (Ausubel, 1961).

Learning strategy: An activity that an individual uses to improve his or her learning of new information (Liu, 2009)

Meaningful Learning: The non-arbitrary, substantive relating of new ideas into cognitive structure (Ausubel, 1968).

Node: Takes the shape of a circle, square, or rectangle and represent concepts (Novak, Gowin, & Johansen, 1983)

Proposition Identifying Concept Map: Partially completed map that students fill in the linking words to complete (Wang & Dwyer, 2006).

Proposition: Two or more concepts connected using linking words to form a meaningful statement (Novak & Canas, 2008).

Rote Learning: The arbitrary, verbatim, non-substantive incorporation of new ideas into the cognitive structure (Ausubel, 1968).

Reception Learning: When an individual learns material that is presented with all of the content to be learned in its final form (Ausubel, 1961).

Student Generated Concept Map: Concept map created entirely by the student (Novak & Gowin, 1984).

Subsumption: The attachment of new ideas and details to anchoring ideas in a subordinate fashion (Ausubel, 1962).

Superordinate Learning: The generation of new, inclusive concepts or ideas which pre-existing ideas or examples can be subsumed (Ausubel, Novak, & Hanesian, 1978).

Teacher Generated Concept Map: Concept map created entirely by the teacher (Lim, Lee, & Grabowski, 2009).

1.10. Organisation of the Study

The study involved five chapters with sub-headings in a systematic order. It includes the background to the study, statement of the problem, purpose of the study and objectives of the study. It continues with the research questions, null hypothesis, significance of the study, limitations, delimitations and definition of terms.

Chapter two is the literature review which requires the researcher to sort ideas from other related materials to the study. The literature was reviewed under the instructional techniques in science, cconcept mapping as a teaching strategy, standard construction of concept mapping, methods of scoring concept maps, concept map scoring instrument, Ausubel‛s learning theory, uses of concept maps as a tool for support of learning and effectiveness of concept mapping in the teaching and learning of science.

Chapter three is on methodology which deals with how the study was carried out and the instruments used during the intervention.

Chapter four involves the results of findings. It deals with presentation and drawing comments about the study. The last chapter being chapter five is summary, conclusions and recommendation.

CHAPTER TWO

LITERATURE REVIEW

2.0. Overview

The literature review for the study covered the following: concept mapping as a teaching strategy, construction methods for concept maps, standard concept map construction method, variations on the standard map construction method, varied concept mapping strategies, concept map scoring methods, gender as a factor in learning, school location as factor in learning, Ausubel‘s learning theory, learning and the concept mapping approaches, uses of concept maps as a tool for support of learning, identifying current understanding, misconceptions, conceptual change collaboration and cooperative learning, assessment of learning using concept maps, the utility of using concept maps for assessment, studies on scoring concept maps, studies on instructional strategies, evidence of effectiveness of concept mapping for education, studies in which an alternative educational intervention was compared to concept mapping, studies on concept mapping, studies that compared concept maps with other forms of learning material and studies on influence of gender on achievement.

Theoretical Framework

2.1. Ausubel’s Learning Theory

Concept mapping is grounded in a sound cognitive learning theory called Ausubels‘ Assimilation Theory. Assimilation theory posits that new knowledge/concept can be learned effectively by relating it to previously existing knowledge. The fundamental idea in Ausubel's cognitive theory is that learning takes place by the assimilation of new concepts and propositions into concepts and propositional frameworks already held by the learner. This knowledge structure as held by the learner is also referred to as the individual's cognitive structure. According to Ausubel (1963), the following conditions must be met for learning to be meaningful.

Firstly, the material to be learned must be conceptually clear and presented with language and examples relatable to the learner's prior knowledge: Concept maps can be helpful to meet this condition both by identifying general concepts prior to instruction in more specific concepts, and by assisting in sequencing of learning tasks through progressively more explicit knowledge that can be anchored into developing conceptual framework. Secondly, the learner must possess relevant prior knowledge and lastly, the learner must choose to learn meaningfully. The one condition over which the teacher or mentor has only indirect control is the motivation of the students to choose to learn. This can be achieved by attempting to incorporate new meanings into their prior knowledge rather than simply memorizing concept definitions or propositional statements or conceptual procedures.

The creation of concept maps supports the incorporation of new meanings into prior knowledge. Thus, concept maps may be viewed as a methodological tool of Assimilation theory that displays fundamental elements of the theory such as subsumption, integrative reconciliation and progressive differentiation. An additional idea from Ausubel's learning theory is that the cognitive structure is organized hierarchically. Concept maps are presented in a hierarchical fashion with the most inclusive and most general concepts at the top of the map while the less general concepts are arranged below. Also, the inclusion of cross-links in concept maps makes explicit the relationships between or among concepts in different regions or domains within the map. Use of linking phrases between concepts form meaningful propositions which is the basic unit of knowledge according to the theory of meaningful learning and Ausubel's Assimilation theory (Novak & Godwin 1984). An added advantage is that concept mapping theory does not constrain the labels that can be used, thereby allowing map makers more freedom and precision in describing the relationship among concepts. The number of hierarchical levels addresses the degree of subsumption, the number of branching indicates progressive differentiation while the number of cross-links indicates the degree of integration of knowledge (Cullen 1990). However, when new learning takes place which has no relationship to the existing cognitive structure, it cannot be fitted into the hierarchy of concepts and consequently, if the new learning remains as an isolated response or lacks meaning, such learning does not transfer to new situations.

To avoid this, Ausubel (1963) advocated the use of 'advance organizer' to foster meaningful learning. Advance organizers are global overviews of the material that is to be learned. They are concepts given to students prior to the material to be learned to provide a stable cognitive structure in which the new learning is to be subsumed. According to Ausubel, they foster meaningful learning by providing a context of the most general concepts into which the students can incorporate progressively differentiated details in situations where the learner has no relevant information to which they can relate the new learning. And also by promoting the learner regarding pre-existing super ordinate concepts that are already in the students cognitive structure, when the relevant cognitive structure are present but are not likely to be recognized as relevant by the learner. A concept map can be utilized as an advance organizer.

Another very powerful use of concept maps is as an evaluation tool for identifying valid and invalid ideas held by the students. In other words, concept maps (as an evaluation tool) constructed by the students can be used as a schematic summary of what the student know. It can also be used to display students' prior knowledge about a given topic. Concept maps in addition to helping learners recognize new relationships and new meanings of concepts to which they are exposed to also improve problem-solving skills in learners, aid the learners to make connections between biological concepts i.e 'learn how to learn' biology (Cullen, 1990 cited in Ezeudu, 1995) and thus ensure meaningful learning of biological concepts. This will then solve the problem of teacher effectiveness as a contributing factor to students under achievement. Concept mapping teaching strategy will also help teachers to make the subject matter more 'conceptually transparent'. This implies emphasizing the meanings of key concepts and principles and their relationships in ways which enables the students to have a better understanding of the subject matter. Concept maps according to Ezeudu (1995) will help teachers view biology as a framework of concepts and concept relationships and methodology for constructing new concepts and new concept relationships. Ezeudu (1995) reported that new knowledge creation is a constructive 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 construct good concept maps are themselves engaged in a creative process and this may be challenging to many, especially to learners who have spent most of their life learning by rote. Meaningful learning contrasts with rote learning (Inomesia & Umuero, 2003; Asiyai, 2005). Rote learning contributes very little, at best, to our knowledge structure and therefore cannot underlie creative thinking or novel problem solving. It is only good for remembering sequences of objects (list of structures) but does not aid the learner in understanding the relationship between the objects. According to Asiyai (2005), when students are taught to plan their studying and reading, monitor their thinking as they learn, use learning strategies that allow them control their thought processes knowledge acquisition and comprehension increases.

In conclusion, Novak and his research team at the Cornel University showed how Ausubel‘s theory of assimilation can be utilized to develop concept maps which can be used as a facilitative tool in teaching. The fundamental ideas in this theory can also be employed in simulation game. These meta-cognitive teaching tools help to foster creativity and co-operation between students and teachers. The researchers desire to work on concept mapping: is strengthened by the words of Cullen (1990) as in Ezeudu (1995).

> *"I find concept maps have great potential for helping student make connections between biological concepts and learn how to learn biology".*

There is at this time a vigorous search for strategies that can be used to deliver effectively and efficiently good quality chemical education. Concept mapping as reported in literature may be potent in enhancing knowledge and skill acquisition.

Conceptual Framework

2.2. Concept Mapping as a Teaching Strategy

Concept map as defined by Novak and Godwin (1984) is a schematic device for representing set of concept meanings embedded in a framework of prepositions. Asiyai (2005) defines maps as diagrammatical representation of geographical regions and these maps help to show one‘s bearing thus helping one to proceed to one‘s destination. In relating the two terms, Asiyai (2005) went further to define concept mapping as a graphical arrangement of key concepts to show meaningful relationship among the selected concepts or ideas being studied. According to Inomesia and

Umuero (2003), Concept mapping is a structural, visual means of representing concepts and their relationships. Concept maps according to Novak (1990) are diagrams indicating inter-relationship among concepts as representation of meanings or ideational framework specific to a domain of knowledge.

Concept-mapping is a meta- cognitive tool developed by Novak and a team of researchers from the Cornell University in 1972 (Kola-Ohsanya, 1998). According to Kola-Ohusanya (1998), this learning strategy was first developed as a research tool to represent learners' prior, relevant knowledge and later as a tool to enhance meaningful learning. The development of the strategy was based on Ausubel's assimilation theory, which is based on the principle that the single and most important factor influencing learning is what the learner already knows. It relates directly to such theoretical principles as prior knowledge, subsumption, progressive differentiation, cognitive bridging and integrative reconciliation (Edmondson & Smith, 1996). Udeani (2000) saw concept mapping as one instructional strategy which allows the theoretical ideas of Piaget and Ausubel to be implemented by teachers. The desire to assist learners to learn led to the development of this meta-cognitive strategy to enhance meaningful learning. Meta-cognitive strategies, Edmondson and Smith (1996) explained, are strategies that empower the learner to take charge of his or her own learning in a highly meaningful fashion. The fundamental idea in Ausubel's cognitive theory is that learning takes place by assimilation of new concepts and prepositions into existing concepts and prepositional structures or framework held by the learner. This knowledge structure already held by a learner is also referred to as the individual's cognitive structure (Edmondson & Smith, 1996).

One of the fundamental goals in the use of concept maps is to foster meaningful learning and to achieve this , the following conditions must be met; firstly, the material to be learned must be conceptually clear and presented with language and examples relatable to the learners prior knowledge. Concept maps can be helpful in meeting this condition both by identifying general concepts prior to instruction in more specific concepts and by assisting in the sequencing of learning tasks into developing conceptual frameworks.

Secondly, the learner must possess relevant prior knowledge and thirdly, the learner must choose to learn meaningfully. The one condition over which the teacher or mentor has only indirect control is the motivation of students to choose to learn. This can be done by incorporating new meanings into their prior knowledge, rather than memorizing concept definitions or propositional statements or conceptual procedures. The creation of concept maps supports the incorporation of new meanings into prior knowledge. While constructing concept maps, concepts are usually enclosed in circles or boxes and the relationship between and among concepts are indicated using ―Cross-links‟ or connecting lines that link them together. The relationship between the concepts are articulated in linking phrases or words on the connecting lines eg _gives rise to‘, _result in‘, _is required by‘ or _contributes to‘ etc,. In addition, in concept mapping the concepts are arranged and presented in a hierarchical order, with the most inclusive, most general concepts at the top of the map and the less general, more specific concepts arranged below.

Basic to making a concept map is the ability of the mapper to identify and relate its salient concepts to the general, super-ordinate concepts. Edmondson and Smith (1996) believe that concept maps can be applied to any subject matter and at any level within the subject. Concept maps can be constructed from texts or after class discussion/ lecture. Students constructing maps constantly use new propositions to elaborate concepts that he or she already knows. In other words, learning effects are enhanced, when, in the course of concept mapping, learners adopt an active, deep questioning approach to the subject matter. Such active, self-engaging, transformational interaction with learning material enhances learning in general.

Concept mapping has been put to many uses in education, business and government (Cullen, 1990). One of the original uses in education was for the assessment of what a learner knows (prior knowledge). It can be used to externalize and make explicit the conceptual knowledge (both correct and erroneous) that the student holds in a knowledge domain. It can also foster the learning of well integrated structural knowledge as opposed to the memorization of fragmentary un-integrated facts. Furthermore, it can be used to organize instructional materials for individual courses or entire curricula.

Despite the effectiveness of concept mapping in enhancing meaningful learning, its extensive use in the Ghanaian class rooms is yet to be established (Udeani, 2000). Asiyai (2005) while deliberating on enhancing science teaching in schools through concept mapping advised that when biology is taught using concept mapping, the students can easily view at a glance all the concepts in the topics taught. He went further to advice that biology teachers should make efforts to make students acquire meaningful learning in biological concepts by making the teaching of the subject exciting, purposeful and participatory. Continuing, Asiyai opined that the concept mapping strategy may be helpful in achieving meaningful and purposeful education, which appears to have eluded the nation‘s educational system. However, like any other tools, the effectiveness of concept mapping depends on how it is used and the conditions in which it is used. This study therefore investigated the efficacy of concept mapping in enhancing the acquisition of meaningful learning in circulatory concepts in biology.

2.3. Construction Methods for Concept Maps

Concept Maps can be constructed by using a variety of methods. The method that is employed depends on the purpose of map construction. Concept Maps can be constructed either by hand or with the assistance of software that supports specific tasks or general diagramming. Concept Maps can be constructed by individuals or groups, either with or without facilitation. The Concept Mapping method defined by Novak & Gowin (1984) involves a series of steps:

1. Define the topic or focus question. Concept Maps that attempt to cover more than one question may become difficult to manage and read.
2. Once the key topic has been defined, the next step is to identify and list the most important or ―general" concepts that are associated with that topic.
3. Next, those concepts are ordered top to bottom in the mapping field, going from most general and inclusive to the most specific, and an action that fosters the explicit representation of subsumption relationships (i.e., a hierarchical arrangement or morphology).
4. Once the key concepts have been identified and ordered, links are added to form a preliminary Concept Map.
5. Linking phrases are added to describe the relationships among concepts.
6. Once the preliminary Concept Map has been built, a next step is to look for crosslinks, which link together concepts that are in different areas or sub-

domains on the map. Cross-links help to elaborate how concepts are interrelated.

7. Finally, the map is reviewed and any necessary changes to structure or content are made.

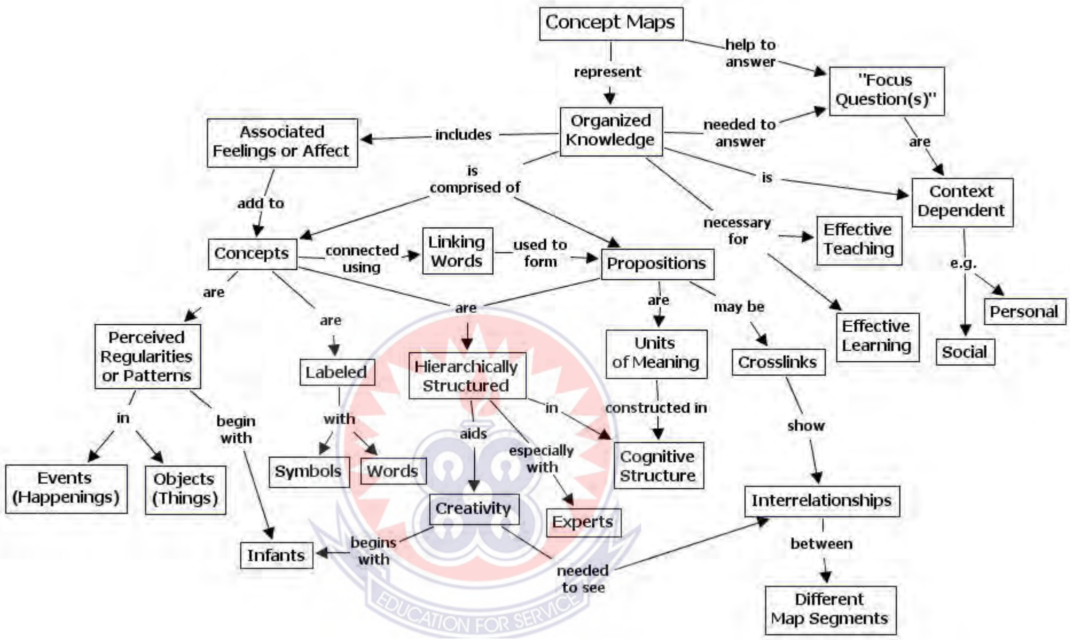


Fig 1: Concept Map that illustrates several points regarding Concept Map construction.

A characteristic of the standard method of Concept Map construction described fig 1 is that the only constraints are the structural format of the map (subsumption expressed in a semi-hierarchy), and the limits imposed by using appropriate concepts and linking words. This method is preferred because it allows the creator freedom in the representation of knowledge. Other methods of map construction have been used to serve a variety of goals, including ease of computer implementation, ease of construction by students and so forth. Ruiz-Primo et al. (2001) suggested that the degree of control or directedness in map construction differs in different mapping tasks. Map builders can be given the structure of the Knowledge Map, and lists of concepts and linking words to use to fill in the slots in the graph (a fill-in task). At the opposite extreme, the creator may be required to provide all concepts and linking phrases (a graph-from-scratch task). Aside from encouraging the semi-hierarchical format, the method proposed in Novak and Gowin (1984) method is a low-directedness mapping task. Ruiz-Primo et al. (2001) have suggested that graph construction tasks that are low in directedness may provide clearer insights into differences among students‘ knowledge structures.

Other Concept Mapping methods include variations designed to address specific tasks or settings. For example, Concept Maps can be constructed on the basis of interviews with students, experts, or other individuals. Concept Maps can be constructed by individuals or by collaborative groups, either in the same location or in remote locations, facilitated by computer networks. Concept Maps can be constructed with or without the use of a facilitator, either within a group or an individual setting. In either case, the facilitator may simply play the role of transcriptionist, or may actively promote elaboration or clarification of ideas in the Concept Map, and improvement of map structure. Concept mapping software has been designed to provide different types of facilitation for map construction, including online scoring and assessment of maps, or suggestions about improvements that may be made to the Concept Map.

The effectiveness of the four types of concept mapping strategies on student learning has been researched; however, the results are inconsistent (Kenny, 1995; Lee & Nelson, 2005; Smith & Dwyer, 1995). Wang and Dwyer (2004) conducted a study that examined the effects of three concept-mapping strategies (concept identifying, proposition identifying, student generated) on students' achievement of different educational objectives in a web-based learning environment. Wang and Dwyer (2004) identified that, despite the pre-existing literature on concept mapping, it could not be implied that all of the concept mapping strategies were equally effective for various learning objectives. The study included 156 college students who were randomly assigned to one of four groups: control, concept identifying mapping, proposition identifying mapping, and student generated mapping. A week prior to the study, six one-hour concept-mapping workshops were provided to the students in the various concept mapping treatment groups. During the study, the students were given a 2,000-word expository text describing the human heart including its parts, locations, and functions during systolic and diastolic phases.

Student achievement was measured using three criterion tests (identification, terminology, and comprehension). The objective of the identification test was to measure transfer of learning. The objective of the terminology test was to evaluate students' knowledge of references for specific symbols. The objective of the comprehension test was to measure understanding of the heart, its parts and functions. Finally, the total criterion test consisted of the items in the identification, terminology, and comprehension tests to provide a total criterion score. The total criterion score was used to measure students' total performance on the three individual criterion measures (Wang & Dwyer, 2004). The students in the control group did not use any of the concept mapping strategies and took the criterion tests after engaging with the instructional material. The concept identifying, proposition identifying, and student generated mapping groups interacted with the instructional material then used their respective concept mapping strategies to individually summarize the instructional material. Finally, the students finished by taking the criterion tests. The results of the study indicated that there were significant differences between the control group and the concept identifying mapping group on all of the criterion tests, with the concept identifying mapping group performing better.

One possible explanation for these results is that through the process of focusing primarily on the concepts, the students were able to remember the concepts and were better equipped to understand other dimensions of the content since the concepts are the foundation from which comprehension can be built (Wang & Dwyer, 2004). The student generated mapping group also performed significantly higher on the identification, terminology, and total tests compared to the control group.

Wang and Dwyer suggested that the absence of significant differences between the control and student generated mapping groups on the comprehension test resulted from the highly cognitively demanding characteristic of the student generated mapping strategy. They stated that during the creation of the concept map the students might not have been persistent enough to make extensive connections between concepts (Wang & Dwyer, 2004). Lastly, the results indicated that there were no significant differences between the achievement of the students in the control group and proposition identifying mapping group on any of the criterion tests. Analysis of the concept maps produced by the students in the proposition identifying group revealed that they had a difficult time accurately completing them; consequently, the proposition identifying concept mapping strategy failed to facilitate learning.

