UNIVERSITY OF EDUCATION, WINNEBA

THE IMPACT OF CONCEPT MAPPING IN REDUCING COGNITIVE LOAD OF STUDENTS

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A DISSERTATION IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTERS OF SCIENCE EDUCATION

DECEMBER, 2016

DECLARATION

Candidate's Declaration

I, PETER ADDO AMOAKO, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledge, is entirely my own original work, and 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 dissertation was supervised by me in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

Supervisor's Name: PROF. MAWUADEM KOKU AMEDEKER, (Ph.D)

Signature:…………………………..…

Date:…………………………..………

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Finally, I am also thanking my colleagues, Luke, Nomolox and Godwin for their prayers too.

DEDICATION

This work is dedicated to my parents, Mr. and Mrs. Amoako. I also dedicate this work to all who believe in my ability to succeed.

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ABSTRACT

The study was conducted to show the impact concept mapping has as a teaching strategy in an attempt to reduce cognitive load of first year biology students of St. Dominic's Senior High School. In the study, the students were taught how to construct concept maps on classification of plants. A convenience sampling technique was used to select a sample of sixty (60) in-tact class of form one biology students in the school. An observation was used by the Researcher to collect data and analysed them. The results showed that the students were able to construct concept maps correctly. In an attempt to reduce cognitive load of students, the concept maps drawn by the students help summarised information needed to be learned by students. It identified and corrected misconceptions. It presented concepts in an orderly manner that promoted easy recall of learned information. These showed that concept mapping was more effective in reducing cognitive loads of students and so improve student's performance.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter discusses the background to the study which describes briefly; causes and effect of cognitive loads, the problem of cognitive load of students of St. Dominic's Senior High and Technical School faces and the rationale for the study. The chapter also explains in brief the scope of the study and the factors that limited the study. Finally, the organisation of the whole five-chapter thesis was outlined in this chapter.

1.1 Background to the Study

Available research shows that any strategy adopted by the teacher that gives more information than needed at any one time, and also has many irrelevant concepts has the tendency of creating cognitive load for the student (Gillmor, Poggio, & Embretson, 2015). Such approach, according to the authors can split the student's attention from the science concepts being learnt. Another research conducted by Paas, Renkl and Sweller (2003) also showed that interactivities of many elements in a topic could lead to cognitive load. This is because the elements could confuse and frustrate students as they attempt to comprehend and assimilate the concepts into their cognitive structure. In all these cases, huge mental effort is needed to process the information in the student's memory and hence leads to cognitive load. Stakeholders and parents of students of St. Dominic Senior High School have consistently for the past four years, raised concerns about the poor performance of their wards offering biology in the school. The Researcher's own experience shows that the way of presenting lessons to the students may be one of the causes of the poor performance. The current research, therefore, explores the advantages of concept mapping as an instructional strategy that is capable of reducing learning cognitive loads for students (Adeneye & Adeley, 2011; Candan, 2006; Esiobu & Soyibo, 2006; Meng-Lei & Ming-Hsiung, 2012).

1.2 Statement of the Problem

Gillmor et al. (2015) have shown that cognitive load hinders the performance of students in American schools. Men-lei and Ming-Hsiung (2012) also supported this claim by explaining how cognitive load caused students in Taiwan to perform poorly. In Ghana, a research on basic and senior high schools (Ntim, 2015) has shown that students' performance is related to teaching approaches used by teachers. The Researcher has also realised that cognitive load hinders the performance of students of St. Dominic Senior High School, and that the students may benefit greatly from a new teaching approach that employs 'Concept Mapping' to reduce their cognitive load and improve their academic performance.

1.3 Purpose of the Study

The study used Concept Mapping as a teaching methodology in an attempt to reduce cognitive load of biology students of St. Dominic's Senior High School. It is expected to help students improve their academic performance in biology.