One of the positive attributes about the study performed by Wang and Dwyer (2004) was that the researchers were able to obtain a holistic view of students‘ understanding of the circulatory system by implementing three different tests to measure performance. Another positive aspect of the study was that the students were offered six workshops on concept mapping before the study began. Nonetheless, although the students had the opportunity to participate in the six concept-mapping workshops, the researchers were not transparent about how many of the students actually received the training and what the training entailed. For example, it was not stated if the students were provided the opportunity to create concept maps and, if they did, it was not mentioned whether or not they received feedback. One of the central reasons why the current study is related to the study conducted by Wang and Dwyer (2004) is because both studies were designed to investigate the effectiveness of concept identifying, proposition identifying, and student generated concept maps. The current study is also similar to the Wang and Dwyer (2004) study because the students received five days of one-hour concept mapping training.

In contrast to the study by Wang and Dwyer (2004), the concept mapping training in the current study was required for all students to attend. Moreover, the students received feedback on the accuracy of their concept maps during the training. The current study is also an extension of the study conducted by Wang and Dwyer (2004) because the students in the current study engaged in the instructional unit over a period of three-weeks compared to a one-day interaction with the instructional material. Additionally, the three types of concept maps were analyzed for accuracy.

In a follow-up study, Wang and Dwyer (2006) performed a similar experiment aimed to investigate the instructional effects of three concept mapping strategies in facilitating student achievement. Two hundred and ninety undergraduate students were randomly assigned to one of four treatment groups: control, concept identifying, proposition identifying, and student generated. Similar to the previous study, concept mapping workshops were conducted one week prior to the experiment. After the students interacted with a 2,000-word expository text of the human heart on the web, all students except those in the control group individually engaged in their assigned concept mapping strategies and then completed the identification, terminology, and comprehension criterion tests.

Analysis of the results indicated that the three concept mapping strategies were not equally effective in facilitating achievement of different educational objectives. The superior concept mapping strategy on all of the criterion tests was the concept identifying mapping. The students in the student generated concept mapping group only demonstrated significantly higher scores in achievement at the conceptual level when compared to the control group.

One possible explanation that Wang and Dwyer (2006) offered for these results is that since the students began the mapping procedure at the factual level by identifying and selecting key concepts, then proceeded to the conceptual level to develop propositions between the concepts, many of the students did not effectively make it to the last level of reorganizing the information using rules and principles to show internal structure of the content. Hence, because reorganizing the concepts and propositions was a highly metacognitive activity, students did not persevere and remain at the conceptual level of learning. The proposition identifying mapping strategy was not effective in facilitating achievement of the educational objectives as measured by the criterion tests when compared to the other three treatments. Wang and Dwyer (2006) identified that the ineffectiveness of the proposition identifying mapping strategy on students‘ achievement may have been a result of the ambiguity associated with the map itself. Based on the learning material, the students may have perceived the concepts without links in a way that differed from what the map provider expected them to see. According to Steward (1979), there could be ―numerous valid propositions that could be generated to link two nodes" (p. 400). Similar to their previous study, a positive characteristic of the Wang and Dwyer (2006) study was that during the pre-experiment phase students were offered concept mapping workshops. In the 2006 study, the researchers identified that the workshops included an explanation of the nature of concept maps, uses of concept maps, and procedures for concept mapping. In addition, the students were required to practice concept mapping and were provided feedback on their concept maps. In spite of this, Wang and Dwyer (2006) identified that the students were not sufficiently prepared with the concept mapping strategies. The current study is related to the 2006 study designed by Wang and Dwyer in several ways. First, the current study was also designed to investigate the effectiveness of concept identifying, proposition identifying, and student generated concept maps.

Second, the students in the current study were also involved in concept mapping training that included an explanation of the nature of concept maps, uses of concept maps, and procedures for concept mapping. Third, similar to the study conducted by Wang and Dwyer (2006), the students in the current study also received feedback on the construction of their concept maps during the training. As indicated earlier, an extension of the Wang and Dwyer 2004 and 2006 studies was that the students in the current study interacted with the instructional material over a period of three-weeks instead of a single day. Furthermore, all of the concept maps produced during the current study were analysed for accuracy. In a recent study conducted by Lim, Lee, and Grabowski (2009), the researchers aimed to identify the impact of teacher generated; student generated, and partially completed (concept and/or linking words omitted) concept maps on student learning. One hundred and twenty four undergraduate students were randomly assigned to one of the three concept-mapping treatment groups. The students in the student generated and partially completed concept mapping groups were provided written instructions on ―how to create a concept map,” while the students in the teacher generated concept mapping group received written instructions on ―how to use a concept map” (Lim et al., 2009). Each student studied the same web-based learning material about the human heart and utilized their assigned concept mapping strategy. After studying the learning material and interacting with the concept maps, the students turned in their concept maps and were administered a post-test to assess their learning. The students completed all of the tasks in one sitting. Results from the post-test revealed that students in the student generated concept mapping group significantly outperformed the students in the teacher generated concept mapping group (Lim et al., 2009).

The mean scores for the student generated, partially completed, and teacher generated concept mapping groups were 26.72, 23.93, and 21.38 with standard deviations of 8.96, 8.48, and 8.73, respectively. Lim et al. (2009) also discovered that that there were no significant differences between the teacher generated concept mapping group and the partially completed concept mapping group, or between the partially completed concept mapping group and the student generated concept mapping group. One of the strengths of the study by Lim et al. (2009) was that they designed specific concept mapping instruction for the treatment groups. For example, the student generated concept mapping group received instruction on ―how to create a concept map” whereas the partially completed concept mapping group received instruction on ―how to use a concept map.” This may have assisted students in focusing on strategies that would help them either create or use the concept maps.

The study designed by Lim et al. (2009) had a few limitations. One of the weaknesses of the study was that it was conducted in one day. The students were taught how to create or use concept maps, learn the instructional material, and take the posttest all in one day. It would have been useful if the students had more time to practice creating or using the concept maps. Another limitation of the study was that the concept maps produced by the students were not analysed for breadth or depth of understanding of the circulatory system. The researchers did not evaluate the concept maps to find out if the students created accurate concept maps of the circulatory system. The students may have created inaccurate concept maps while performing well on the posttest. The study designed by Lim et al. (2009) is similar to the current study because both studies aimed to evaluate the effectiveness of the various concept mapping strategies. The current study builds upon the study by Lim et al. (2009) in several ways. First, the students in the current study received five days of concept mapping training and feedback before they engaged with the instructional material. Similar to the study by Lim et al. (2009), the students received specific training on the concept mapping strategy they were assigned to. Second, the students had the opportunity to learn the instructional material over a three-week period compared to the one-day interaction with the instructional material provided in the Lim et al. (2009) study. Third, the concept maps produced in the current study were evaluated for accuracy.

Although researchers have conducted studies to investigate the effectiveness of the varied concept mapping strategies, none of the studies have been carried out in college of education setting. The majority of concept mapping studies has taken place in high school and undergraduate/graduate school settings. Additionally, further research is necessary because the results of the effectiveness of the varied concept mapping strategies are inconsistent. In both of the studies conducted by Wang and

Dwyer (2004, 2006), the results suggested that the concept identifying groups were superior in performance compared to the student generated and proposition identifying groups.

Alternatively, the results from the study by Lim et al. (2009) revealed that the students in the student generated concept mapping group outperformed the students in the partially completed and teacher generated concept mapping groups. Evidently, there is a need for additional research that compares the effectiveness of the varied concept mapping strategies.

2.4. Concept Map Scoring Methods

Since the introduction of concept mapping, researchers have been interested in developing ways to measure meaningful learning by using concept maps as assessment tools. Koul, et al. (2005) explained that the interpretation and scoring of concept maps involves judgments along numerous dimensions that represent the breadth, depth, and connectedness of the knowledge all based on only the concepts, propositions, cross-links, and levels of hierarchy in the concept map. One of the critical components of a scoring method is that the concept map score strongly relates to the student‘s actual understanding of the content. Hence, it is especially important to select an appropriate scoring method since different scoring methods will result in different scores for the same set of maps.

In 1984, Novak and Gowin developed the first comprehensive concept map scoring system. The scoring system consists of evaluating concept maps based on the number of valid components in a map. The valid components include propositions, levels of hierarchy, cross-links, and examples. The propositions are worth one point and are evaluated based on the presence of a meaningful, valid relationship between two concepts indicated by a connecting line and linking word(s). Five points are allotted for each level of hierarchy that displays subordinate concepts that are more specific and less general than the concepts drawn above it. Cross-links that exhibit meaningful connections between one segment of the concept hierarchy and another segment that are both significant and valid are given 10 points. On the other hand, cross-links that are valid but do not illustrate a significant connection between sets of related concepts or propositions are only given two points. Finally, one point is allotted for every concept that is accompanied by a valid example. After all of the components of the concept map are scored, they are added together to establish the final score.

An alternative scoring method by McClure and Bell (1990) focuses exclusively on propositions included in a concept map. The three aspects of the propositions that are scored are: (1) the relation between the concepts, (2) the label, and (3) the direction of the arrow indicating either a hierarchical or causal relationship between concepts. If there is a relationship between the subject and object, the label indicates a possible relationship between the words, and the direction of the arrow indicates a hierarchical or causal relationship between the words that is compatible with the label, then the proposition is given three points. The absence of a relationship between the subject and object results in zero points; however, the presence of a relationship between the subject and object is assigned one point. If there is a relationship between the subject and object and the proposition includes a label that indicates a possible relationship between the words, two points are assigned.

A more recent scoring system developed by Kinchin and Hay (2000) consists of analysing the overall organization or structure of the map. This scoring system is based on the idea that knowledge structure is a more holistic variable rather than a "sum of the individual components" type variable. A concept map score is assigned after the evaluator judges the overall structure of the map and identifies progressive levels of understanding. The scoring methods described above are useful for scoring specific types of concept maps. For example, the scoring method by Novak and Gowin (1984) would be useful for scoring student generated concept maps since all aspects including concepts, propositions, cross-links, and examples are evaluated. In contrast, the scoring method designed by McClure and Bell (1990) would only be useful for evaluating proposition identifying maps because the propositions are the only components of the concept map evaluated using this specific scoring method. The scoring method by Kinchin and Hay (2000) evaluates the overall organization of the concept map so it would be useful for scoring student generated concept maps. Concept identifying and proposition identifying concept maps would not be scored effectively using this scoring method because the maps are already partially organized. A scoring method designed by Lomask, Baron, Greig, and Harrison (1992), was better suited to score the concept identifying, proposition identifying, and student generated concept maps produced in the current study.

The scoring system created by Lomask et al. (1992) entails arriving at an overall score by counting the number of concepts and the correct links between the concepts. Initially, Lomask et al. scaled both the count of concepts and the count of links. The "size" of the count of concepts was expressed as a proportion of terms in an expert concept map mentioned by a student. This proportion was scaled from complete (100%) to substantial (99%-67%) to partial (66%-33%) to small (32%-1%) to none (0%). Similarly, they characterized the "strength" of the links between concepts as a proportion of necessary, accurate connections with respect to the expert map. Strength ranged from strong (100%) to medium (99%-50%) to weak (49%-1%) to none (0%).

Next, Lomask etal, created a rubric (Table 1) that produced scores taking into account both ―size” of concepts and ―strength” of links.

Table 1: Scores Based on Combinations of "Size" and "Strength" of Students' Concept Maps

		Strength (Links)		
Size (Concepts)	**Strong (100%)**	**Medium (99%-50%)**	**Weak (49%-1%)**	**None (0%)**
Complete (100%)	5	4	3	2
Substantial (99%-67%)	4	3	2	1
Partial (66%-33%)	3	2	1	1
Small	2	1	1	1
None/irrelevant (0%)	1	1	1	1

Lomask et al (1992)

The concept identifying, proposition identifying, and student generated concept maps produced in the current study were evaluated based on the scoring method created by Lomask et al. (1992). The justification for utilizing this particular scoring method was that previous research has demonstrated that scoring approaches with the highest reliability and criterion-related validity compare specific features in student concept maps to those in expert concept maps (Taricani & Clariana, 2006). Furthermore, the scoring method developed by Lomask et al. (1992) could be used to score the three different types of concept maps produced in the current study because it involved evaluating the concepts and links independently.

.

2.5. Learning and the Concept Mapping Approaches

The definition of learning varies among the various and different learning theories. For instance, learning means to bring changes in the behaviour of the organism. Gagne (1992) defined learning as change in human disposition or capacity which persists over a period of time and which is not simply ascribable to the process of growth. Chauhan (1979) defined learning as a relatively enduring change in behaviour which is a function of prior behaviour (usually called practice). It is a relatively permanent change in behaviour of an organism.

Despite the seeming varied definitions of learning, as a process, there are some attributes that are common to all of them and these common attributes tend to unite them. The issue of change in behaviour or capability is central to all definitions. It does not include changes due to growth (maturation), illness, fatigue, or use of in-toxicants Secondly, the change must be due to experience, study, training or practice. Another common and uniting characteristic in these definitions is that learning is not directly observable but manifests in the activity of the individual. Lastly, learning results in some changes of enduring nature. The major difference is how the change takes place.

There are two groups of learning theorists: The Stimulus-Response Associationist Theories and the Cognitive Field Theories. The Stimulus-Response associationists are concerned with observable or overt behavioural changes of organisms and how these behavioural changes could be controlled and so their approach to learning is also referred to as behaviourism. They posit that learning occurs due to formation of associations between stimulus and response. They maintain that the quality of learning and retention depends on the strength and the nature of the association between the stimuli and the responses. The behaviourists are also of the view that the environment shapes behaviour. The theory emerged from operant conditioning using reinforcement. The theorists include; Pavlor, Thorndike and Skinner. The Stimulus-Response association theory has found various applications in learning such as in teaching, programmed learning, computerized systems and instructions (teaching machine) as well as in behaviour modification.

On the other hand, the Cognitive field theorists or Gestalt psychologists maintain that the human mind is actually involved in learning, otherwise, the learning will not be meaningful. They are of the view that learning is a re-arrangement of thought pattern, and hence stresses the importance of structure and provision of opportunities for initiative thinking in the class room (Biehler, 1974). They also emphasized issues like insight, perception, discovery and understanding in any learning situation. The proponents of this theory include; Piaget, Gagne, Brunner, Ausubel, Lewin and Koffka. They see the stimulus-response association (S-R) as too trivial and mechanical to explain and understand learning. Instead they view learning as an interaction between the cognitive structure (previous knowledge) and the new or in coming information and this interaction results in meaningful learning, the specific emphases of four cognitive field theorists are stated below; Piaget's developmental Psychology assumes that the cognitive development unfolds in fixed sequences up to maturity. Piaget emphasizes that children do not move abruptly from one period to another. Instead, the child's capacity to learn depends on the stage of his development in age. He proposed four of such developmental stages, as the child progresses from infancy to maturity, namely: sensory motor, the pre-operation, the concrete operations and formal operations stages. Piaget also gave a profile of the thought processes of each of the stages. The implications of Piagetian theory is that certain periods in the child's mental development are critical and therefore should be taken into consideration when planning the curriculum or even instruction. Therefore before a new concept is introduced to the child, it is necessary to ensure that he has mastered the pre-requisites for learning the concept. Concept mapping by its nature will require the teacher and students to break up the main concepts into the sub-ordinate concepts and arrange them in a hierarchical order.

2.6. Uses of Concept Maps as a Tool for Support of Learning

Concept Maps created by students can be used in several ways to facilitate meaningful learning. Novak and Gowin (1984) pointed out that Concept Maps are a kind of schematic summary of what students know. They can be used to display students‘ prior knowledge about a given topic, or they can be used to summarize what has been learned, for example, after reading an assignment or completing some other classroom lesson. In this regard, Concept Mapping is often used for note taking or as a study aid. Novak and Gowin noted that the act of mapping is a creative activity, in which the learner must exert effort to clarify meanings, by identifying important concepts, relationships, and structure within a specified domain of knowledge. The activity fosters reflection on one‘s knowledge and understanding, providing a kind of feedback that helps students monitor their learning and, perhaps with assistance of teachers or peers, focus attention on learning needs. As a creative activity, Concept Mapping can also be used as a planning tool or as an alternative to essay writing.

From the volume of literature on the subject of uses of Concept Maps, it is easy to conclude that the most prevalent use of Concept Mapping is for teaching and learning. A variety of uses of concept maps have been identified including:

- As a scaffold for understanding,

- For consolidation of educational experiences,
- To improve affective conditions for learning,
- As an aid or alternative to traditional writing,
- To teach critical thinking, and
- As a mediating representation.

2.7. Identifying Current Understanding, Misconceptions, Conceptual Change

What conceptual understandings students achieve in a new learning activity is highly dependent on what they already know. Concept Maps have been used to examine students' prior knowledge, to track a student's progression of knowledge throughout a course, to compare students at different levels of knowledge and so forth (Adamczyck & Willson, 1996; Cho, 1988; Hoz, Bowman & Kozminsky, 2001; Pearsall, Skipper & Mintzes, 1997; Songer & Mintzes, 1994). Concept Maps have also been used to identify specific misconceptions in knowledge (e.g., Gonzalez, 1997; Regis & Albertazzi, 1996; Trowbridge & Wandersee, 1994), and to identify alternative educational approaches to address misconceptions (McNaught & Kennedy, 1997; Passmore, 1998). Teachers and students are often able to more clearly identify misconceptions within the context of a Concept Map.

Cullen (1990) found that using a reflective writing exercise in conjunction with Concept Mapping revealed additional misconceptions and provided more information about students' understanding than did mapping alone. Kinchin, Hay, & Adams (2000) proposed that qualitative assessment of students' Concept Maps is more appropriate than quantitative methods when the intent is formative assessment of student learning.

Edmondson and Smith (1996) used Concept Maps in several different ways in a veterinarian curriculum. Faculty members were able to identify student misconceptions and adjust teaching to address these. Another set of studies stands out because they are all related to teacher development (e.g., Bolte, 1999; Butler, 2001). Edmondson and Smith (1996) used Concept Maps in conjunction with questionnaires and interviews to study in-service teachers‘ understanding of the structure, function, and development of their respective science disciplines. Beyerbach and Smith (1990) tracked pre-service teachers‘ knowledge about the processes of teaching and learning, using Concept Maps teachers constructed throughout their final year of the teacher preparation program. Ferry, Hedberg and Harper (1998) suggested that Concept Mapping helps pre-service teachers to organize their knowledge and curriculum content in integrated frameworks. Jones, Carter and Rua (1999) used teachers‘ pre- and post-course Concept Maps, along with journal reflections and portfolios, to examine professional growth as a result of changes in conceptual understanding of content and pedagogical knowledge.

In contrast, Lang and Olson (2000) looked at pre-service teacher knowledge and the effects of practical experience, found decreases in complexity and organization of knowledge from pre-or early course to post-course Concept Maps. Finally, Morine-Dershimer (1993) used pre- and post- course Concept Mapping to assess conceptual change in pre-service teachers. She developed a scoring technique that enabled her to identify patterns of change associated with particular features of the educational environment, which, she suggested would be useful for course or program evaluation.

2.8. Collaboration and Cooperative Learning

The benefits of collaboration in Concept Mapping have been noted in a number of studies. For example, Esiobu, and Soyibo (1995) compared groups using both Concept Mapping and V-diagramming, individually or in small groups, as a summarization or study strategy at the end of regular classroom instruction, with a control group that used neither tool. Both treatment groups did better than the control group as measured by multiple-choice-question achievement tests, and showed some advantage for cooperative group learning. Roth and Roychodury (1993) used Concepts Maps to examine the quality of students understanding.

Other researchers have found that collaboration does not appear to benefit students. For example, Chung, O'Neil, and Herl (1999) examined team processes that occurred as students jointly constructed a Concept Map over a computer network. The quality of constructed maps was not related to teamwork processes. In another study looking at collaborative map construction, Herl, O'Neil, Chung, and Schachter (1999) found no benefit for collaboration. In this study, researchers looked at two conditions for knowledge mapping. In one group, students collaborated over a network to construct group maps. In the other group, students worked individually to construct maps using information from web searches. Students in the individual mapping condition showed significant improvement in mapping scores over the course of a year. Students in the collaboration condition did not show change. The nature of the interaction among participants appears to have an influence on whether or not effects of collaboration are positive (Chinn, O'Donnell & Jinks, 2002; Van Boxtel, Van Der Linden & Kanselaar, 1997, 2001). Collaborative Concept Mapping promoted more debate and reasoning in the interaction among students. Although outcome measures indicated no significance difference between the two conditions, frequency of elaborative episodes in the discourse of Concept Mapping students was positively correlated with individual learning outcomes. Among other benefits of Concept Mapping, Baroody and Bartels (2000) and Baroody and Coslick (1998) also noted that when used collaboratively, Concept Mapping promotes questioning, discussion, and debate. Interestingly, Stoyanova and Kommers (2002) found that synchronous collaboration with Concept Mapping ―provoked a more intense collaboration", and resulted in ―a more dense conceptual representation" than did mapping in distributed or mediated groups. Chiu, Huang and Chang (2000) also looked at group interaction during collaborative web-based Concept Mapping. Using a system for interaction analysis based on systems by Hertz-Lazarowitz (1990; 1992) and by Webb (1989; 1995), researchers found that, in particular, a type of high-level interaction called complex co-operation correlated most highly with mapping performance.

In closing this section, we describe a few other collaborative activities using Concept Maps, which exemplify a range of uses. For example, students can collaborate to indirectly support each other‘s learning. Canas, et al. (2003) described a computer-based collaboration environment as part of the Concept map tools software, designed to promote meaningful learning by means of a unique collaboration tool. The software allows students from distant schools to share claims (propositions) derived from their concept maps regarding any domain of knowledge being studied. Sharing takes place through the Knowledge Soup, a repository of propositions submitted by the students stored in a server. Propositions in the Soup that are found to be similar to those submitted by the student are displayed on the student‘s screen. He or she can use these propositions from other students to enhance his or her concept map. In addition, the student can question or criticize propositions submitted by other students, leading to a peer-review type of environment, where students themselves are responsible for the validity of the propositions in the Soup. Cristea and Okamoto (2001) described a Concept-Mapping environment that is designed to support collaborative course authoring. The authors believe the mapping process can be useful for course designers because of its theoretical basis, which suggests mapping leads to additional creativity, as well as effective externalization and visualization of ideas. Finally, Francisco, Nicoll and Trautmann (1998) reported on the use of Concept Maps in college level science classes. In review sessions before exams, participants were provided with a relatively large map and asked to work together to integrate information from other Concept Maps or topics. By repeating this process throughout the course, students built a collaborative, integrated view of the science topics covered in the course.

Empirical Studies

2.9. Studies on Instructional Strategies

Adiyiah (2011) investigated the effects of concept mapping on selected senior high students‘ achievement on the cell theory. The study used a total of fifty-four (54) first year students from a Senior High School in Ghana. The design of the study was quasi experimental pre-test post-test, non-randomized control group. Three hypotheses guided the study. Data collected was analysed using means, standard deviation, t-test comparisons. Closeness index technique of scoring concept maps proposed by Goldsmith, et al. was used in the assessment process of the students drawn micro-concept maps on the structure of the cell. It was found among other things that students exposed to concept mapping strategy performed significantly better than those exposed to the conventional lecture method. Other findings include that gender was not significant though gain differences were recorded in the achievement mean scores.

Brobby (2012) investigated how computer assisted instruction and concept mapping improve the teaching and learning of glycolysis and the krebs‘ cycle in selected senior high schools in Ghana and the findings was not different from the above. The present studies focus on the circulatory system and is carried on colleges of education students

Akinsola and Igwe (2002) investigated the relative effects of meta-cognitive strategy of framing on students" achievement in selected difficult biological concepts. The study used a total of 187 students from two co-educational colleges in Ibadan. The design of the study was quasi experimental pre-test post-test, non-randomized control group. Data collected was analysed using means, standard deviation, t-test comparisons and one-way ANOVA. It was found among other things that students exposed to framing strategy performed significantly better than those exposed to the conventional lecture method.

This study is relevant to the present study because both focused-on influence of teaching strategies on students" achievement. Influence of gender was determined in both cases. The present study also utilized some of the statistical tools used in the reviewed work. Agbi (2006) investigated the effects of interaction of teaching methods and study habits on senior secondary students" achievement and interest in Biology. A total of 240 SS 2 biology students randomly selected from Ogoja Education Zone of Cross-Rivers State participated in the study. The design of the study was quasi-experimental and 2 intact classes were used; 1 treatment, 1 control. Biology Achievement Test (bAT) was used. Results of the analyses revealed that teaching methods have significant effects on the achievement and interest of students in biology. The present work investigated the effect of concept mapping teaching strategy on achievement in the circulatory system of colleges of education students.

Udobia (2002) assessed the effect of pedagogy on the output of instructional programmes in science technology and mathematics (STM). The purpose of the study was to find out the effect of teaching method, classroom management and evaluation in the quality of the output of instruction in STM. The research design was a survey and structured questionnaires were used to extract information from the respondents. The sample comprised 200 STM teachers in Rivers State randomly selected. The z-95

test statistics was used for data analysis. Results of the study showed that pedagogy has a significant influence on the output of educational programmes in STM. Other reports from the study include, that good pedagogical approach has a very positive and fruitful effect on the products as it assists the learner to learn well. Literature reviewed (Ezeudu, 1995; Udeanu, 2000; Ali, 2006; Longjohn, 2009) pointed concept-mapping as problem based and activity oriented instructional strategy that may enhance academic achievement.

2.10. Evidence of Effectiveness of Concept Mapping for Education

Concept Mapping had its roots in education, and education and learning probably still constitute the bulk of its use. Hence, concept mapping was used in this study. The issue is not whether or not Concept Mapping enhances learning. Like any other tool, the effectiveness of Concept Mapping depends on how it is used and the conditions in which it is used. There is no doubt that Concept Mapping enhances learning. An earlier review of the educational effectiveness of Concept Mapping (Horton et al., 1993) concluded that Concept Mapping can have educational benefits that range from what can only be described as huge, all the way to having negative effects (i.e., when some alternative instructional intervention produced learning effects greater than Concept Mapping), although the great majority of the studies reviewed showed differing degrees of positive effect for Concept Mapping.

2.11. Studies on Concept Mapping

Since the development of concept mapping by Joseph D. Novak and his associates at Cornell University in the 1970's, some studies have been carried out on this teaching strategy in different areas like Biology, Chemistry, Physics, Integrated science, Mathematics.

The goal of Jegede, Alaiyemola and Okebukola (1990) was to test whether the addition of concept mapping to instruction would aid achievement and reduce anxiety. The study involved a total of 51 SS 2 students. The design of the study was treatment and control with pre and post testing. There was random assignment of classes to condition. The subject matter in Biology was nutrition in green plants and respiration in cells. There were positive effects in favour of concept mapping in both achievement and for anxiety reduction. The present study investigated the effect of concept mapping on students‘ achievement in the circulatory system. Unlike the above reviewed work, the effect on anxiety reduction was not investigated. Schmid and Telaro (1990) tested the effectiveness of concept mapping on high school Biology and assessed this by students‘ ability level**.** The study was conducted in Montreal, Canada and involved students at levels "4 and 5" of the Canadian system. The subject matter was a unit of a biology course on the nervous system. The experimental design combined treatment and control crossed with three levels of academic ability (high, medium and low). The results indicated that the helpfulness of concept mapping increased as groups went from high to medium and to low ability levels. The researchers are of the view that concept mapping helps low ability students to a greater degree because it requires them to take an organized and deliberate approach to learning. The present work was done in the circulatory system. Students‘ ability level was not a factor.

Ezeudu (1995) carried out a study to ascertain if the use of concept mapping could be found significantly effective in accelerating students‘ achievement in Biology in Nigeria. The study involved 411 SS 2 Biology students in Nsukka, Enugu State. She found out that there was a significant difference between the achievements and interest of students taught with concept mapping strategy and those who were taught using conventional approach- lecture method. The difference was in favour of those taught with concept mapping. Gender was consistently insignificant with respect to achievement, retention and interest. The study also reported the existence of significant interaction effect between gender and concept mapping on students‘ achievement but not with interest and retention in Biology. The design, method of data analysis in the above study was employed in this study. Though the two studies are in the same subject area, the units or subject matter considered are different. In addition, the levels of students are also different.

Jegede et al (1990) went on to test if the addition of concept mapping to instruction in a physical science course would improve or enhance achievement, reduce anxiety towards physical science on the part of students and also reduce anxiety about teaching physical sciences on the part of the teachers. The study was conducted in the United State, using a total of 104 pre-service undergraduate science education students. The subject matter in physical science included electricity, heat, light, sand, matter, energy and basic mechanics.

The pre-test, post- test mode was employed and ANCOVA was used for analysing data. The result showed that concept mapping increased achievement and decreased anxiety for learning physical science. Results however did not indicate increased self-efficacy for teaching physical sciences. The effect of concept mapping on achievement and interest is the main focus of this study. Anxiety was not investigated and the subject matter used for the present study is circulatory system in biology. However, the design and method of analysis used was adopted in this study. Kola-Olusanya (1998) investigated the relative effectiveness of concept mapping and analogies in enhancing understanding of global warming and Ozone layer depletion. The investigation involved 31 teachers, and 39 students. The research finding showed that the teachers ranked concept mapping as being the better of the two strategies in bolstering student‘s performance. This study investigated if students‘ achievement in circulatory system will be enhanced by the method as indicated by the teachers using colleges of education students. Ahove (1998) determined the influence of three teaching strategies namely concept mapping, lecture/discussion and the use of analogies on the attitude of Nigerian science teachers and students towards the control of Ozone layer depletion and global warming. He used a total of 31 teacher (20 male, 11 female) and 39 SS II students (25 male and 14 female). According to the results obtained, the teachers used in the study confirmed that concept mapping enhances understanding of the environmental problem which in the turn permits the development of favourable attitude. The present study concerned itself with achievement not attitude, and therefore explored if concept mapping will enhance achievement as indicated by the teachers. More over gender difference were compared in terms of their achievement and in the present study.

Ezeugo and Agwagah (2000) determined the effect of concept mapping on students' achievement in Algebra. The study also investigated the differential effects of concept mapping on the achievement of boys and girls in algebra. A total of 387 SS 2 students selected randomly were used for the study. The design was quasi-experimental, pre-test, post-test and data obtained was analysed using ANCOVA. Results revealed that students exposed to the concept mapping technique achieved more in the algebra content than those who were not, male students in the experimental group scored more than the females (also from the experimental group) in the achievement test. The above reviewed study was done in a unit in mathematics while the present one was done in Biology. However, the design and method of data analysis used were adopted in the present study.

In another development, Udeani (2000) conducted an investigative survey to explore the knowledge and use of concept mapping instructional strategy by science teachers in the class room. Seventy -one science teachers provided the data for the study through the use of a 25-item questionnaire. The major findings of the study include that 86% of the teachers responded that they were aware of the existence of the strategy but virtually all of them (91% approximately) could neither described what it is or how to use it. It therefore follows that most of the teachers in the sample were aware of the strategy but do not have adequate knowledge of what it is and how to use it in teaching to enhance learning. This is rather frightening because the extensive gains to student's meaningful understanding and learning of difficult concepts are lost due to the teachers‘ lack of knowledge about the teaching strategy.

The present study afforded the teachers who participated in the study the opportunity to learn more about the strategy and how to effectively use it to enhance achievement and interest. Niccoll, Francisco and Nakhleh (2001) investigated the value of using concept mapping in general Chemistry and more particularly, to see if concept mapping would produce a more interconnected knowledge base in students compared to ordinary instruction. The study was conducted in U.S.A and a total of 20 first year University students participated. The design was quasi -experimental where 2 intact classes were used (one concept mapping and the other, the traditional lecture method). The researcher utilized a specially structured interview used at the end of instruction to determine the degree of interconnectedness in students' knowledge base. The structured interview was used instead of concept mapping so as not to disadvantage the students who did not do the concept mapping the researchers explained. The result showed that the concept mapping group knew more concepts, more useful linking relationships and less negligible erroneous linking relationships than the non-concept mapping students. The reviewed study utilized first year university students and a very small sample size. The present study utilized college of education students in Ghana. However, the design of this study was employed in the present work.

The efficacy and potency of concept mapping technique in improving senior secondary school students" achievement and retention in ecology was determined by Danmole and Femi-Adeoye (2004). A total of 137 students comprising 58 males and 79 females; were involved in the investigation. The findings of the study showed that the experimental group performed significantly better than the control group thereby showing that concept mapping technique is very effective for meaningful learning. The present study however investigated the efficacy and potency of concept mapping in enhancing achievement in circulatory system while the above reviewed work was done in Ecology. However, the design and method of data analysis used were employed in this work.

In Cameroon, Nekang (2004) investigated the effect of concept mapping on two groups of form V (final year secondary school) student ' achievement and interest in elementary probability. The study also determined the differentia effect of concept mapping on the achievement of male and female students in probability. The result of the study showed that concept mapping enhances students' achievement and interest. The researcher recommended that teachers and students should apply the knowledge of concept mapping in every subject and at all levels of instruction from primary to tertiary. The study reviewed was carried out outside Ghana and also in units in mathematics. The present work was done in Ghana and in units in Biology. The present work also looked at effects of concept mapping teaching strategy on students' achievement.

Looking at the works reviewed, many were done in other subject areas, some at different locations including outside Ghana. Also, some were done using undergraduate students, secondary school students and even teachers in some other instances the researcher observed that concept-mapping were compared with other methods like Analogy, Lecture and Discussion. Some of the works determined the effectiveness of concept mapping with reference to anxiety reduction and attitude. The present study looked at the effectiveness of concept mapping strategies on students' achievement and to determine whether there is gender difference in achievement in circulatory system. While reviewing literature, the researcher did not come across any study that determines the effects of concept mapping strategy on students' achievement on the circulatory system in Colleges of Education in Ghana. From the finding of the studies reviewed, concept mapping technique was reported to be effective for achieving meaningful learning.

CHAPTER THREE

METHODOLOGY

3.0. Overview

This chapter consists of the research design, population, sample and sampling technique, research instruments, pilot- testing. The chapter also includes data collection procedure, data analysis, and treatment.

3.1. Research Design

The quasi-experimental design was adopted for the study. Specifically, the pre-test, post-test, non-equivalent control group design was employed for the study. This design was adopted because it was not possible to have randomization of the subjects to avoid the disruption of school organization (streaming of classes). Consequently, two intact classes were used for the study. The class that received the treatment was the experimental groups 1 (E) and the other as control group (C). The design is illustrated as shown in figure 2.

Groups	Pretest	Treatments (x)	Post test
Experimental (EI) Concept Mapping (CM)	O1	X1	O2
Control group C	O1	_	O2

Fig 2: Illustration of Research Design

Where 1= Experimental Group 1 (concept mapping)

C= Control group (Conventional Lecture Method Only)

O1= Pretest for all groups

X1= Treatment given to E1

O2= Posttest for all groups

3.2 Population

The population for this study consisted of all first year students in Gbewaa College of Education. The accessible population was 208 first year trainee teachers who offer integrated science in Gbewaa College of education.

3.3. Sample and Sampling Techniques

Sampling is the process of selecting a portion of the population to represent the entire population (Alhassan, as cited by Adiyiah, 2011).

Data gathering is crucial in research, as the data is meant to contribute to a better understanding of a theoretical framework (Creswell, 2005). It then becomes imperative that selecting the manner of obtaining data and from whom the data will be acquired be done with sound judgment, especially since no amount of analysis can make up for improperly collected data (Bernard, 2002).

The Sample of the study comprised of 95 first year integrated science students purposively drawn from two Colleges of Education in the Northern part of Ghana. 50 students from Gbewaa College of Education consisting 28 males and 22 females as the experimental group and 45 students from Bagabaga College of Education made up of 25 males and 20 females as the control group. The 95 students selected were first year science students who offered the circulatory system in which the difficulty was found. The 50 students from Gbewaa College of Education were selected as the experimental group because they had difficulty in answering questions in the circulatory system. An intact class of 45 students of Bagabaga College of Education was used as the control group because they were in the same level and studying the same course. The experimental group was divided in to three groups according to their ability levels as high achievers, average achievers and low achievers. The high achievers were made up of 14 students consisting of ten males and four females, the average achievers made up 16 students consisted of nine males and seven females while the low achievers were made up of 20 students consisting of nine males and 11 females.

3.4. Instrumentation

Two instruments: Circulatory System Achievement Tests (CSAT) and a structured questionnaire on effectiveness of concept mapping developed by the researcher were used for data collection.

Circulatory System Achievement Tests (CSAT)

A multiple-choice test item which is an example of close-ended objective test item was used as an instrument to collect the data on the circulatory system achievement of students at the pre-test and post-test levels. Both the pre-test and post-test were made up of 20 multiple choice questions each. The closed ended questions were appropriate for this study since it allows respondents to choose between options that were provided by the researcher and have increasingly become popular compared with open-ended questions (Smith, Disessa, & Roschelle, 1993). The pre-test was administered to both the experimental and control groups. The scores were analysed using descriptive and inferential statistics. The test items are shown in appendix A.

The circulatory system concept identifying, proposition identifying, and student generated concept maps was assessed using a scoring instrument created by Lomask, Baron, Greig and Harrison (1992). The scoring instrument involved obtaining an overall score by comparing the number of correct concepts and/or links between the students' concept identifying, proposition identifying, and/or student generated concept maps to a teacher generated concept map (expert concept).

Questionnaire is widely used for data collection in educational research when information is to be obtained from a larger number of subjects (Babbie & Rubin, 1989). A structured questionnaire was used to ascertain the subjects' perception of the effectiveness of concept mapping strategy in the teaching and learning of the circulatory system.

It has a 4-point Likert-type response scale. Originally the items were 20 in number. After Factor-Analysis the number of items reduced to 15. The respondents were expected to indicate their degree of agreement or disagreement on a number of statements (positive and negative) about the concept mapping teaching strategy on the circulatory system. Care was taken to write the items in simple language for easy understanding. The scale and scoring are shown;

i For positive items Strong Agree 4; Agree =3; Disagree=2; Strongly Disagree = 1.

ii For negative items: Strongly Agree=1; Agree =2; Disagree =3; Strongly Disagree = 4.

3.5. Validity

A test is valid if it results are appropriate and useful for making decision in judgment about an aspect of students achievement (Gronlund & Linn, as cited in Brobby, 2012).

Validity describes whether the means of measurement are accurate and measure what they intended to measure (Galafshani, 2003). The instruments for the data collection were validated by my supervisor and some experts in Science Education Department.

Their comments guided the modification of the stems or keys of the items. The modified items were assembled for trial testing. The data obtained from the trial testing was used to determine the construct validity of the items using Factor Analysis.

3.6. Pilot Testing

Pilot testing helps in the establishment of the reliability, validity and the practical use of the questionnaire. This checks the clarity of the items and gives feedback on the validity of the test items and to ensure the data collected answers the research questions. In view of this, the instruments used in this study were pilot tested at St John Bosco College of Education. The data collected from the pilot test results were statistically analysed and determined the reliability of the test instruments using Pearson‗s test – retest correlation co-efficiency. This formula was considered appropriate as it is applied to items that are dichotomously scored such as multiple-choice items.

3.7. Reliability of the instrument

Reliability concerns with the extent to which a questionnaire, test or any measurable procedure produces the same results on a repeated trial. That is, it is the consistency of score over time.

To ensure the reliability of the research instrument, a pilot test was carried out on a sample of 50 first year integrated science students at St John Bosco College of Education in Navrongo. Data from the pilot test was statistically analysed and determined the reliability of the test instruments using Pearson‗s test – retest correlation co-efficient. This formula was considered appropriate as it is applied to items that are dichotomously scored such as multiple-choice items. The calculated value obtained was 0.84. The internal consistency estimate for the test gives a measure of the homogeneity of the items in the instrument. This kind of reliability is necessary for the achievement test as the scores obtained from it would represent a composite attribute of the subjects.

3.8. Treatment Procedure

Concept identifying, proposition identifying, and teacher generated concept maps (expert maps) were used to enhance student's achievement in the circulatory system.

Concept mapping visually illustrates the relationships between concepts and ideas. The concepts or ideas are often represented in circles or boxes. The concepts are linked by words and phrases that explain the connection between the ideas helping the students, organized and structure their thoughts to further understand information and discover new relationships. Concept maps represent a hierarchical structure, with the overall, broad concept first with connected sub-topics, to more specific concepts.

The study involved two groups of subjects. A pre-test was administered to two intact classes after they had been purposively assigned to Experimental group and control group. This enabled the researcher determine the achievement of the subjects before treatment. The students were taught concepts on circulatory system by the researcher using concept mapping strategy. The control groups were taught the same topics using traditional and appropriate lesson plans.

For the Experimental Group using concept mapping, the tutor began the lesson with a brief explanation of what concept mapping is, and how it is constructed, using the concept maps constructed by the researcher.

The sudents were giving a partially field concept maps with only the links provided but no concepts. Students were tasked provide the right concepts as in fig. 3.

The sudents were giving a partially field concept maps with only the concept provided but no links. Students were tasked provide the right links as in fig. 4.