1.4 Research Objectives

The objectives that guided the study were to:

1. Construct concept map on classification of Plants.

2. Determine the role played by concept mapping in reducing cognitive load of the students.
3. Determine the effect of concept mapping in improving the academic performance of students in biology.

1.5 Research Questions

To guide this study, the following research questions were addressed:

1. How did students construct concept map on classification of Plants?
2. What roles did concept mapping play in reducing cognitive load of students when learning classification of Plants?
3. What is the effect of concept mapping on the academic performance of students in learning classification of Plants?

1.6 Significance of the Studies

The results from this project would give another alternate method of teaching biology which can reduce cognitive load of students and as such increase academic achievements of biology students in schools.

1.7 Delimitations of the Study

Simon and Goes (2013) also proposed delimitations to be the deliberate inclusions and omissions made in a research. In this research, reducing cognitive load of students in biology was restricted to only cognitive achievements based on the accuracy with which they constructed the concept maps. It was also delimited to first year biology students of St. Dominic’s Senior High Technical School.

1.8 Limitations of the Study

According to Simon and Goes (2013) limitations are occurrences in a research the researcher has no control over. In this study the limitations were the number of lessons conducted during the period of the study and the absence of some students from class because they owed fees. The number of lessons conducted during the study was five (5).

1.9 Research Organisation

This thesis write-up is segmented under five chapter headings, namely introduction, review of related literature, research methodology, data analysis and discussion of results, summary, conclusion and recommendations. The introductory chapter, captioned chapter one provides detailed information on the background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, limitations and delimitations of the study. Chapter two of this thesis deals with the review of related and relevant literature from sources like books, journals, abstracts and online resources on the Performance of a student in a particular activity involving the use of the concept mapping teaching methodology.

Chapter three provides detailed information on the conduct of the study, under the following headings; research design, population, sample and sampling technique, research instruments, data collection and data analysis procedure. The fourth chapter presents the data collected, their appropriate analysis and discussion of results by research questions whiles the fifth and final chapter presents the summary of the results of the study, conclusions arrived at, recommendations and suggestions for further study made by the researcher.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The role of teacher's pedagogical knowledge and skills is helpful to reduce the cognitive load of students and is a key factor to make them achieve well in examination. Due to this, documents both published and unpublished, including books, journals, newspapers and articles that have information on cognitive load and how to reduce it would be reviewed in this chapter. The Literature would be reviewed under three main headings; theoretical framework, Concept map and concept mapping, Cognitive load, Measurement of Cognitive Load, effect of cognitive load and how to reduce cognitive load.

2.1 Theoretical Framework

This study is based on the theory of constructivism. This is because the notions that learning is influenced by prior knowledge and ideas have led to the development of constructivism (Bennett, 2003). Based on Piaget and Vygotskian learning theories, constructivist mirror the way the mind collects, assesses and retains information. Basically constructivism is based on how people learn on their own with little assistance (Educational Broadcasting, 2004). Specifically, in constructivism, understanding is built gradually through engagement with problems, issues and questions. Constructivism also emphasises that a learner willingly searches and finds knowledge, as well as understanding. To a constructivist, students must create their own meanings from what they experience, rather than acquiring knowledge from their teachers. The teacher in a constructivist class is therefore a facilitator where the teacher and the learners in this case are equally involved in the learning process .The impact and development of this view led to the development of different methodologies such as concept mapping in the teaching and learning of science .This is because, constructivism and concept mapping all share the same objectives of engaging students in the learning process and promoting independent learning. Thus when students construct concept maps on topics, they are able to learn independently of their teachers and understand concepts better. They gain insight when they show connections and relationship between concepts and ideas.

2.2 Concept Map and Concept Mapping

According to Ajaja (2009) Concept map is a graphical representation of concepts and are usually shown by circles of bones, forming the nods of the new work, labelled by links and arranged in a hierarchical manner. The term concept map and concept mapping have been used interchangeably to mean a technique for picturing the relationships among different concepts (Ajaja, 2009; Bennett, 2003). At first glance, one would observe a concept map to look like a flow chart in which the key terms are placed in boxes connected by directional arrows. The nodes are linked together by propositions and this show how students connect or link concepts. Concept maps are based on the idea that concepts do not exist in isolation but depend upon others for its meaning.