The students were instructed to construct their own concept maps as the lesson proceeds and also after the lesson under the supervision of the researcher as a facillitator. The concept maps constructed by the students were then compared to the expert constructed map and scored. The students were divided into low achievers, high achievers and average achievers to construct the maps.

For the control group, the conventional lecture method only was used. Post tests were administered to all the groups in each school a day after the completion of treatment. The whole exercise lasted for six weeks. Fig 3, 4 and 5 show examples of Concept identifying map, proposition identifying map, and teacher generated concept map (expert maps) on the circulatory system that were used for the treatment.

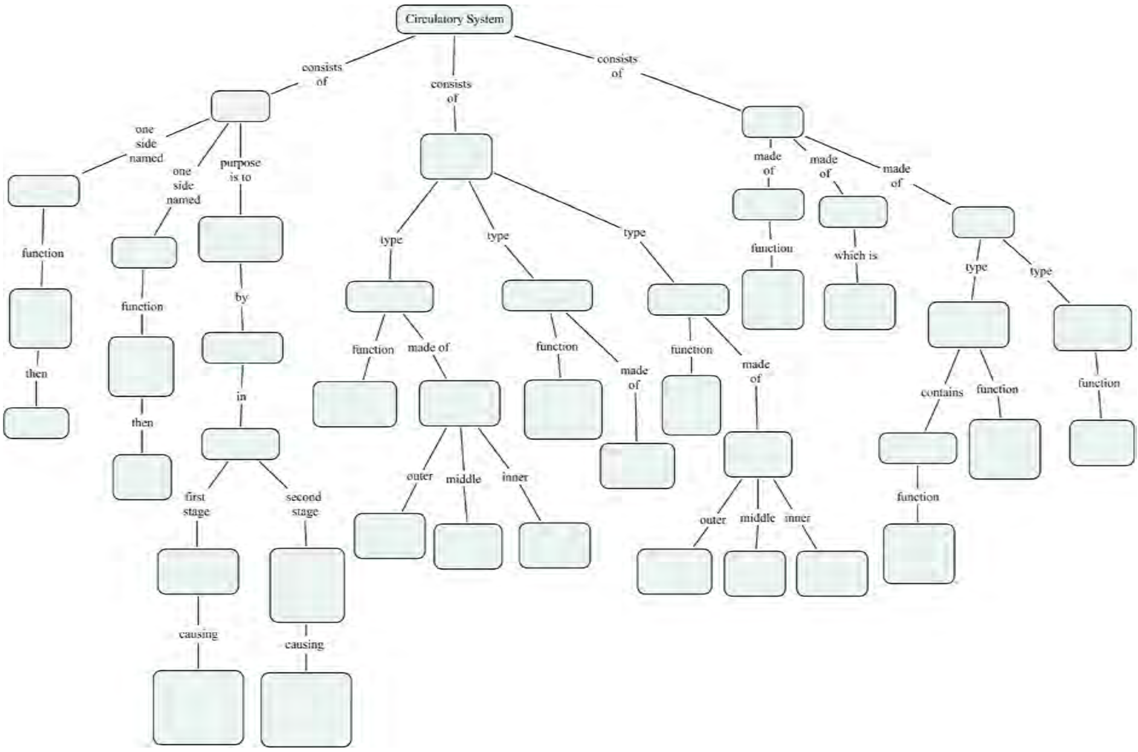


Fig 3: Identifying Concepts using concept Map on the circulatory system

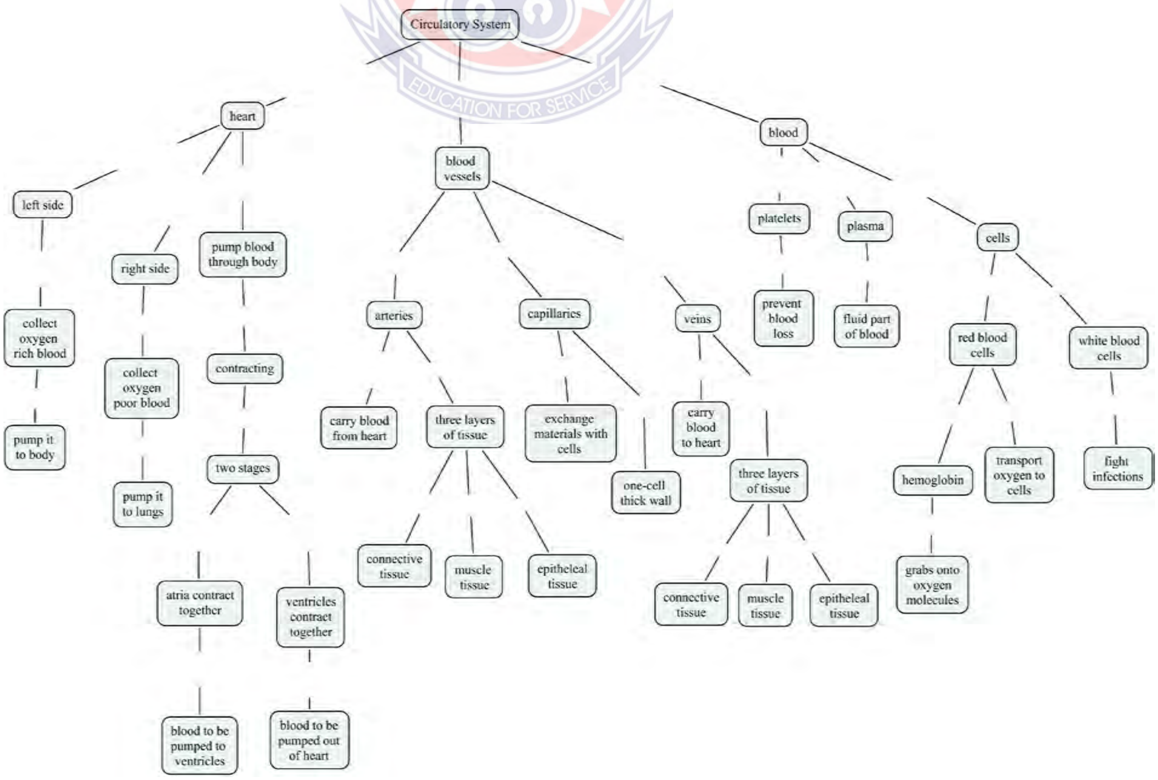


Fig. 4: Identifying Propositions using Concept Map on the circulatory system

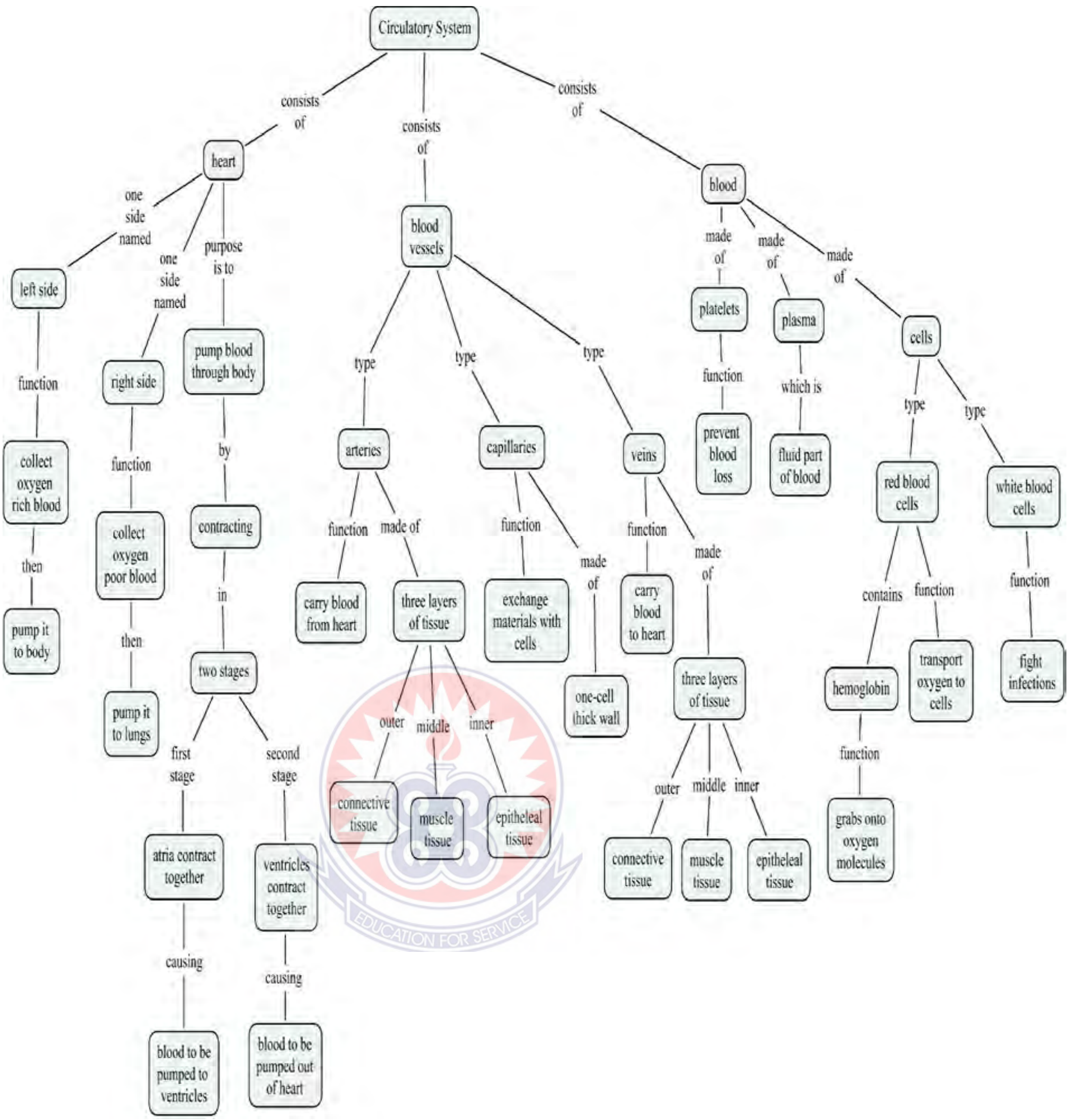


Fig 5: Teacher generated Concept map on the circulatory system.

3.9. Data Collection Procedure

The test items and a questionnaire were administered personally by me to the students after seeking permission from the principal and the head of department of science. The mode used for administering the test items was the investigator-administered mode.

This mode of administration ensured 100% collection of the test item response. Also respondents were not allowed to communicate among themselves to ensure that responses were not affected by other respondent‘s views. The questionnaire was administered to only the experimental group as posttest. This was done to allow students respond according to their perception on concept mapping strategy. Again for respondents to be candid about their responses they were made aware of the fact that the test was for academic purpose only and that the information they would provide would be kept strictly confidential and that no name was to be written on the test items.

3.10. Data Analysis Procedure

Means, Standard Deviation and Analysis of variance (ANOVA) were used to analyse the data. Mean and Standard deviation scores were used to answer the research questions, while t-test and ANOVA were used to analyse the null hypotheses. Null hypotheses 1, 2 and 3 were analysed using t-test while ANOVA was used in testing the null hypotheses 4 at 0.05 level of significance. The pre-test scores were used as covariates or control measure to the post- test scores. Since the study involved pre-testing and post-testing, ANOVA was considered appropriate because it helped remove or control any initial differences between the groups. There is the possibility that the effects of the treatments could have been influenced by uncontrolled variables such as intellectual ability, motivation, self-concept, socio-economic factors, and attitude.

Concept maps were assessed using a scoring instrument created by Lomask, Baron, Greig and Harrison (1992). The scoring instrument involved obtaining an overall score by comparing the number of correct concepts and/or links between the students‘

concept identifying, proposition identifying, and/or student generated concept maps to a teacher generated concept map.

3.11. Research Ethics

Ethics in research is a very important issue. Research ethics provide guidelines for the responsible conduct of research. To ensure ethical consideration, the following ethical principles were observed; the nature of the research was explained to participants. The participants were made to understand that it is for academic purpose. The anonymity of participants was also ensured. Participants were also treated with their concerns respected. The researcher had to maintain the privacy, and confidentiality of the participants' details. Pseudonyms were used to ensure the participants' confidentiality.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0. Overview

This chapter presents the results and discussions of the findings of the study to provide an understanding of the effects of concept mapping strategy on the teaching and learning of the circulatory system in integrated science in Gbewaa College of Education. The results and discussions were presented in the order of the research questions and the null hypotheses. The guiding research question of this study was to determine whether the students of Gbewaa College of Education would perform well academically in circulatory system or not when they were taught using Concept Mapping strategy.

The source of data on circulatory system was academic performance in the pretest and posttest scores for both students instructed by using Concept Mapping strategy and traditional teaching method. The student t-test analyses of the collected data were performed alongside with the discussion. Additional, questionnaire was used determine the perceptions of students towards the use of Concept Mapping strategy in teaching and learning of the circulatory system. All of the data from this study were intended to complement one another in order to provide evidence for the interpretation of effect of Concept Mapping strategy on the students' achievement and perceptions on the circulatory system.

4.1. Analysis with respect to Research Question 1.

1. What is the difference in achievement between the experimental and the control groups mean scores before using concept map strategy in teaching circulatory system in Gbewaa College of Education?

Tables 2 and 3 were obtained when a 20 test question items on circulatory systems in integrated science was administered to two classes (control and experimental). The data contains the raw scores in class intervals, frequency and corresponding percentages

Table 2: Pre-test Scores, and Frequency of Students in Experimental Group

Marks	Frequency	Percentage (%)
0 – 49	23	46
50 – 54	2	4
55 – 59	8	16
60 – 64	5	10
65 – 69	5	10
70 – 74	4	8
75 – 79	3	6
80 – 100	0	0
Total	**50**	**100**

Source: Field Survey, 2019

Out of the 50 students, no student scored 80-100 in the experimental group; only three students scored 75-79 representing 6%. Four students scored 70-74 representing 8%, five students scored 65-69 representing 10%. Five students scored 60-64 representing 10%, eight students representing 16% scored 55-59, then 50-54 was scored by two students also representing 4%, followed by 0-49 which was scored by 23 students representing 46% thus indicated that majority of the students in the experimental group scored low marks in the pretest.

Table 3: Pre-test Scores, and Frequency of Students in Control Group

Marks	Frequency	Percentage (%)
0 – 49	0	0
50 – 54	9	20
55 – 59	8	17.8
60 – 64	3	6.7
65 – 69	18	40
70 – 74	3	6.7
75 – 79	2	4.4
80 – 100	2	4.4
Total	**45**	**100**

In Table 3, two out of the 45 students, scored 80-100 in the control group representing 4%, two students also scored 75-79 representing 4%. Three students scored 70-74 representing 6.7%, 18 students scored 65-69 representing 40%. Three students scored 60-64 representing 6.7%, eight students representing 17.8% scored 55-59, and then 50-54 was scored by nine students also representing 20%. None of the students scored 0-49 thus indicated that almost no student in the control group failed in the pretest. The results in Tables 2 and 3 showed that students in the control group performed better than the students in the experimental group before the treatment.

Table 4 shows some statistical tendencies of the pre-test

Table 4: Mean and Standard Deviation Scores of the Experimental and the Control Groups at Pre-test

Groups	Mean	Number of students	Standard Deviation	Standard Error
Experimental	57.22	50	10.77	1.52
Control	62.38	45	7.93	1.18

The melan for the experimental was 57.22 while the standard deviation was 10.77. So the mean score of the test result shows the knowledge and the level of performance of the students in the experimental group before the use of the concept mapping teaching strategy. The mean for the control group was 62.38 while the standard deviation was 7.93. So the mean score of the test result shows the knowledge the students possess and the level of performance of students in the control group before the study.

The control group had a mean score of 62.38 as compared to the experimental group of 57.22. The mean difference is 5.16 between the two groups which showed that the control group had a mean higher than that of the experimental group before the treatment using the concept mapping strategy. To ascertain whether the observed differences was significant, hypothesis I was tested at 0.05 level of significance.

4.2 Analyses with Respect to Null Hypothesis 1

1. There is no significant difference in achievement between the experimental and control groups mean scores before using concept map strategy in teaching circulatory system in Gbewaa College of Education.

The control group had a mean score of 62.38, SD of 7.93 and SE of 1.18. The experimental group had a mean score of 57.22, SD of 10.77 and SE of 1.52. The mean score of the students in the control group was 62.38 which was high than the mean score of the students in the experimental group. The result was further analysed using t-test. The results in Table 5 indicated the results of t-test analysis between the control and experimental groups of the pre-test mean scores differences before the treatment.

Data was collected from both groups and the information is contained in Table 5.

Table 5: Mean scores, and Results of t-Test Analysis between Control Group and Experimental Group Pre-test Scores.

Groups Test	Mean	Cqs2alculated Value	Degree of Freedom	P(2-Tailed)	Mean Difference
Experimental	57.22	1.99	93	0.01	5.16
Control	62.38				

Significance at 0.05; $p < 0.05$

Results from the t-test analysis shown in Table 5, t (93) =1.99, p<0.05 showed a significance difference between the pre-test mean scores of the control and the experimental groups. Since the p-value (0.0090) is less than 0.05, the difference is a statistically significant between the performance of the control group and the experimental group and hence, the null hypotheses are rejected. This showed that there was significant difference in mean score between the achievement of the students in the control group and students in the experimental group. So the study was carried out using concept mapping teaching strategy to improve the achievement of the experimental group.

4.3 Analysis with respect to Research Question Two.

Research question 2: What is the difference in achievement between the experimental and the control groups mean scores after using concept map **strategy in teaching circulatory system in Gbewaa College of Education?**

The Tables 6 and 7 were obtained when a 20 test question items on circulatory systems in integrated science was administered to the control and experimental groups. The data contains the raw scores in class intervals, and their corresponding frequencies and percentages.

Table 6: Group Frequency Distribution of students' scores for Control Group at Post-test

Marks (%)	Frequency	Percentage (%)
0 – 49	1	2.22
50 – 54	3	6.67
55 – 59	10	22.22
60 – 64	1	2.22
65 – 69	12	26.67
70 – 74	1	2.22
75 – 79	11	24.44
80 – 100	6	13.33
Total	**45**	**100**

Source: Field Survey, 2019

In Table 6, one of the students score 0-49 representing 2.22% of the sample. Also three students obtained 50-54 representing 6.67% of the sample. Ten students representing 22.22% of the sample scored 55-59. 60-64 was scored by one person representing 2.22%. 12 students representing 26.67% of the sample scored 65-69. One student scored 70-74 representing 2.22%. 75-79 was scored by eleven 11 students representing 24.44% and finally six students representing 13.33% scored 80-100.

Also the scores of the experimental group at post-test was calculated and the results are shown under Table 7.

Table 7: Group Frequency Distribution of Experimental Group Students' Score for post-test

Marks (%)	Frequency	Percentage (%)
0 – 49	0	0
50 – 54	3	6
55 – 59	9	18
60 – 64	2	4
65 – 69	13	26
70 – 74	1	2
75 – 79	13	26
80 – 100	9	18
Total	**50**	**100**

Source: Field Survey, 2019

From Table 7, nine students scored 80-100 representing 18%. The table also shows that the 75-79 has a frequency 13 representing 26%, followed by 70-74 which had a frequency of one representing 2%. 65-69 also had a frequency 13 representing 26%. The best mark obtained by students was _excellent' which had a frequency of 7 representing 14% of the sample. The results showed that, no student in the experimental group scored 0-49 mark in the post-test thus indicating an improvement in achievement.

Information from Tables 6 and 7 were compared in table 8 shown here.

Table 8: Students mean value of post-test for control and Experimental Groups

Group	Mean	Number of students	Standard Deviation	Standard Error
Control group	67.67	45	10.68	1.59
Experimental Group	69.98	50	11.32	1.60

Source: Field Survey, 2019

Table 8 shows some statistical tendencies of the post-test. The control group had mean score of 67.67, standard deviation of 10.68 and the standard error 1.59. The experimental group had a mean of 69.98, standard deviation of 11.32 and standard error 1.60. The experimental group had a mean score of 69.98 which was higher than the control group mean score of 67.67. So the mean score of the test result showed that students in the experimental group had significantly improved after they were taught using concept mapping.

4.4 Analysis with Respect to the Null Hypothesis Two

1. There is no significant difference in achievement between the experimental and the control groups mean scores after using concept map strategy in teaching circulatory system in Gbewaa College of Education.

Table 9 shows results of t–test analysis mean scores of experimental group and control group for post-test. This was done to determine whether significant difference exist between the mean scores.

Table 9: Mean scores, and Results of t-Test Analysis between Experimental and Control for Post-test

Group test	Mean	Calculated Value	Degree of Freedom	P(2-Tailed)	Mean Difference
Control	67.67	1.99	93	0.31	2.31
Experiment	69.98				

Significance at 0.05; $p > 0.05$

From Table 9, the null hypothesis two which states that, there is no significant difference in achievement mean scores between the control group and the experimental group after the intervention using concept mapping. The control group had a mean score of 67.67, SD of 10.68 and SE of 1.53. The experimental group had a mean score of 69.98, SD of 11.32 and SE of 1.60. Results from 9 table, $t(93)=1.99$, $p>0.05$ showed no significance difference between mean scores. As a rule of thumb, the p-value (0.31) is greater than 0.05 so we accept the null hypothesis which implies that there is no significant difference between the mean scores of the control and experimental groups after using concept mapping in teaching the experimental group and using the Traditional method in teaching the control group.

4.5. Analysis with respect to Research Question 3.

3. What is the difference in achievement between the experimental male and experimental female groups mean scores after using concept map strategy in teaching circulatory system in Gbewaa College of Education?

The mean post-test performance of male and female students in the experimental groups were compared as shown under Table 10.

Table 10: Mean Scores and Standard Deviation of Students in the Experimental Males and Females for Post-test

Gender	Mean	NO	Standard Deviation	Standard Error
Male	71.82	28	8.87	1.68
Female	71.59	22	11.18	2.38

Source: Field Survey, 2019

Table 10 shows the posttest achievement mean scores for males and females after the intervention using concept mapping. The posttest mean scores for males and females were 71.82 and 71.59 respectively. Similarly, the standard deviations were 8.87 for the males and 11.18 for the females. After post-test, it was observed that for the males, mean achievement score was just slightly higher than that of the females. This implies that males achieved higher than females considering their higher mean achievement scores at post-test. As a result of this observed difference in mean achievement scores, the null hypothesis three was tested at 0.05 significant level using t-test analyses to determine if the observed difference was statistically significant.

4.6. Analysis with respect to Null Hypothesis Three

3. There is no significant difference in achievement between the experimental male and experimental female groups mean scores after using concept map strategy in teaching circulatory system in Gbewaa College of Education

The mean performances of male and female students in the post test was compared further using t-test analysis to see if any significant difference between them was observed. The results are shown under Table 11.

Table 11: Mean scores, and Results of t-Test between the Male and Female in the Experimental Group for Post-test Scores

Group test	Mean	Calculated Value	Degree of Freedom	P(2-Tailed)	Mean Difference
Male	71.82	2.01	48	0.94	0.23
Female	71.59				

Significance at 0.05; $p > 0.05$

From the null hypothesis three which states that there is no significant difference in achievement mean scores between the males and females in the experimental group after the intervention using concept mapping. Results from Table 11, $t(48)=2.01$, $p>0.05$ showed no significance difference between mean scores. As the P-value (0.94) is greater than 0.05 so we failed to reject the null hypothesis which implies that there is no significant difference between the mean scores of the males and females in the experimental groups after intervention using concept mapping teaching strategy. The null hypotheses is accepted that there no statistically significant difference in achievement mean scores between the experimental male and the experimental female after the intervention.

4.7 Analysis with respect to Research Question Four

4. What is the difference in the experimental group students‘ concept maps mean scores among the low achievers, average achievers and high achievers groups‘ after using concept mapping strategy on the teaching and learning of the circulatory system in Gbewaa College of Education?

The performance scores of low achievers, average achievers, and high achievers were compared using their mean scores at the post test. Results are shown under Table 12.

Table 12: Mean and Standard Deviation of Low Achievers, Average Achievers and High Achievers in the Experimental Group for post-test

Ability levels	Mean	No. of students	Standard Deviation	Standard Error
High achievers‘	34.50	14	1.74	0.47
Average achievers	34.81	16	4.45	1.11
Low achievers	34.55	20	3.97	0.47

Source: Field Survey, 2019

Table 12 illustrates the mean scores of the various ability groups after the intervention using concept mapping strategy. The mean scores were 34.50, 34.81 and 34.55 for high achievers, average achievers and low achievers respectively. The standard deviation for the high achievers was 1.74 and a standard error of 0.47. The average achievers had the standard deviation of 4.45 and standard error of 1.11 while the standard deviation and standard error for the low achievers were 3.97 and 0.47 respectively. The mean difference between the low achievers and the high achievers is 0.5 with low achievers having a mean of slightly higher than the high achievers after the intervention. The average achievers had a mean of 34.81 which is slightly higher than the mean of the low achievers and the high achievers. To find out whether there is a significant difference between the mean scores for the high achievers, average achievers and the low achievers, analysis of variance (ANOVA) was carried out. The results of the analysis are presented in table 22.

4.8 Analysis with respect to the null hypothesis four

4. There is no statistical significant difference in the experimental group students' concept maps mean scores among the low achievers, average achievers and high achievers groups after using concept map strategy in teaching circulatory system in Gbewaa College of Education**.**

An F-statistic was calculated using the scores of the three groups and the results are contained in Table 13.

Table 13: F-Statistics Results of Means of Low Achievers, Average Achievers and High Achievers Groups Student Generated Concept Map for Post-test Scores

Source of Variation	Sum of Squares	Df	Mean Square	F-Ratio	P-Value	F-Crit
Ability groups	0.89	2	0.45	0.03	0.10	3.20
Error	634.89	47	13.51			
Totals	**635.78**	**49**				

Source: Field Survey, 2020.

In Table 13, F (2, 47) = 0.03, $p>0.05$ showed no significance difference among the means scores of the low achievers, average achievers and high achievers groups. Since the p-value (0.10) is greater than the alpha value (0.05) there is no significant difference between the means of the ability groups and hence, the null hypothesis which states that there is no significant difference in achievement mean scores among the ability levels is accepted. The results of the ANOVA revealed that the differences between the means of the high achievers, average achievers and low achievers were not statistically significant.

This research question sought to investigate whether the concept maps teaching strategy improved students' achievement on the high achievers, average achievers and low achievers. The concept identifying concept maps were scored by comparing the *concepts* on the students' maps to the *concepts* on the teacher generated map. Following the identification of the correct number of concepts on the maps, the concept portion of the scoring rubric created by Lomask et al. (1992) was used to assign a score that ranged from one to five to each map. There were a total of 42 concepts that were compared between the concept identifying and teacher generated concept map. The mean number of correct concepts for the concept identifying maps was 34.88 (83%) (Mean number divide by total number of counts on expert map multiply by 100 i.e. 34.88/42 x100=83%). Based on Lomask et al.'s rubric, the majority of the students (N = 43) in the concept identifying group earned a score of four on their concept maps. These students correctly identified 67%-99% of the concepts that were present on the teacher generated concept map. Four students earned a score of five representing 100% and three students earned three representing 66%-33%.

Additionally, based on Lomask et al.'s (1992) scoring rubric, a score of four means that the size of the students' knowledge of the concepts was _substantial', a score of five means a complete 100 and three means partial. Table 14 shows the distribution of the experimental group students' scores on concept identification using concept mapping teaching strategy.

Table 14: Distribution of Students' Scores on Concept Identification using concept mapping

% Concepts in Map	Score	No. of Students
Complete (100)	5	4
Substantial (99 - 67)	4	43
Partial (66 - 33)	3	3
Small (32 – 1)	2	0
None/Irrelevant (0)	1	0

Source: Field Survey, 2019

In Table 15, the proposition identifying concept maps were scored by comparing the *links* on the students' maps to the *links* on the teacher generated map. There were a total of 42 links that were compared between the proposition identifying and teacher generated concept maps. The mean number of correct links for the proposition identifying maps was 36.14 (86%). The scoring rubric created by Lomask et al. (1992) was used to assign a score that ranged from two to five points for each map. The majority of the students (N = 39) earned a score of four on their concept maps. These students correctly identified 50%-99% of the links on their concept maps. Based on Lomask et al.'s (1992) scoring rubric, a score of four means that the strength of the students' knowledge of the relationships between concepts was ―medium" and 11 students earned five which represents strong.

The student generated concept maps were scored using the complete scoring rubric created by Lomask et al. (1992). The concept maps were compared to the teacher generated concept map and were assessed based on the accuracy of both the concepts and links. The results are indicated in Table 15.

Table 15: Distribution of Students' Proposition Identifying Scores

% Links in Map	Score	No. of Students
Strong (100)	5	11
Medium (99 – 50)	4	39
Weak (49 – 1)	3	0
None (0)	2	0

Source: Field Survey, 2019

Each student generated map was assigned a score that ranged from one to five points. There were a total of 42 concepts and 42 links that were compared between the student generated concept maps and teacher generated concept maps. The mean number of correct concepts for the student generated maps was 34.6 (82.4%). Thirty-five of the students correctly identified 67%-99% of the concepts on their concept maps. Additionally, 4 of the students had 50%-99% of the links correct on their concept maps. The mean number of correct links for the student generated maps was 28.5 (67%).

Table 16 reports the distribution of the accurate number of concepts identified by students.

Table 16: Distribution of Students Generated Concept Maps' scores

% Concepts in Map	Score	No. of Students
Complete (100)	5	11
Substantial (99 - 67)	4	35
Partial (66 - 33)	3	4
Small (32 – 1)	2	0
None/Irrelevant (0)	1	0

4.9 Analysis with respect to Research Question five

5. What are the perceptions of the experimental group on the effect of concept mapping strategy on the teaching and learning of the circulatory system in Gbewaa College of Education?

A five-point Likert scale ranging from ‗strongly agree to strongly disagree was used to collect data on students perceptions about the use of concept maps teaching strategy. The responses of the students were analysed through descriptive statistical analysis such as frequency and percentage.

Table 17 shows the results of the analysis of students ‗responses on questionnaire items on perceptions about the use of concept mapping strategy on the circulatory system.

Table 17: Presenting Frequencies and Percentages' of Students' Perceptions on Items in the Questionnaire

Item	Count in % (Number of Students				
	SA	**A**	**NS**	**D**	**SD**
1. Concept mapping strategy improved my understanding of the circulatory system	38%(19)	54%(27)	6%(3)	2%(1)	0%(0)
2. The use of concept mapping strategy reduces forgetfulness in examination	52%(26)	42% (21)	6% (3)	0%(0)	0%(0)
3. I do not always enjoy the lesson when our teacher uses concept mapping strategy	0%(0)	6%(3)	2%(1)	54%(27)	38%(19)
4. Concept mapping strategy motivated me to learn	52%(26)	42%(21)	2%(1)	4%(2)	0%(0)
5. I learn better when teachers teach without concept mapping strategy	0%(0)	0%(0)	10%(5)	40%(20)	50%(25)
6. Concept mapping strategy reduces my personal interaction with my colleagues	0%(0)	2%(1)	6%(3)	40%(20)	52%(26)
7. Concept mapping strategy is an effective means of assisting students to under the relationships among concepts	50%(25)	48%(24)	2%(1)	0%(0)	0%(0)
8. I learn better when teachers teach with concept mapping strategy	58%(29)	42%(21)	0%(0)	0%(0)	0%(0)
9. The use of concept mapping strategy does not effectively assist students to understand the relationships among concepts	0%(0)	2%(1)	4%(2)	46%(23)	48%(24)
10. I always enjoy the lesson when our teacher uses concept mapping strategy	46%(23)	50%(25)	4%(2)	0%(0)	0%(0)
11. Concept mapping prevents rote learning	58%(29)	32%(16)	6%(3)	4%(2)	0%(0)
12. Concept mapping strategy help students in private studies	60%(30)	32%(16)	4%(2)	4%(2)	0%(0)
13. Concept mapping can reduce recitation and stress	44%(22)	40%(20)	10%(5)	4%(2)	2%(1)
14. Concept Mapping strategy help with concept knowledge application	54%(27)	40%(20)	0%(0)	4%(2)	2%(1)
15. Concept mapping does not prevent rote learning	0%(0)	4%(2)	6%(3)	50%(25)	40%(20)

Source: Field Survey, 2020

From Table 17, item 1, students were to respond to whether concept mapping strategy improved their understanding of the concepts in circulatory system or not. According to the students' response, 38% (19) strongly agreed, 54% (27) of them agreed, 6% (3) of them not sure, 2% (1) disagreed and none of them strongly disagreed. Majority of the students (92%) strongly agreed and agreed with item 1 which indicates that concept mapping strategy improved their understanding of the circulatory system.

In terms of item 2, whether the use of concept mapping reduces forgetfulness in examination or not, it is observed that 52% (26) of the students strongly agreed, 42% (21) agreed, 6% (3) were not sure and none disagree or strongly disagree to the item. This indicated that most (94%) of the students strongly agreed and agreed that the use of concept mapping in teaching and learning reduces forgetfulness in examination.

From item 3, students were to respond to a negative statement that they do not always enjoy their lessons when teachers uses concept mapping teaching strategy. The observations from table 28 showed that none of the students strongly agreed, 6% (3) of them agreed, 2% (1) of them not sure, 54% (27) of them disagreed and 38% (19) strongly disagreed. The responses clearly indicated that majority of the students disagreed with the item three.

In terms of item 4, whether concept mapping motivate students to learn, 52% (26) strongly agreed, 42% (21) of them agreed, 2% (1) of them not sure, 4% (2) of them disagreed and none of them strongly disagreed. Majority of the students (94%) of them strongly agreed and agreed to this item of the questionnaire that concept mapping motivate students to learn

The item 5 in the questionnaire was to find out whether students learn better when teachers teach without using concept mapping strategy, 0% strongly agreed, 0% of them agreed, 10% (5) not sure, 40% (20) disagreed and 50% (25) of them strongly disagreed. It therefore suggested that students prefer the use of concept mapping strategy in teaching and learning.

With respect to questionnaire item 6 in table 28 which seeks to find out whether concept mapping reduces the student‘s interaction with their colleagues, none of the students strongly agreed, 2% (1) of the students agreed, 6% (3) not sure, 40% (20) disagreed and 52% (26) strongly disagreed. The responses of the students show that majority of the students in the experimental group disagreed and strongly disagreed to this item.

In terms of item 7, whether the use of concept mapping is effective means of assisting students to understand the relationships among concepts, it is observed that 50% (25) of the students strongly agreed, 48% (24) agreed, 2% (1) were not sure and none disagree or strongly disagree to the item. This indicated that most (98%) of the students strongly agreed and agreed that the use of concept mapping in teaching and learning is effective means of assisting students to understand relationship among

From Table 28, item 8, students were to respond to whether they learn better when teachers teach with concept mapping strategy. According to the students‘ response, 58% (29) strongly agreed, 42% (21) of them agreed, 0% of them not sure, none disagreed or strongly disagreed. Almost all the students (100%) strongly agreed and agreed with item 8 which indicates that they learn better when teachers teach with concept mapping strategy.

The item 9 in the questionnaire was negatively worded to find out whether the use of concept mapping strategy does not effectively assist students to understand relationship among concepts, none of them strongly agreed, 2% (1) of them agreed, 4% (2) not sure, 46% (23) disagreed and 48% (24) of them strongly disagreed. It therefore suggested that students prefer the use of concept mapping strategy in teaching and learning.

In terms of item 10, whether, the students always enjoy the lessons when teachers use concept mapping strategy in teaching. It was observed that 46% (23) of the students strongly agreed, 50% (25) agreed, 4% (2) were not sure and none disagree or strongly disagree to the item. This indicated that majority (96%) of the students strongly agreed and agreed that they always enjoy the lesson when teachers use concept mapping in teaching and learning.

From Table 17, in item 11, students were to respond to whether concept mapping strategy prevents rote learning. According to the students' response, 58% (29) strongly agreed, 32% (16) of them agreed, 6% (3) of them not sure, 4% (2) disagreed and none of them strongly disagreed. Majority of the students (90%) strongly agreed and agreed with item 1which indicates that concept mapping strategy prevent rote learning.

With respect to questionnaire item 12 in table 28 which seeks to find out whether concept mapping help students in their private studies, 60% (30) of the students strongly agreed, 32% (16) of the students agreed, 4% (2) not sure, 4% (2) disagreed and none strongly disagreed. The responses of the students show that majority of the students in the experimental group agreed and strongly agreed to this item.

In terms of item 13, from table 17, whether the use of concept mapping strategy in teaching reduces recitation for examinations, it is observed that 44% (22) of the students strongly agreed, 40% (20) agreed, 10% (5) were not sure and 4% (2) disagree and 2% (1) strongly disagree to the item. This indicated that majority (85%) of the students strongly agreed and agreed that the use of concept mapping in teaching and learning reduces recitation.

Item 15 was negatively worded with none of the students strongly agreed, 4% (2) agreed, 50% (25) disagreed and 40% (20) strongly disagreed. This showed that majority of the respondents disagreed with the statement that concept mapping does not prevent rote learning.

The responses from the students revealed generally that the use of concept mapping have improved their understanding of the circulatory system and should be integrated in instructional strategies to enhance the learning of science concepts.

These results are also similar to Saima, et al (2011) who also used a Likert scale to determine the effectiveness of concept mapping and audio visuals in teaching. Concept maps are effective tool that ―invest the past with an air of reality." They provide the learners with realistic experience, which capture their attention and help in the understanding of the concepts or phenomena (Saima et al, 2011).

4.10 Discussion of the Results

In Table 4, the control group had a mean score of 62.38 as compared to the experimental group of 57.22 in the pre-test. This shows that the control group achieved better in the pre-test than the experimental group. To ascertain whether the observed differences was significant, hypothesis I was tested at 0.05 level of significance. Results from the t-test analysis shown in Table 5 gave a Mean difference of 5.16, t-value of 1.99 and a p-value of 0.10 at a degree of freedom 95% significance level. Since the p-value (0.01) is less than 0.05, the difference is a statistically significant between the mean scores of the control group and the experimental group.

The post- test results shows that the experimental group had a mean of 69.98, standard deviation of 11.32 and standard error 1.60. The experimental group had a post- test mean score of 69.98 which was higher than the control group mean score of 67.67. So the mean score of the test result showed that students in the experimental group had significantly improved after they were taught using concept mapping.

From Table 9, the control group had a mean score of 67.67, SD of 10.68 and SE of 1.53. The experimental group had a mean score of 69.98, SD of 11.32 and SE of 1.60. Results from the t-test analysis gave a mean difference of 2.31, t-value of 1.99 and a p-value of 0.31 at a 95% significance level. As a rule of thumb, the p-value (0.31) is greater than 0.05 so we accept the null hypothesis which implies that there is no significant difference between the mean scores of the control and experimental groups after using concept mapping strategy.

Table 10 shows the posttest achievement mean scores for males and females after the intervention using concept mapping. The posttest mean scores for males and females were 71.82 and 71.59 respectively. Similarly, the standard deviations were 8.87 for the males and 11.18 for the females. After post-test, it was observed that for the males, mean achievement score was just slightly higher than that of the females. This implies that males achieved higher than females considering their higher mean achievement scores at post-test. As a result of this observed difference in mean achievement scores, the null hypothesis three was tested at 0.05 significant level using t-test analyses to determine if the observed difference was statistically significant.

Results from the t-test analysis shown in Table 11 gives as a Mean difference of 0.23 t-value of 2.01 and a p-value of 0.94 at a 95% significance level. As the P-value (0.94) is greater than 0.05, there is no statistically significant difference in achievement mean scores between the experimental male and the experimental female after the intervention.

Table 12 illustrates the mean scores of the various ability groups after the intervention using concept mapping strategy. The mean scores were 34.50, 34.81 and 34.55 for high achievers, average achievers and low achievers respectively. The standard deviation for the high achievers was 1.74 and a standard error of 0.47. The average achievers had the standard deviation of 4.45 and standard error of 1.11 while the standard deviation and standard error for the low achievers were 3.97 and 0.47 respectively. The mean difference between the low achievers and the high achievers is 0.5 with low achievers having a mean of slightly higher than the high achievers after the intervention. The average achievers had a mean of 34.81 which is slightly higher than the mean of the low achievers and the high achievers.

To find out whether there is a significant difference between the mean scores for the high achievers, average achievers and the low achievers, F-Statistics was carried out.

The F-statistics at alpha value of 0.05, at degree of freedom 2, 47 and p-value of 0.10. Since the p-value (0.10) is greater than the alpha value (0.05) there is no significant difference between the means of the ability groups and hence, the null hypothesis which states that there is no significant difference in achievement mean scores among the ability levels is accepted. The results of the ANOVA revealed that the differences between the means of the high achievers, average achievers and low achievers were not statistically significant.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter contains the summary of the findings, conclusion and recommendations as well as areas for further studies.

5.1 Summary of Study

The purpose of the study was to find out the effect of concept mapping strategy on students‘ achievement in the teaching and learning of circulatory system in Integrated Science. Test items of 20 were administered at pre-test for both control and experimental groups and post-test to find out the achievement of students before and after the study.