Therefore, concept mapping is a technique used to represent the relationships among concept and serves as a strategy to help learners arrange their cognitive frameworks into more powerful integrated patterns (Kinchin, 2005). Most of the definitions of concept mapping describe the techniques as a knowledge representation tool (Huai & Kommers 2004). As a knowledge representation tool, concept mapping has some characteristics that could make it a powerful problem-solving tool as well (Stoyanov, 2001). They believed that the technique is an adequate, flexible and an intuitive way to express the mental model of the problem solver. To Stoyanov (2001) what make concept mapping a powerful problem-solving technique is its knowledge representation, knowledge elicitation, knowledge reflection and a knowledge changing tool.

2.2.1 Construction of concept map

As suggested by Akeju, Rotimi and Kenni (2011) to construct concept maps one must follow systematically the steps below:

- Identifying the major components of the concept (topic)
- Arranging the concept's components in hierarchical order
- Linking the components with linking phrases
- Making cross links with directed lines

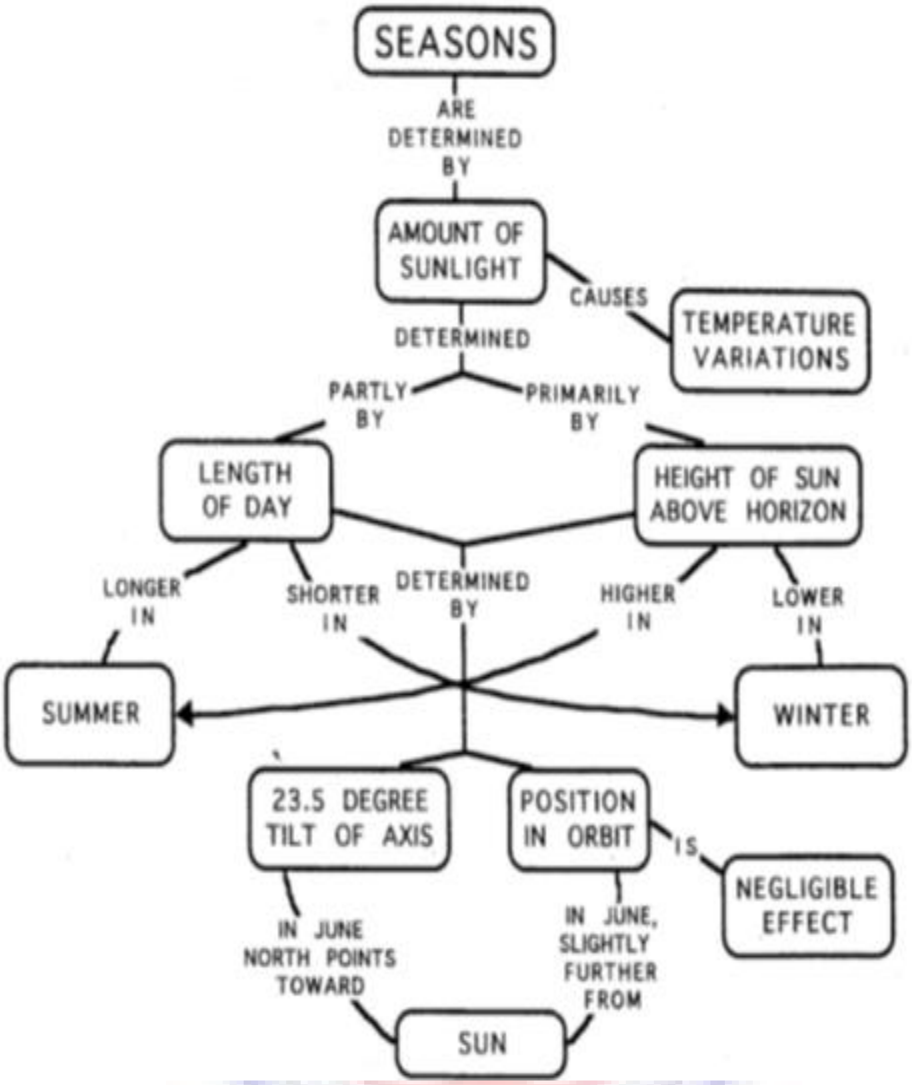

Figure 1: An Example of Concept Map on Seasons (Navak & Cañas, 2008).

According to Navak and Cañas (2008), in constructing a concept map, it is important to begin with a domain of knowledge that is very familiar to the person constructing the map. Since concept map structures are dependent on the context in which they will be used, it is best to identify a segment of a text, a laboratory or field activity, or a particular problem or question that one is trying to understand. This creates a context that will help to determine the hierarchical structure of the concept map. It is also helpful to select a limited domain of knowledge for the first concept maps.

A good way to define the context for a concept map according to the two researchers is to construct a 'Focus Question' that is, a question that clearly specifies the problem or issue the concept map should help to resolve. Every concept map responds to a focus question, and a good focus question can lead to a much richer concept map.

Furthermore, given a selected domain and a defined question or problem in this domain, the next step is to identify the key concepts that apply to this domain. Usually 15 to 25 concepts will suffice. These concepts could be listed, and then from this list a rank ordered list is established from the most general, most inclusive concept, for this particular problem or situation at the top of the list, to the most specific, least general concept at the bottom of the list. Although this rank order may be only approximate, it helps to begin the process of map construction. They referred to the list of concepts as a parking lot, since they move those concepts into the concept map as they determined where they fit in. Some concepts may remain in the parking lot as the map is completed if the mapmaker sees no good connection for those with other concepts in the map.