The analysis of the pre-test results showed that the control group achieved better in the pre-test than the experimental group. To ascertain whether the observed differences was significant, hypothesis I was tested which indicate significant difference between the mean scores of the control group and the experimental group.

The post- test results showed that the experimental group had mean score higher than the control group mean score as a result of the treatment using concept mapping strategy.

Results from the t-test analysis gave a mean difference of 2.31, t-value of 1.99 and a p-value of 0.31 at a 95% significance level. As a rule of thumb, the p-value (0.31) is greater than 0.05 so we accept the null hypothesis which implies that there is no significant difference between the mean scores of the control and experimental groups after using concept mapping strategy.

The posttest mean scores for males and females were 71.82 and 71.59 respectively. Similarly, the standard deviations were 8.87 for the males and 11.18 for the females. After post-test, it was observed that for the males, mean achievement score was just slightly higher than that of the females.

As a result of this observed difference in mean achievement scores, the null hypothesis three was tested at 0.05 significant level using t-test analyses to determine if the observed difference was statistically significant.

Results from the t-test analysis shown no statistically significant difference in achievement mean scores between the experimental male and the experimental female after the intervention.

The mean scores were 34.50, 34.81 and 34.55 for high achievers, average achievers and low achievers respectively. The mean difference between the low achievers and the high achievers is 0.5 with low achievers having a mean of slightly higher than the high achievers after the intervention. The average achievers had a mean of 34.81 which is slightly higher than the mean of the low achievers and the high achievers.

To find out whether there is a significant difference between the mean scores for the high achievers, average achievers and the low achievers, F-Statistics was carried out.

The F-statistics at alpha value of 0.05, at degree of freedom 2, 47 and p-value of 0.10. Since the p-value (0.10) is greater than the alpha value (0.05) there is no significant difference between the mean scores of the ability groups.

The effectiveness of using concept mapping strategy was also confirmed from the questionnaire administered to the students about their perception about the approach of teaching. The students indicated that the treatment improved their abilities to understand the concept (Table 10). Considering the results, it means that students have positive attitudes towards the use of concept mapping teaching strategy to teach circulatory system.

Summary of Key Findings

Based on the analysis of the results presented the key findings were presented as follows:

1. The control group had a higher pre-test mean score as compared to the experimental group before the treatment using concept mapping strategy in teaching the circulatory system in Gbewaa College of Education.

2. However, the experimental group had a higher post-test mean score as compared to the control group. This is as a result of the treatment using the concept mapping strategy.

3. The males in the experimental group had a post-test mean score slightly higher than that of the females. However, the t-results showed no significant difference between post-test mean scores of the male and female in the experimental group.

4. Concept mapping and strategies improved students‘ achievement in the concepts of circulatory system more than the conventional lecture method.

5.2 Conclusions

The use of concept mapping strategy in teaching produced a significant improvement in students‛ understanding of circulatory system as compared to the traditional instructional approach. Students‛ abilities to interpret and comprehend the concept were hugged when they were taught using concept mapping teaching strategy.

Results from this study also indicated that majority of the students enjoyed the interactive lessons with concept maps and thus, they were motivated more to participate actively in the lessons therefore they preferred concept mapping instructional strategy to traditional strategy of instruction.

Finally, it was concluded that the use of concept maps in teaching was effective way of improving student‛s performance in the teaching and learning of concepts of the circulatory system in science.

5.3 Recommendations

From the findings, the following are recommended to schools and teachers who would like to use concept maps in the teaching and learning of concepts in Science:

- Science tutors should be encouraged to employ the use of concept maps in the delivery of their lessons so that students can perform better in colleges of education.
- Science tutors should use concept mapping teaching strategy to improve their students understanding in difficult topics such as the respiratory system, excretory system, and so on
- Science teachers are encouraged to get personal training on the construction of concept maps that could enhance their teaching.

- Head of colleges of education should encourage their science tutors to employ the use of concept maps in the delivery of their lesson.
- The findings have far reaching educational implications for teachers and students, policy makers, teacher educators, curriculum planners, various examining bodies and the society at large.

5.4 Areas for Further Research

Reflecting on the findings of this study, the following recommendations are made for further research with respect to the use of concept mapping strategy:

- Investigation on the effect of gender on students' achievement in circulatory system using concept mapping strategy.
- Investigation on the causes of gender difference in achievement using the concept mapping strategy in teaching selected concepts in science.
- The difference in perceptions of male and female student on the use of concept mapping method of teaching.

REFERENCE

Adamczyk, P., & Willson, M. (1996). Using Concept Maps with trainee Physics teachers. *Physics Education,* 31(6), 374-381.

Adiyiah, M. (2011). Using concept mapping to enhance the learning of cell theory. *Unpublished M. Phil Thesis.* Winneba. University of Education.

Agbi, A. I. (2006). *Effects of interaction of teaching methods and study habits on students' achievement and interest in chemistry*. Nsukka: University of Nigeria.

Ahove, M. A. (2001) *Environmental Management and Education.* Lagos: Golden pen Books.

Aiyedun, J.O. (2000). Influence of sex differences of students on their achievement in secondary school mathematics. *Journal of the Mathematics Association of Nigeria,* 25 (1), 109-133.

Akinsola & Igwe (2002). The relative effectiveness of meta cognitive strategy of framing on students‟ achievements in selected difficult chemistry concepts. *Journal of STAN* 37(1) 20-28.

Alhassan, S. (2006).*Modern Approaches to Research in Educational Administration.* Kumasi, Ghana: Payless publication.

Ali, A. (2006). *Conducting Research in Education and Social Sciences:* Tashiwa Networks. Nigeria.

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.

Ameyaw, Y. (2012). Closeness index (CI): An assessment tool for students' performance of cell theory. *International Journal of Science and Nature, 3* (3).

Ameyaw, Y. (2015). Improving teaching and learning of glycolysis and krebs' cycle using concept mapping technique. *International Journal of Sciences, 6* (4).

Ameyaw, Y., & Okyer, M. (2018). Concept Mapping Instruction as an Activator of Students' Performance in the Teaching and Learning of Excretion. *Annals Review and Research, 1*(4).

Asiyai, R. I. (2005). Enhancing chemistry teaching in secondary schools through concept mapping instructional strategy. *Proceeding of 46th Annual conference of STAN* 205-209.

Ausubel, D. P. (1963).*The psychology of meaningful verbal learning.* New York: Grune and Stratton.

Ausubel, D. P. (1968). *The psychology of meaningful verbal learning*. New York: Grune and Stratton.

Ausubel, D. P. (1961). In defense of verbal learning. *Educational Theory,* 11, 15-25.

Ausubel, D. P. (1962). A subsumption theory of meaningful verbal learning. *Journal of General Psychology,* 66, 213-224.

Ausubel, D. P. (1963b). Cognitive structure and the facilitation of meaningful verbal learning. *Journal of Teacher Education,* 14, 217-221.

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1978). *Educational psychology: A cognitive view* (2nd ed.). New York: Holt, Rinehart and Winston.

Babbie, E., & Rubin, A. (1989). *Research Methods for Social Work.* California: Wadsworth.

Bernard, H. R. (2002). *Research Methods in Anthropology: Qualitative and quantitative methods*. Walnut Creek, California: Alta Mira Press.

Baroody, A. J., & Bartels, B. H. (2000). Using Concept Maps to link mathematical ideas. *Mathematics Teaching in the Middle School*, 5(9), 604-609.

Baroody, A. J., & Coslick, R. (1998). *Fostering children's mathematical power.* Mayweh, New Jersey: Lawrence Erlbaum Associates.

Beihler, R. F. (1974). *Psychology Applied to Teaching.* Boston: Houghton Mifflin Company.

Beyerbach, B., & Smith, J. (1998). Using a computerized concept mapping program to assess preservice teachers' thinking about effective teaching. *Journal of Research in Science Teaching*, 27(10), 961-971.

Bolte, L. A. (1999). Enhancing and assessing preservice teachers' integration and expression of mathematical knowledge. *Journal of Mathematics Teacher Education,* 2(2), 167-185.

BouJaoude, S., & Attieh, M. (2008). The effect of using concept maps as study tools on achievement in chemistry. *Eurasia Journal of Mathematics, Science andTechnology Education,* 4, 233-246.

Brobby, K. (2012). *Using computer assisted instruction and concept mapping to improve the teaching and learning of glycolysis and the krebs' cycle*. Unpublished M. Phil Thesis.Winneba: University of Education.

Butler, A. (2001). Pre-service music teachers' conceptions of teaching effectiveness, microteaching experiences, and teaching performance. *Journal of Research in Music Education,* 49(3), 258-272.

Buntting, C., Coll, R. K., & Campbell, A. (2006). Student views of concept mapping use in introductory tertiary biology classes. *International Journal of Science and Mathematics Education,* 4, 641-668.

Canas, J. A., Coffery, J. W., Carnot, M. J., Hoffman, R. R., Feltovich, P. J., & Novak, J. D. (2003). *A summary of literature Partaining to the Use of concept Mapping Technique and Performance Support*. Pensacola: FL 32502. www. Ihmc .us.

Chang, K., Sung, Y., & Chen, I. (2002). The effect of concept mapping to enhance text comprehension and summarization. *Journal of Experimental Education, 7*(1), 5-23.

Chauhan, S. S. (1979). *Innovations in Teaching Learning Process*. New Delhi: Vikas publishing House PVT ltd.125-130.

Chinn, C. A., O'Donnell, A. M., & Jinks, T. S. (2000). The structure of discourse in collaborative learning. *Journal of Experimental Education,* 69(1), 77-97.

Chiu, C. H., Huang, C. C., & Chang, W. T. (2000). The evaluation and influence of interaction in network supported collaborative Concept Mapping. *Computers & Education*, *34*(1), 17-25.

Chung, G. K. W. K., O'Neil, H. F., & Herl, H. E. (1999). The use of computer-based collaborative knowledge mapping to measure team processes and team outcomes. *Computers in Human Behavior,* 15(3), 463-493.

Cresswell, J. W. (2005). *Educational research: planning, conducting and evaluating quantitative research*. New Jersey: Pearson Education.

Cristea, A., & Okamoto, T. (2001). Object-oriented collaborative course authoring environment supported by Concept Mapping in My EnglishTeacher. *Educational Technology and Society, 4*(2), 104-115.

Cullen, J. (1990). Using concepts maps in chemistry an alternative view. *Journal of Research in Science Teaching* 27 (10) 1067-1068.

Clymer, J. B., & Wiliam, D. (2007). Improving the way. *Educational Leadership,* 64, 36-42.

Danmole, B. T., & Femi- Adeoye K.O (2004). Effect of concept mapping techniques on senior secondary school students‟ achievement and retention of ecology concepts. *Journal of STAN 39*(1&2), 31-37.

Edmondson, K. M., & Smith, D. F. (1996). . Concept mapping for the development of medical curricula. *Journal of Research in Science Teaching*, *32*(7), 777-793.

Ekwueme, C.O., & Umionyang, I. E. (2006). Gender differences in mathematics: Factors among secondary school students in Calabar, Cross-Rivers State. *45th Annual Conference Proceedings of STAN* 224-228.

Esiobu, G. o., & Soyibo, K. (1995). Effect of concept mapping and Vee- mapping under three learning modes on students cognitive achievement in ecology and genetics. *Journal of Research in Science Teaching*, *32* (9), 971-995.

Ezeudu, F.O (1995). *Effect of concept maps on students" achievement, interest and retention in selected units of organic chemistry.* Unpublished Ph.D Thesis Nsukka: University of Nigeria.

Ezeugo, N. C., & Agwagah U.N.V (2000). Effect of concept mapping on students‟ achievement in algebra: Implications for secondary mathematics education in the 21st Century *ABACUS 25* (91), 1-12.

Ferry, B., Hedberg, J. & Harper, B. (1998). How do preservice teachers use Concept Maps to organize their curriculum content knowledge? *Journal of Interactive Learning Research, 9*(1), 83-104.

Felder, R. (1993). Reaching the second Tier: Learning and Teaching styles in college science education. *Journal of college science Teaching*, *23*(5), 286-290.

Francisco, J. S., Nicoll, G., & Trautmann, M. (1998). Integrating multiple teaching methods into a general chemistry classroom. *Journal of Chemical Education, 75*(2), 210-213.

Francisco, J. S., Nakhleh, M. B., Nurrenbern, S. C., & Miller, M. L. (2002). Assessing student understanding of general chemistry with concept mapping. *Journal of Chemical Education, 79*, 248-257.

Gagne, R. L. (1992). *Principles of Instructional Design* (4th Ed.) Fort worth, TX: HBJ College publishers. R. Hall, & A. O'Donnell, (1996). Cognitive and affective outcomes of learning from knowledge maps. *Contemporary Educational Psychology,* 94-101.

Georgina, N. (2012). Effects of prior knowledge on learning: a study of two consecutive courses in earth sciences. *Instructional Science*, *29*(187-211).

Golafshani, N. (2003). Understanding reliability and validity in qualitative research.*The qualitative report, 8* (4), 597-606.

Gonzalez, F. M. (1997). Evidence of rote learning of science by Spanish university students. *School Science and Mathematics*, *97*(8), 419-428.

Gronulund, N. E., & Linn, R. (1990).*Measurement and evaluation teaching* (6th ed.). New York: Macmillan.

Hall, J. & O'Donnell, G. (1996). Effects of prior knowledge on learning: a study of two consecutive courses in earth sciences. *Instructional Science*, *29*(187-211).

Harpaz, I., Balik, C., & Ehrenfeld, M. (2004). Concept mapping: an educational strategy for advancing nursing education. *Nursing Forum,* 39, 27-36.

Harrison, G., Andrews, J., & Saklofske, D. (2003).Current perspectives on cognitive learning styles. *Education Canada,* 43, 44-47.

Harpaz, I., Balik, C., & Ehrenfeld, M. (2004). Concept mapping: an educational strategy for advancing nursing education. *Nursing Forum,* 39, 27-36.

Harrison, G., Andrews, J., & Saklofske, D. (2003).Current perspectives on cognitive learning styles.*Education Canada,* 43, 44-47.

Herl, H. E., O'Neil, H. F., Chung, G. K. W. K., & Schachter, J. (1999). Reliability and validity of a computer-based knowledge mapping system to measure content understanding. *Computers in Human Behavior, 15*, 315-333.

Hertz-Lazorowitz, R. (1990). *An integrative model of the classroom: the enhancement of cooperation in learning*. Paper presented at the American Educational Research Association Conference, Boston, MA.

Hilbert, T. S., & Renkl, A. (2008). Concept mapping as a follow-up strategy in learning from text: what characterizes good and poor mappers? *Instructional Science,* 36, 53-73.

Hill, L. H. (2005). Concept mapping to encourage meaningful student learning. *Adult Learning,* 16, 7 13.

Hilbert, T. S., & Renkl, A. (2008). Concept mapping as a follow-up strategy in learning from text: what characterizes good and poor mappers? *Instructional Science,* 36, 53-73.

Hill, L. H. (2005). Concept mapping to encourage meaningful student learning.*Adult Learning,* 16, 7 13.

Horton, P. B., McConney, A. A., Gallo, M., Woods, A. L., Senn, G. J., & Hamelin, D. (1993). An investigation of the effectiveness of concept mapping as an instructional tool. *Science Education, 77*(1), 95-111.

Hoz, R., Bowman, D., & Kozminsky, E. (2001). The differential effects of prior knowledge on learning: a study of two consecutive courses in earth sciences. *Instructional Science*, *29*(187-211).

Ifeakor, A. C. (2005). Evaluation of commercially produced computer assisted instruction package for teaching secondary school chemistry. *An Unpublished doctorate thesis* Nsukka: University of Nigeria.

Igboegwu, E. N. (2005). *Factors that influence the acquisition of sciences process skills among secondary school chemistry students*. Unpublished M.Ed thesis Awka: Nnamdi Azikiwe University.

Imoko, B. I. (2004). *Effect of concepts mapping on students achievement and interest in Trignometry*. Unpublished Ph.D Thesis. Nsukka: University of Nigeria.

Inomesia, E. A. (1989). Sex and school location as factors in primary school sciences achievement. *Journal of Research in Science Teaching, 27*(10), 951-960.

Inomesia, E.A., & Unuero, J. U. (2003). Concept mapping: A paradigm to guided-discovery method in the teaching of Sciences in Nigeria. *Journal of Educational Research and Development 2*(1), 111-119.

Isa, H. (2005). Science teaching as a challenge for teachers to develop new conceptual structures. *Research in Science Education*, *30*(1), 213-224.

Jacobs-Lawson, J. M., & Hershey, D. A. (2002). Concept maps as an assessment tool In psychology courses. *Teaching of Psychology,* 29, 25-29.

Jahun, J. U., & Momoh, J. S. (2001). The effect of environment and sex on mathematics achievement of J.S.S III students in Kwara State. *ABACUS Journal of Mathematics Association of Nigeria* 53-58.

Jegede, O. J., Alaiyemola, F., & Okebukola, P. A. (1990). The effect of concept mapping on students' anxiety and achievement in biology. *Journal of Research in Science Teaching, 27*(10), 951-960.

Jones, M. G., Carter, G., & Rua, M. (1999). Children's concepts: Tools for transforming science teachers' knowledge. *Science Education*, *83*(5), 545-557.

Joseph, E. U. (1996). Gender difference in senior secondary chemistry performance in Akwa-Ibom State. In E.U. Okpara (Eds.). *Gender Issues and Education and Development* APQEN book of reading 8 189-195.

Kenny, R. (1995). The generative effects of instructional organizers with computer-based interactive video. *Journal of Educational Computing Research,* 12, 275-296.

Kinchin, I., Hay, D., & Adam, S. (2000). How a qualitative approach to concept map analysis can be used to aid learning by illustrating patterns of conceptual development. *Educational Research*, *42*(1), 43-57.

Kaptan, F., & Korkmaz, H. (2001). *Effective teaching and learning in elementary level teacher handbook.* Ankara: MEB knowledge of Vee-mapping with junior high school students. *Science Education,* 67, 625-645.

Kleinsasser, A. M. (1995). Assessment culture and national testing. *The Clearing House:A Journal of Educational Strategies, Issues and Ideas*, *68*, 205-210.

Kola-Olusanya, A. (1998). Effects of instructional organizers with computer-based interactive video. *Journal of Educational Computing Research, 12*, 275-296.

Koul, R., Clariana, R. B., & Salehi, R. (2005). Comparing several human and computer based methods for scoring concept maps and essays. *Journal of Educational Computing Research, 32*, 227-239.

Lang, M., & Olson, J. (2000). Integrated science teaching as a challenge for teachers to develop new conceptual structures. *Research in Science Education*, *30*(2), 213-224.

Lee, Y., & Nelson, D. W. (2005). Viewing or visualizing-which concept map strategy works best on problem-solving performance? *British Journal of Educational Technology, 36,* 193-203.

Lehman, J., Carter, C., & Kahle, J. (1985). Concept mapping, vee mapping and achievement: results of a field study with black high school students. *Journal of Research in Science Teaching, 22*(7), 663-673.

Lim, K. Y., Lee, H. W., & Grabowski, B. (2009). Does concept-mapping strategy work for everyone? The levels of generativity and learners' self-regulated learning skills. *British Journal of Educational Technology,* 40, 606-618.

Liu, H. (2009). Concept mapping and knowledge of Vee mapping with junior high school students. *Science Education,* 67, 625-645.

Lomask, M., Baron, J. B., Greig, J., & Harrison, C. (1992). *ConnMap: Connecticut's Use of concept mapping to assess the structure of students' knowledge of science.* Paper presented at an annual meeting of the National Association of Research in Science Teaching, in Cambridge, MA.

Longjohn, I. T. (2009). Effects of instructional organizers with computer-based interactive video. *Journal of Educational Computing Research,* 12, 275-296.

Lomask, M., Baron, J. B., Greig, J., & Harrison, C., (1992).*ConnMap: Connecticut's use of concept mapping to assess the structure of students' knowledge of science*

Mari J.S (2002). Conceptual change in preservice teachers. *Teaching and Teacher Education, 9*(1), 15-26.

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

McClure, J. R., & Bell, P. E. (1990). *Effects of an environmental education related STS approach instruction on cognitive structures of pre-service science teachers*. University Park, PA: Pennsylvania State University.

McNaught, C., & Kennedy, D. (1997). Use of Concept Mapping in the design of learning tools for interactive multimedia. *Journal of Interactive Learning Research*, *8*(3-4), 389-406.

Moreland, J. L., Dansereau, D. F., & Chmielewski, T. L. (1997). Recall of descriptive information: The roles of presentation format, annotation strategy, and individual differences. *Contemporary Educational Psychology, 22*(4), 521-533.

Morine-Dershimer, G. (1993). Tracing conceptual change in preservice teachers. *Teaching and Teacher Education, 9*(1), 15-26.

Neill, D. M., & Medina, N. J. (1989). Standardized testing: Harmful to educational health. *Phi Delta Kappan,* 70, 688-697.

Nekang, J. (2004). *The effect of concept mapping on students" achievement and interest in elementary probability.* Unpublished Ph.D thesis University of Nigeria Nsukka.

Nicoll, G., Francisco, J., & Nakhleh M. B. (2001). An investigation of the value of using Concept Maps in General Chemistry. *Journal of Chemical Education 78*(8), 1111-1117.

Njoku, Z. C. (2007). Comparison of students" achievement in the three categories of questions in SSCE practical chemistry examination. *Teaching and Teacher Education, 9*(1), 15-26.

Njoku, Z. C. (1997). *Effects of practical work under different sex grouping on Students" skill acquisition and interest in chemistry practical activities*. Unpublished Ph.D thesis. Nsukka: University of Nigeria.

Novak, J. D., & Godwin, D. (1984). *Learning how to lear*n. New York: Cambridge University Press.

Novak, J. D. (1991). Clarify With Concept Maps: A Tool for Students and Teachers alike. *The Science teacher*, 58, 45-49.

Novak, J. D. (1990). Concept maps and Vee diagrams: two metacognitive tools to facilitate meaningful learning. *Instructional Science,* 19, 29-52.

Novak J. D. (2004). Meaningful learning: The essential factor for conceptual change in limited or inappropriate propositional hierarchies leading to empowerment of learners. *Science Education* 86, 54-57.

Novak, J. D., & Canas, B. (2008). *Learning how to learn.* Cambridge, MA: Cambridge University Press.

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

Nworgu, B. G. (2003). *Educational Measurement and Evaluation. Theory and Practice.* Nsukka: Hallman Publishers.

Nworgu, L. N. (2004). *Effects of gender sensitization of science teachers on gender Gap In science achievement and interest among Students*. An Unpublished Ph.D. Thesis. Nsukka: University of Nigeria

Nworgu, L. N. (2005). Effects of gender sensitization package (G.S.P) on students" achievement in integrated science *JSTAN* 40 (1&2) 74-79

Obeka, S. S. (2007). *Comparative effect of epodewald and power simulation games on students" achievement and interest in some environmental education concepts in geography*. Unpublished Ph.D thesis. Nsukka: University of Nigeria.

Odo, T. O. (1999). *Gender and school location as factors of students" difficulty in secondary schools Trigonometry*. Unpublished M.Ed. thesis Nsukka: University of Nigeria.

Oganwu, P. I. (1996). *Nigerian Women in Politics: Traditional and Religion Constraints.* Ibadan: The Vintage Publishers.

Ogunkola, B. J. (2011). Science teachers and students perceived difficult topics in integrated science curriculum of lower secondary schools in Barbado. *Journal of education 1*(2), 19-29.

Okebukola, P. A. (1999). An Examination of the Potency of the Concept Mapping technique. *Journal of research in science teaching 25*(5).

Okwo, F. A., & Otubah. S. (2007). Influence of gender and cognitive style on students" achievement in physics essay test. *JSTAN* 42 (1&2) 85-88.

Olokun, M. (2002). Gender inequality in higher education: A remedial approach. *The Nigerian Teacher Today 10*(1), 134-142.

Onwukwe, E. O. (2010). Linking electrolysis and related topics with analogical thinking processes of students–using Play simulations. *STAN Chemistry Panel Workshop Series 6* Guzau: STAN.

Osuafor, A. M. (2001). *Effects of field Trip and role play on pupils" achievement and interest environmental concepts in primary science*. Unpublished Ph. D Thesis. Nsukka: University of Nigeria.

Passmore, G. (1998). Using Vee diagrams to facilitate meaningful learning and misconception remediation in radiologic technologies laboratory education. *Radiologic Science and Education*, *4*(1), 11-28.

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.

Plotnick, E. (2001). A graphical system for understanding the relationship between concepts, *Teacher Librarian,* 28, 42-44.

Regis, A., & Albertazzi, P. G. (1996). Concept Maps in Chemistry education. *Journal of Chemical Education*, *73*(11), 1084-1088.

Rewey, K., Dansereau, D., Dees, S., Skaggs, L., & Pitre, U. (1989). Scripted cooperation and knowledge map supplements: Effects on the recall of biological and statistical information. *Journal of Experimental Education, 60*(2), 93-107.

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), 503-554.

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

Rye, J. A., & Rubba, P. A. (2002). Scoring concept maps: an expert map-based scoring scheme weighted for relationships. *School Science and Mathematics, 102*(1), 33- 44.

Saima R., Qadir B. & Shadia B. (2011). A study to analyse the effectiveness of audio visual aids in teaching learning process at university level. *Procedia - Social and Behavioural Sciences* 28 (2011) 78 – 80

Schmid, R. F., & Telaro, G. (1990). Concept Mapping as an Instructional Strategy for High School Biology. *Journal of Educational Research*, 84(2), 78-85.

Shaka, F., & Bitner, B. (1996). Construction and validation of a rubric for scoring concept maps. Paper presented at the Association for the Education of Teachers of Science

Smith, J. P., Disessa, A., & Roschelle, J. (1993). Misconceptions reconceived: A constructivist analysis of knowledge in transition. *Journal of the Learning Sciences, 3* (2), 115-163.

Smith, K., & Dwyer, F. M. (1995). The effect of concept mapping strategies in facilitating student achievement. *International Journal of Instructional Media,* 22, 25-31.

Smith, J. P., Disessa, A. & Roschelle, J. (1993). Misconceptions reconceived: A constructivist analysis of knowledge in transition. *Journal of the Learning Sciences, 3* (2), 115-163.

Songer, C., & Mintzes, J. (1994). Understanding cellular respiration: An analysis of conceptual change in college biology. *Journal of Research in Science Teaching*, 31(6), 621-637

Spaulding, D. T. (1989). Concept mapping and achievement In High school biology and chemistry. *Unpublished Dissertation,* Florida: Institute of technology.

Steward, J. (1979). Content and cognitive structure: critique of assessment and representation techniques used by science educational researchers. *Science Education,* 63, 395-405.

Stoyanov, S. (1997). Cognitive mapping as learning method in hypermedia design. *Journal of Interactive Learning Research,* 8, 309-323.

Stoyanova, N., & Kommers, P. (2002). Concept mapping as a medium of shared cognition in computer-supported collaborative problem solving. *Journal of Interactive Learning Research*, *13*(1-2), 111-133.

Taricani, E. M., & Clariana, R. B. (2006). A technique for automatically scoring open-ended concept maps. *Educational Technology Research & Development,* 54, 65-82.

Thompson F., & Logue S. (2007). An exploration of common student misconceptions in science. *International Education Journal,* 7, 553-559.

Trowbridge, J. E. & Wandersee, J. (1994). Identifying critical junctures in learning in a college course on evolution. *Journal of Research in Science Teaching, 31*(5), 459- 473.

Udeani, U. (2000). Concept mapping: An under-utilized Meta cognitive learning strategy in Nigerian science classrooms. *41st STAN Annual Conference Proceeding* 389-392.

Udobia, E. E. (2002). Science Technology and Mathematics for Sustainable Development in Africa: A Focus on the Effect of Pedagogy on Output. *43rd Annual Conference Proceeding Of STAN* 129-135.

Ueckert, C. W., & Newsome, J. G. (2008).Active learning strategies. *The Science Teacher,* 75, 47-52.

Ukwungwu, J. O. (2002). Gender differences Study of performances in integrated Science; A summary of studies conducted in Nigeria. *JSTAN* 37(1&2) 55-59.

Van Boxtel, C., Van Der Linden, J., & Kanselaar, G. (1997). Collaborative construction of conceptual understanding: Interaction processes and learning outcomes emerging from a Concept Mapping and a poster task. *Journal of Interactive Learning Research, 8*(3-4), 341-361.

Van Boxtel, C., Van Der Linden, J., & Kanselaar, G. (2001). Collaborative learning tasks and the elaboration of conceptual knowledge. *Learning and Instruction, 10*, 311- 330.

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.

Wang, C. X., & Dwyer, F. (2004). Effect of varied concept mapping strategies on Student achievement of different educational objectives. *International Journal of Instructional Media,* 31, 371-382.

Wang, C. X., & Dwyer, F. M. (2006). Instructional effects of three concept mapping strategies in facilitating student achievement. *International Journal of Instructional Media,* 33, 135-151.

Wang, C. X., & Dwyer, F. (2004).Effect of varied concept mapping strategies on student achievement of different educational objectives. *International Journal of Instructional Media,* 31, 371-382.

Wang, C. X., & Dwyer, F. M. (2006).Instructional effects of three concept mapping strategies in facilitating student achievement. *International Journal of Instructional Media,* 33, 135-151.

Webb, N. (1995). *Testing a theoretical model of student interaction and learning in Small groups.* In R. Hertz-Lazorowitz & N. Miller (Eds.), Interaction co-operative groups. Cambridge: Cambridge University Press.

Webb, N. (1989). Peer interaction and learning in small groups. *International Journal of Educational Research, 13*, 21-39.

APPENDICES

APPENDIX APRETEST

30 MINS

Choose the correct answer to each of the questions below

1. The major component of human blood is …….

   A. plasma B. platelets C. red cells D. white cells.

2. An important function of white blood cells is to

   A. buffer blood B. carry oxygen C. fight infection D. carry carbon dioxide

3. What is the organ that pumps blood all throughout the human body?

   A. The lungs B. The heart C. The kidneys D. The blood vessels and capillaries

4. Which of the following is a function of red blood cells?

   A. clot blood B. carry oxygen C. fight infection D. regulate osmotic pressure

5. Blood pressure will be at its highest when

   A. atria relax B. atria contracts C. ventricles relax D. ventricles contract.

6. The blood vessel that carries blood from the lungs to the heart is the

   A. Coronary vein. B. coronary artery C. pulmonary vein D. pulmonary artery

7. The main function of the valves in the heart is to A. prevent back-flow of blood.

   A. Divide the heart into four chambers C. control the volume of blood leaving the heart D. control the volume of blood entering the heart.

8. The function of an artery is to

   A. transport blood toward the heart B. transport blood away from the heart. C. connect the right and left atria directly D. carry carbon dioxide to the tissue cells.

9. A blood vessel that transports blood out of a capillary bed is a(n)

   A. Vein B. artery C. venule D. arteriole.

10. The most muscular chamber of the heart is the

    A. left atrium. B. right atrium. C. left ventricle. D. right ventricle.

11. Blood vessels that allow diffusion of gases through their thin walls are the

    A. arteries B. venules C. arterioles D. capillaries

12. The watery part of the blood is called….

    A. Veins B. Platelets C. Plasma D. Capillaries

13. Chambers of the heart

A. Atria or auricles and ventricles B. Veins and arteries

C. Adenoids and tonsils D. Tarsal and carpals

14. These blood vessels take deoxygenated blood to the heart and oxygenated blood from lungs. A. Veins B. Capillaries C. Arteries D. Lymph

15. Hypertension would be indicated by a blood pressure reading of

A. 100 / 80 B. 120 / 50 C. 120 / 80 D. 150 / 110

16. Which of the following would describe the path of the blood in the pulmonary circuit?

A. Right ventricle → pulmonary trunk → pulmonary vein → left atrium

B. Left ventricle → pulmonary vein → pulmonary trunk → right atrium.

C. Right ventricle → pulmonary vein → pulmonary artery →left atrium.

D. Right atrium→ pulmonary trunk → aorta →vena cava → right atrium.

17. Which of the following correctly matches structure with function?

A. platelets — provide immunity B. plasma proteins — carry oxygen

C. red blood cells — carry carbon dioxide D. white blood cells — initiate blood clotting

18. All of the following are components of plasma **except**

A. salts. B. water. C. proteins. D. platelets.

19. Blood which lacks platelets would not be able to

A. clot. B. carry oxygen. C. fight infections. D. transport

20. Which type of blood vessel has thick walls in order to withstand high pressure?

A. vein B. artery C. arteriole D. capillary

MARKING SCHEME FOR PRETEST

1. A
2. C
3. B
4. B
5. D
6. C
7. A
8. B
9. C
10. C
11. D
12. C
13. A
14. A
15. D
16. A
17. C
18. D
19. A
20. B

APPENDIX B

POST-TEST

30 MINS

Choose the correct answer to each of the questions below

1. What is the circulatory system? A. The body's breathing system B. The body's system of nerves C. The body's food-processing system D. The body's blood-transporting system
2. The organ that pumps oxygenated blood to the body and deoxygenated blood to the lungs. A. Brain B. Liver C. Heart D. Kidney
3. The major component of human blood is ……. A. plasma B. platelets C. red cells D. white cells.
4. An important function of white blood cells is to A. buffer blood B. carry oxygen C. fight infection. D. carry carbon dioxide
5. Where is Red blood cells produced? A. Bone marrow B. Liver C. Pancreas D. Spleen
6. Blood pressure will be at its highest when A. atria relax. B. atria contracts. C. ventricles relax. D. ventricles contract.
7. The blood vessel that carries oxygenated blood from the lungs to the heart is the A. coronary vein. B. coronary artery C. pulmonary vein. D. pulmonary artery
8. The main function of the valves in the heart is to
   A. prevent back-flow of blood. B. divide the heart into four chambers.
   C. control the volume of blood leaving the heart. D. control the volume of blood entering the heart.
9. The function of an artery is to A. transport blood toward the heart. B. transport blood away from the heart. C. connects the right and left atria directly. D. carry carbon dioxide to the tissue cells.
10. A blood vessel that transports blood out of a capillary bed is a (an) A. vein. B. artery.C. venule D. arteriole.
11. The most muscular chamber of the heart is the A. left atrium. B. right atrium. C. left ventricle. D. right ventricle.
12. Blood vessels that allow diffusion of gases through their thin walls are the A. arteries. B. venules C. arterioles. D. capillaries

13. Which type of blood vessel has thick walls in order to withstand high pressure? A. vein B. artery C. arteriole D. capillary
14. Chambers of the heart A. Atria and ventricles B. Veins and arteries C. Adenoids and tonsils D. Tarsal and carpals
15. These blood vessels take deoxygenated blood to the heart and oxygenated blood from lungs. A. Veins B. Capillaries C. Arteries D. Lymph
16. Hypertension would be indicated by a blood pressure reading of A. 100 / 80 B. 120 / 50 C. 120 / 80 D. 150 / 110
17. Which of the following would describe the path of the blood in the pulmonary circuit? A. Right ventricle → pulmonary trunk → pulmonary vein → left atrium. B. Left ventricle → pulmonary vein → pulmonary trunk → right atrium. C. Right ventricle → pulmonary vein → pulmonary artery →left atrium. D. Right atrium→ pulmonary trunk → aorta →vena cava → right atrium.
18. Which of the following best describes a vein? A. Thin-walled, elastic, and equipped with valves. B. Thick-walled, elastic, and equipped with valves. C. Thin walled, muscular, and supplied with nerves. D. Thick-walled, muscular, and supplied with nerves.
19. Plasma is composed mostly of A. Salt. B. Water. C. Protein. D. Hormones.
20. These tiny blood cells clot the blood when a person gets cut. A. Red B. White C. Platelets D. Lymph

MARKING SCHEME OF POST-TEST

1. D

2. C

3. A

4. C

5. A

6. D

7. C

8. A

9. B

10. C

11. C

12. D

13. B

14. A

15. A

16. D

17. A

18. A

19. B

20. C

APPENDIX C

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

RESEARCH QUESTIONNAIRE

This questionnaire has been designed to gather information on students‘ perceptions about the effectiveness of concept mapping in teaching and learning of circulatory system. The information collected will be used solely for academic purposes and as such will remain confidential.

Please tick to indicate your level of agreement or disagreement about each of the following statements in the spaces provided. Kindly respond to all questions as accurate as possible to you.

Tick (√) the box for appropriate response.

RESPONDENT ID NUMBER…………..

1. Sex: Male [ ] Female [ ]

2. Age: 20 years and above [ ] 17-19 years [ ] 16 and below [ ]

Keys:

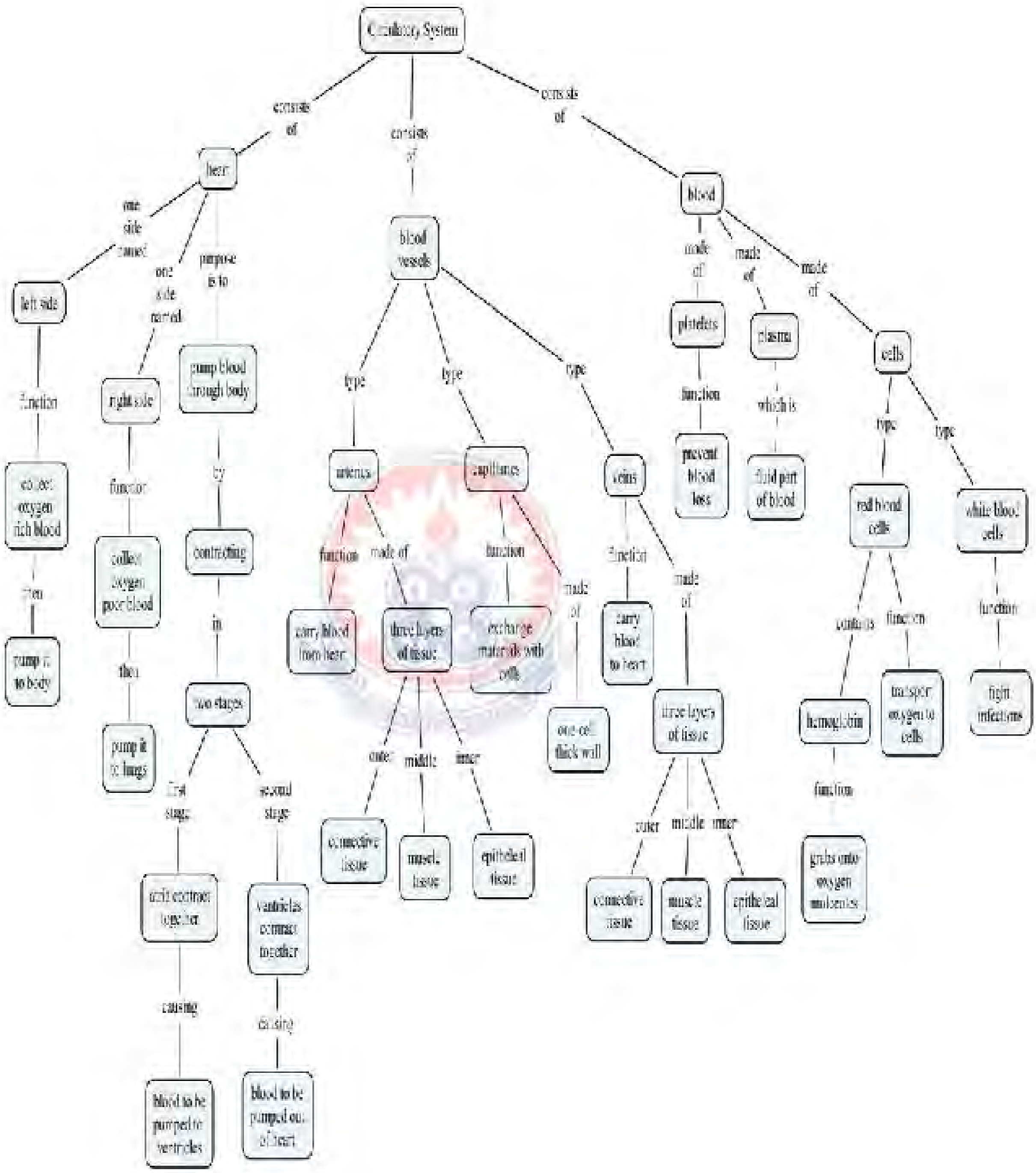
Strongly Agree = SA Agree = A Not Sure = NS

Disagree = D Strongly Disagree = SD

Question items	**Responses**				
	SA	**A**	**NS**	**D**	**SD**
1.Concept mapping strategy improved my understanding of the circulatory system					
2.The use of concept mapping strategy reduces forgetfulness in examination					
3. I do not always enjoy the lesson when our teacher uses concept mapping strategy					
4. Concept mapping strategy motivated me to learn					
5. I learn better when teachers teach without concept mapping strategy					
6. Concept mapping strategy reduces my personal interaction with my colleagues					
7. Concept mapping strategy is effective means of assisting students to understand the relationships among concepts					
8.I learn better when teachers teach with Concept mapping strategy					
9.The use of concept mapping strategy does not effectively assist students to understand the relationships among concepts					
10. I always enjoy the lesson when our teacher uses concept mapping strategy					
11.Concept mapping prevents rote learning					
12.Concept mapping help students in private studies					
13.Concept mapping can reduce recitation and stress in examination					
14. Concept mapping strategy help with concept and knowledge application					
15.Concept mapping does not prevent rote learning					