The next step according to Navak and Cañas (2008), to construct a preliminary concept map. This can be done by writing all of the concepts linking them to arrows which extend downwards. This is necessary as one begins to struggle with the process of building a good hierarchical organisation. After a preliminary map is constructed, it is always necessary to revise this map. Other concepts can be added. Good maps usually result from three to many revisions.

Moreso, the preliminary map is built, cross-links should be sought. These are links between concepts in different segments or domains of knowledge on the map that help to illustrate how these domains are related to one another. Cross-links are important in order to show that the learner understands the relationships between the sub-domains in the map. It is important to help students recognise that all concepts are in some way related to one another. Therefore, it is necessary to be selective in identifying cross-links, and to be as precise as possible in identifying linking words that connect concepts. In addition, one should avoid "sentences in the boxes", that is, full sentences used as concepts, since this usually indicate that a whole subsection of the map could be constructed from the statement in the box.

Once students begin to focus-in on good linking words, and on the identification of good cross-links, they can see that every concept could be related to every other concept. This also produces high levels of cognitive performance. Concept mapping is an easy way to encourage very high levels of cognitive performance, when the process is done well. This is one reason concept mapping can also be a very powerful evaluation tool (Ajaja, 2011).

Finally, the map should be revised, concepts re-positioned in ways that lead to clarity and better over-all structure, and a "final" map prepared. When computer software is used, one can go back, change the size and font style, and add colours to "dress up" the concept map. Thus, we see that concept maps are not only a powerful tool for capturing, representing, and archiving knowledge of individuals, but also a powerful tool to create new knowledge.

2.2.2 Scoring of concept maps

There are numerous methods of scoring concept maps according to Keppens (2007). They include such methods like; Holistic scoring method, weighted component scoring methods, the closeness index (Quantitative assessment methods) and Linkage analysis (Qualitative assessment method).