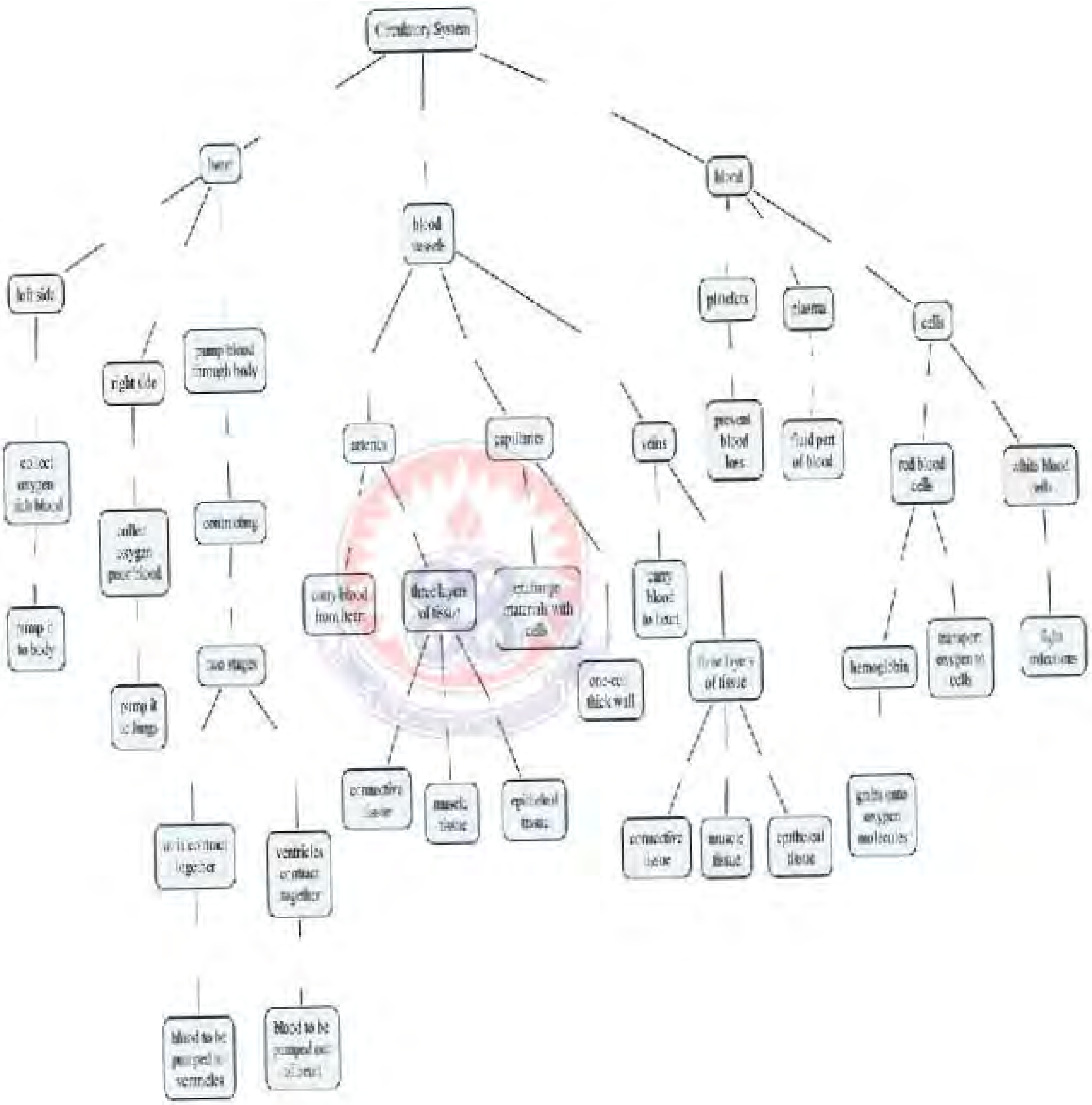
APPENDIX D

Teacher Created Concept Maps



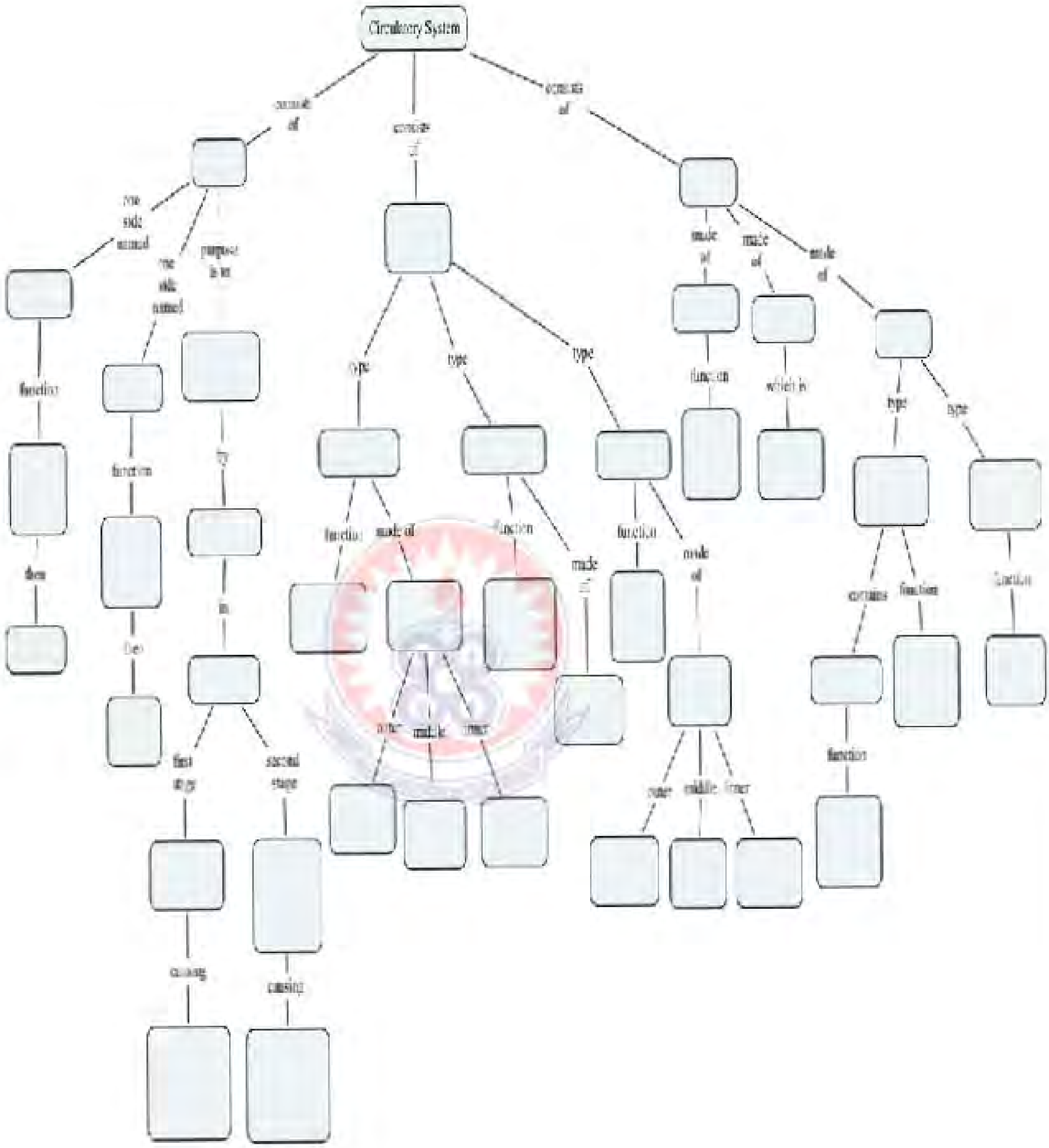
Using Concept Map to Identify Propositions/ Links ID #: _____

Directions: Fill in the linking words or phrases between the concepts to complete the circulatory system concept map.



Using Concept Map to Identify Concepts ID #: _____

Directions: Fill in the concepts to complete the circulatory system concept map.

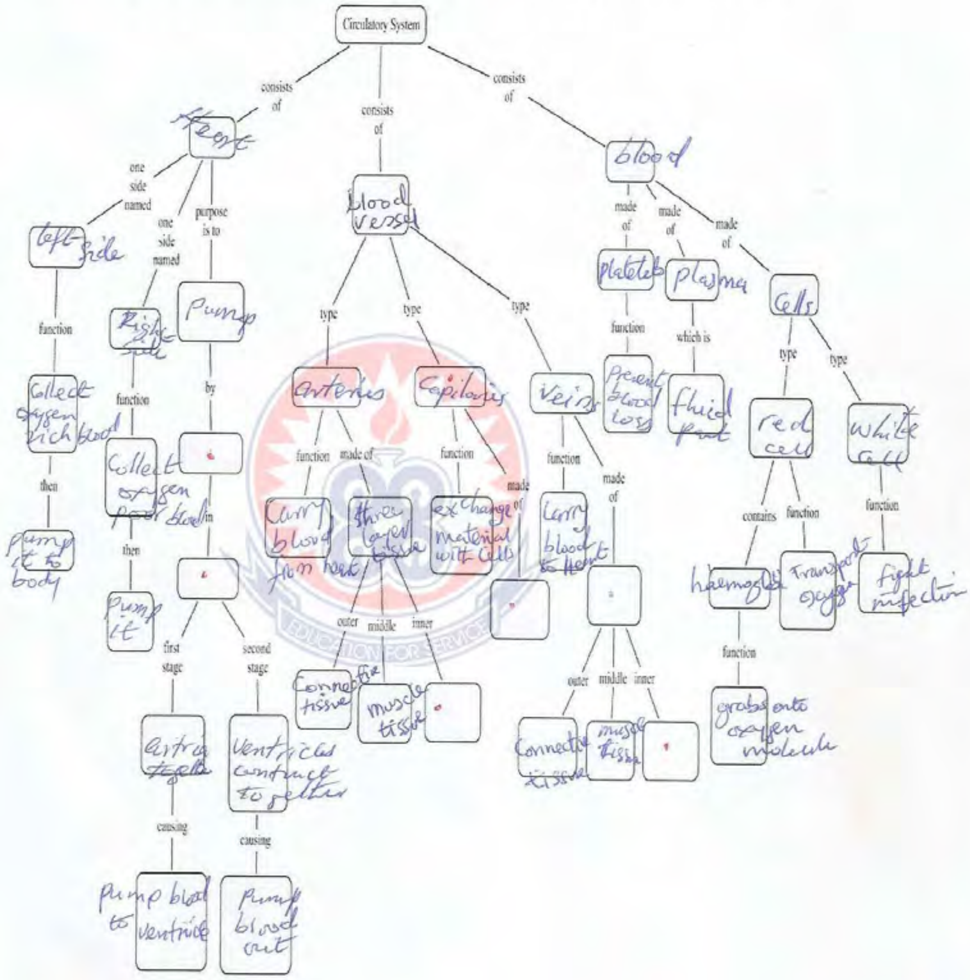


APPENDIX E

SAMPLES OF STUDENTS' WORK

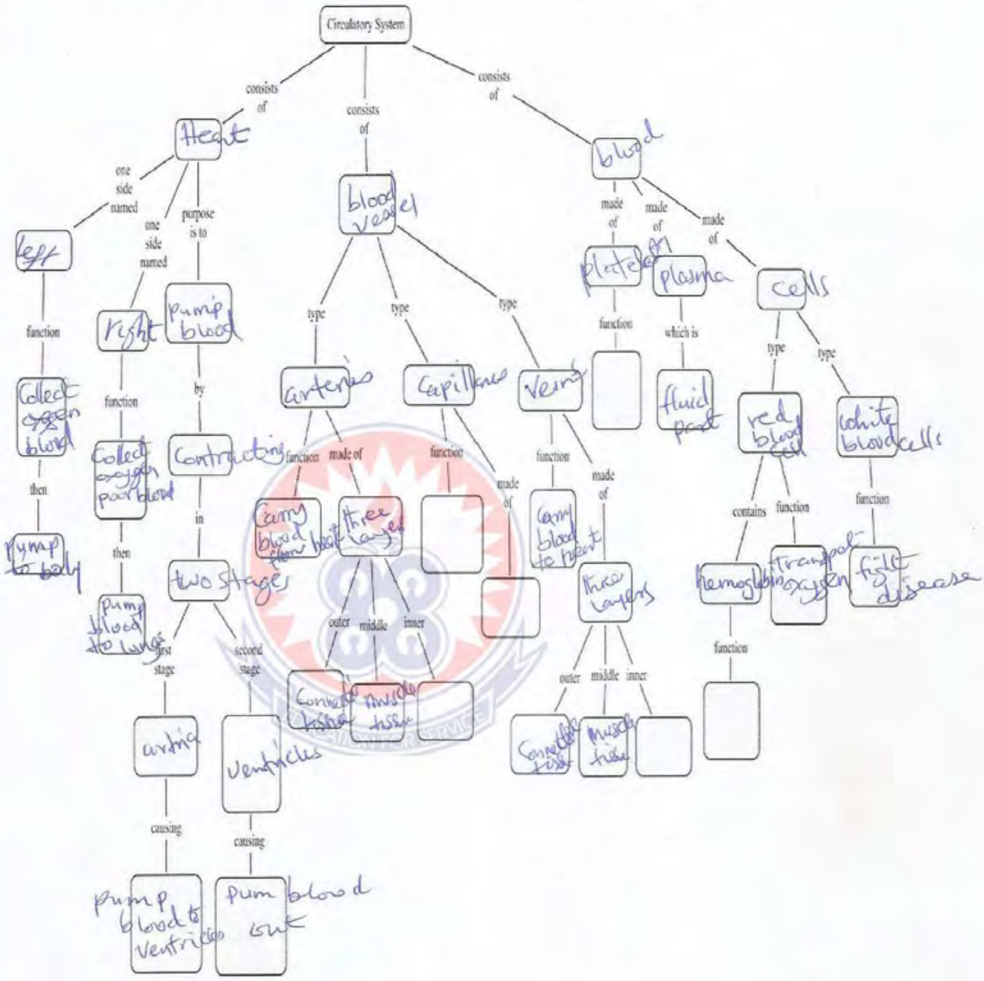
Using Concept Map to Identify Concepts ID #: 5

Directions: Fill in the concepts to complete the circulatory system concept map.



Using Concept Map to Identify Concepts ID #: 24

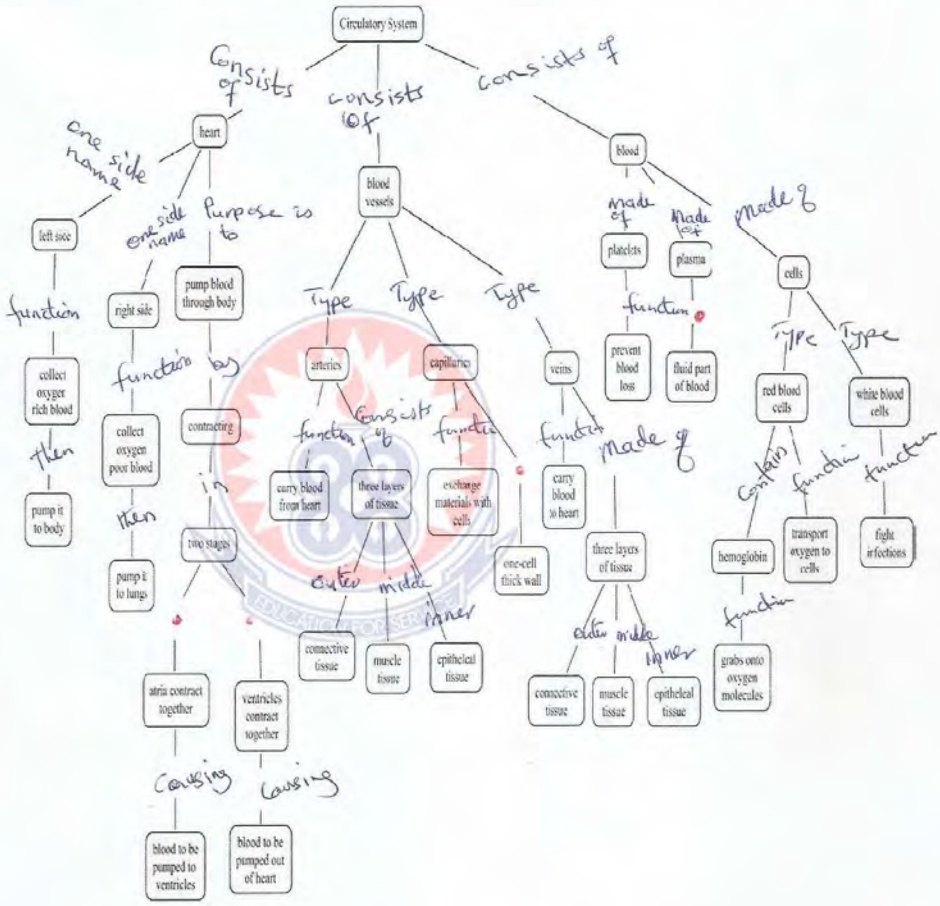
Directions: Fill in the concepts to complete the circulatory system concept map.



APPENDIX A

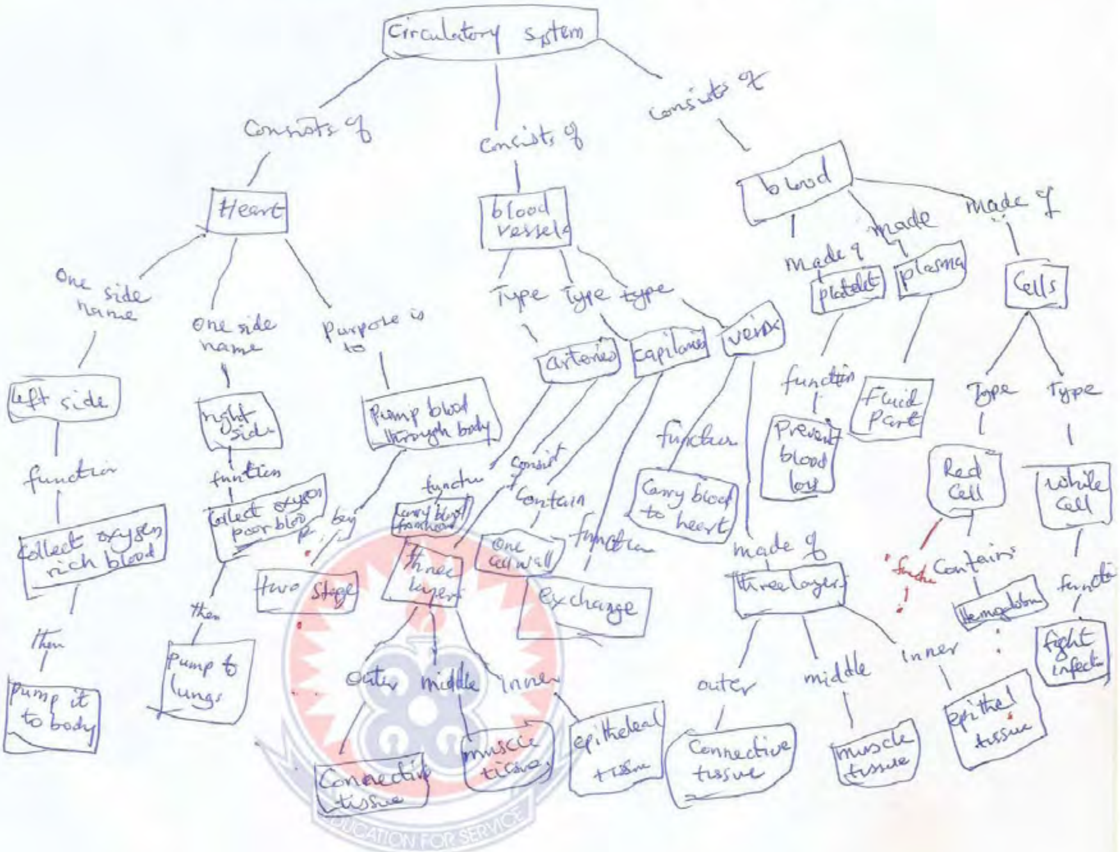
Using Concept Map to Identify Propositions/ LinksID #: 10

Directions: Fill in the linking words or phrases between the concepts to complete the circulatory system concept map.



Student Generated Concept Map

Direction: Create a Concept Map of the Circulatory System **ID:** 39



Student Generated Concept Map

Direction: Create a Concept Map of the Circulatory System **ID:** 30