2.2.3 Holistic scoring method

In the holistic scoring method, experts score concept maps of students on a scale, say 0 to10, indicating the student's overall understanding of the concept. It does not give any algorithm, or guidelines to calculate the scores (Keppens, 2007).

2.2.4 Weighted component scoring method

According to Keppens (2007) the weighted component scoring method gives point scores to certain concepts or links between concepts. The method proposes a relatively small score for each valid link and each valid example of a concept. It also gives a substantially higher score to links that express a hierarchical relation, such as "is a kind of" or "contains" relationships. Thus the highest scores are reserved for links between concepts that are located on different branches of hierarchical structures. In this case, the score associated with a concept map equals the sum of the partial point scores awarded to each component of that concept map.

2.2.5 The closeness index

The closeness index according to Keppens (2007), is a heuristic approach that aims to calculate the similarity between a student's and a teacher's concept maps. The approach focuses on the concepts and links between concepts that the two maps have in common, ignoring the labels of the links.

2.2.6 Linkage analysis

Linkage analysis, devised by Liu, Don and Tsai (2005), aims to identify potential misconceptions of students by comparing the concepts each individual concept is directly linked to in a student's and the teacher's concept map of a particular domain. In this way, linkage analysis identifies certain symptoms that indicate potential misconceptions and may be able to suggest improvements to the concept maps.

For example, linkage analysis can identify potentially confused concepts. If a concept **A** in the student's map is linked to a set of concepts **C,** whiles the teacher's map contains a concept **B** that is mostly connected to most of the concepts in **C**, then the student may be confusing **B** with **A**. In this case, **A** is said to be a confused concept. If a student incorrectly links a concept **A** to a set of concepts **C**, while in the teacher's map, a concept **B** is connected to the concepts in **C**, then it can be suggested to the student that **A** may have to be substituted to **B**. Linkage analysis can also identify less obvious misconceptions. For example when a concept **E** is correctly linked to other concepts in a set **D**, but the concepts in **D,** are incorrectly linked, then the student may have misunderstood **E** in the first place.

The simplistic nature and the ease at which misconceptions could be detected by students themselves make this a preferred method in this study. Also this qualitative assessment method is preferred due to its ability to identify and corrects student's confusion of concepts.

2.3 Importance of Concept Mapping

2.3.1 Concept mapping as an instructional strategy

Literature on concept mapping indicates that concept mapping has long been used as instructional, assessment and learning strategies (Bennett, 2003).

Some studies on the effects of concept mapping when used as an instructional strategy for teaching and learning, indicated its importance in improving the cognitive and affective aspects of learning.

As a teaching tool, Kabaca (2002) Mclay and Brown (2003) compared concept mapping to the traditional method of teaching. They concluded that concept mapping was more successful as a teaching and learning tool because students who used it gain higher marks an indication that they understood the concept taught with ease. The reason could be that concept mapping organised and visualised the relationships between the key concepts in a semantic way as was proposed by Pill (2005).

According to Safdar (2010), concept learning is an active process that is fundamental to understanding science concepts, principles, rules, hypotheses, and theories. It is the responsibility of the teacher to organise learning experiences in a way that will facilitate student learning. As students are introduced to new science concepts, they embark on a cognitive process of constructing meaning and making sense by consciously or subconsciously integrating these new ideas with their existing knowledge. This is best facilitated by Concept Maps. In the view of Safdar (2010), if teachers learn how to construct concept maps and use them for planning and assessing lessons, they will be able to teach students better how to make concept maps to organise their thoughts and ideas. Science teacher can use concept maps to determine the nature of students' existing ideas, and make evident the key concepts to be learned and suggest linkages between the new information to be learned and what the student already knows.

According to Ahmed (2010) and Kommers (2004), concept maps can be used as advanced organiser to improve learner's achievement. As an advanced organiser, concept mapping can elicit the learner's previous knowledge about a concept, making the learner learn from known to unknown to promote meaningful learning. In views of Ahmed (2010), to learn meaningfully, students must relate new knowledge (concepts, proposition, rule, principles) to what they already know. He believes that information or concept is learned more easily if it is organised and sequenced logically. This gives rise to the term advance organiser. He proposes the notion of an advance organiser as a way to help students link their ideas with new material or concepts. Kommers (2004), advance organisers are concepts given to students prior to the material actually to be learned to provide a stable cognitive structure directing attention to what is important in the coming material; highlighting relationships among ideas that will be presented; and reminding the students of relevant information already in memory. These organisers are introduced in advance of learning itself, and are also presented at a higher level of abstraction, generality, and inclusiveness.

Advance organiser Concept Maps might be constructed by teachers or other experts (Kommers, 2004). The Concept Map advance organisers can be used in various ways as part of the classroom experience. They might be presented at the beginning of a textbook chapter or other instructional unit, or used as a guide for a lecture that is presented in a class. They might be used to present an overview of multimedia, with links to instructional materials associated with different topics. In theory, advance organisers are most effective if they make explicit the relationship among learned concepts that learners already know, thus providing a structure into which the new concepts can be integrated.

Concept Maps created by students can be used in several ways to facilitate meaningful learning. Ajaja (2011) pointed out that Concept Maps are a kind of schematic summary of what students know and also provide a unique graphical view of how students organise, connect, and synthesise information. They 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.

This show that the students that viewed or made concept maps would have a broader knowledge base and therefore be more able to solve problems compared to those students that learned by rote memorisation. They also found that the students with low prior knowledge learned better with concept mapping than the other. Cognitive structure and concept mapping are highly personal as each individual's knowledge is unique. Hence, concept maps are idiosyncratic.

This equips teachers with a new approach to make them teach well. Ajaja (2011) noted that concept maps help in understanding of ideas by showing the connections with other ideas. The process of simplifying concepts and arranging them on a page forces the learner to think about what is most important.

2.3.2 Importance of concept mapping as a learning tool

Ajaja (2011) determined the effects of concept mapping as a study tool for student's achievement in Biology. The major findings of that study indicated a significant and consistent improvement in Biology achievement as the period of experience with the use of the method increased. The students who also used concept mapping as a study tool retained biological knowledge longer than those who used other methods. All the students interviewed in the concept mapping classroom agreed that concept maps helped them not only in the determination of the relationships among the concepts but also shaped their understanding of the concepts and increased their critical thinking. The findings of Kinchin (2000) were similar to those of Ajaja, where there was a significant impact of concept mapping on the achievement of biology students. In that study, Kinchin compared the effect of the use of concept mapping as a study skill on student's achievement. He found a positive effect on students who used concept maps to revise and summarise the materials they have been given.

2.3.3 Concept mapping helps to clear student's misconceptions

The hierarchical arrangement of concepts showing links and interrelationship among other concepts, clarifies learners misconceptions as suggested by Liu et al (2005). They are of the view that if students compare their concept maps with their teachers', their misconceptions would be rectified. Concept mapping also allow students to reflect on their own misunderstanding as well as their confused concepts and then take ownership of their learning (Fitzgerald, 2004). This clarifies the learner's thought and understanding making learning more meaningful. It therefore helps in the development of critical thinking skills. Perhaps this is the reason why Johnston and Otis (2006) suggested concept mapping to be used as a personal learning tool.

2.3.4 Concept mapping helps in prompt recall of learned materials

Akeju et al. (2011) in a study discovered a significant effect of concept mapping as an instructional strategy on students' learning achievements. The strategy helped in prompt recall of learned materials. Candan (2006) investigated the effect of concept mapping on primary school students understanding of the concepts of force and motion. The result revealed a significant difference between the mean scores of the experimental and control groups.

Esiobu and Soyibo (2006) investigated the effects of concept mapping and vee mappings on student's cognitive achievement in ecology and genetics. They discovered that the experimental groups outperformed the control group. Adeneye and Adeleye (2011) in a similar study also discovered that concept mapping strategy enhanced student's achievement in mathematics because the method offered the student's another means to create the environment that differentiated mathematics instruction from the series of isolated activities.

2.3.5 Concept mapping as a strategy to reduce cognitive load

Men-lei and Ming-Hsiung (2012) conducted a study to determine the effect of concept mapping on students cognitive load and discovered that students in the concept mapping class reduced their cognitive load more than students in the traditional teaching class. According to Ajaja (2009) and Bennett (2003) concept mapping is one method that could reduce cognitive load of students especially in biology. The researchers concluded that concept mapping reduced word counts and simplified terminologies; provided visual means of showing connections and relationships between ideas being taught. A reason why the student's learning loads were reduced. On the effect of concept mapping for attitudinal change, the study by Eravwoke (2011) found a significant and positive effect on students' attitude when used for chemistry concepts. The students were motivated intrinsically to attend and learn chemistry on their own with the use of concept mapping.

2.4 Limitations of the Use of Concept Mapping as an Instructional and Learning Tool

Bennett (2003) identified two major limitations of the use of concept mapping in instruction. According to him, concept maps are not easy to construct, and respondents require training and practice in constructing the maps. Also, there are difficulties with the interpretation of concept maps in particular with devising appropriate ways of scoring to enable valid comparisons to be made. These limitations frustrate low achievers and tap on high cognitive abilities. However if teachers teach their students well enough to construct the maps better, this problem would not be an issue. The students themselves would enjoy using it for their studies.

2.5 Cognitive Load

Cognitive load is considered to be a theoretical construct describing the internal processing of task that imposed load or pressure on the cognitive structure during the completion of the task (Kruger, Hefer & Mathew, 2013). Cognitive load has been conceptualised in three dimensions, namely the mental load, mental effort and the performance of the participant (Brünken, Plass, & Leutner, 2003). To the researchers, mental load is the load imposed by the demands that relate to the difficulty of the task or the environment in which the task is being done whiles mental effort, is the learners' efforts to process and comprehend learning materials (Chang & Yang 2010).

2.5.1 Assumptions about how the mind works

According to Mayer, (2001) there are three assumptions about how the human mind works; the dual channel assumption, the limited capacity assumption, and the active processing assumption. Mayer stated further that the human information processing system consists of two separate channels; an auditory or verbal channel for processing auditory input and verbal representations and a visual or pictorial channel for processing visual input and pictorial representations. Each channel in the human information processing system has a limited capacity where limited amount of cognitive processing can take place at any one time. However, meaningful learning requires a substantial amount of cognitive processing to take place in the verbal and visual channels. This is the central assumption of Mayer's (2002) theory of active learning. These processes include paying attention to the presented material, mentally organising the presented material into a coherent structure, and integrating the presented material with existing knowledge to promote active learning.

2.6 Types of Cognitive Load

Cognitive Load Theory defined three types of load that put demand on the limited memory capacity during learning: intrinsic, extraneous, and germane (Paas et al. 2003). These three types of cognitive load: intrinsic, extraneous, and germane are used additively with the remaining free space to comprise total working memory capacity.

2.6.1 Intrinsic cognitive load

According to Paas et al. (2003) intrinsic cognitive load is associated with the inherent challenge or level of difficulty of the material being processed in the memory. The level of intrinsic cognitive load of a given content will vary across students and cannot be manipulated or altered through instructional designs (Kruger et al., 2013). It is highly related to the intrinsic nature of the concept and cannot be changed. For example, the mental calculation of **1 + 1** has lower intrinsic load than solving an advanced algebraic equation, due to a higher number of elements that must be handled simultaneously (element interactivity) in working memory.

2.6.2 Extraneous load

Extraneous load is defined as anything in the instructional materials that occupies working memory capacity but is irrelevant to the intended material. Therefore when materials in a course or sentence are high in element interactivity, extraneous cognitive load would be produced (Paas et al. 2003). Extraneous cognitive load could be induced by inadequate instructional designs. Thus when a course is not properly designed before it is presented to the learners. In educational designs, subtitles are even assumed to increase extraneous cognitive loads (Kalyuga, Chandler, Tuovinen and Sweller, 2001).

Students are prone to extraneous cognitive load if they are given volume of notes with more word counts and big terminologies. Instructional designers have dedicated much research to methods of reducing extraneous cognitive load in order to free up space in the working memory for learning and problem solving.

2.6.3 Germane cognitive load

Germane cognitive load refers to the cognitive resources dedicated to constructing new schema in long-term memory (Kruger et al. 2013). Germane cognitive load directly reflects learners' efforts to construct and store schemas during learning as explained in Piaget's theory of assimilation (meaningful learning could only occur if new information is able to fix into an already formed schema). Germane cognitive load increases with student motivation to participate in the learning process. It is therefore the ultimate goal of instructors to plan lessons with low intrinsic and extraneous cognitive load but high germane cognitive load (Paas et al. 2003). This would intrinsically motivate students to learn on their own without being prompted by anyone.

2.6.4 Causes of cognitive load

2.6.4.1 Split attention

According to Burkes (2007), several studies have documented split attention as a cause of cognitive load and that the integration of instructional materials has a significant effect on both learning outcomes and measures of cognitive load. She further posited that closely organised texts would reduce extraneous cognitive load. Because less effort is needed for the integration of related ideas, the searching for and maintaining related information in memory. Split-attention effect holds that the use of materials that require learners to split their attention between two sources of information causes a higher cognitive load on working memory and therefore impedes the learning process (Mayer & Moreno, 2003).

Learning enhancements were also demonstrated when printed text and pictures were physically integrated rather than separated (Moreno & Mayer, 2000). Mayer and

Chandler (2001) examined the temporal aspects of text presentation, in which the pace of text presentation was in focus. In all these cases, it was found that a more closely integrated method of presenting text and pictures resulted in lower measures of mental effort (cognitive load). These findings supported the validity of the split-attention effect on text processing in learning. These studies also demonstrated that removing the effects of split attention influenced cognitive load, and in each case, improved the performance of students.

2.6.4.2 Redundancy of learning materials

Redundancy as described by Burkes (2007) is the duplication of information within the design of instructional materials. In situations where one source of instruction, either textual or graphical, provides full intelligibility, then only one source of instruction should be used. The other sources would be redundant and should be removed from the instructional materials to avoid any mental load. Based on this, different forms of redundancy have been described in literature which includes; Diagram or text redundancy, mental or physical activity redundancy and auditory or visual redundancy.

These studies show that establishing relationships between different sources of information may be difficult for learners dealing with multiple representations and that various forms of redundancy can interfere with learning and should be eliminated (Mayer, 2001). One could therefore make the inference that both intrinsic and extraneous cognitive loads are the major types of cognitive load that could make students under perform. With concept mapping, redundant information could be eliminated since they would not form part of the map.

2.7 The Measurement of Cognitive Load

The analytical approach was developed as strategy to use secondary task measurement to determine mental load. This secondary task technique has also been used in studies by (Brünken, et al. 2003).

However, measurements limited to only secondary task performance may not provide good approximations of cognitive load since a learner may pay for mental load by increasing mental effort thereby maintaining a constant level of performance. Measurements of mental effort are therefore necessary to index cognitive load.

For this reason, the self – rating scale was tried by some researchers. Gimino, (2000) Kalyuga, Chandler, Tuovinen and Sweller, (2001) used various rating scales especially the Paas rating scale in the context of survey questions in which the participant indicated the perceived level of cognitive load.

Although self-ratings may appear questionable, it has been demonstrated that people are quite capable of giving a numerical indication of their perceived mental burden. Since then, several studies have successfully applied this method or an alternative method combining learning effort and test performance.

2.8 Reduction of Cognitive Load

2.8.1 Goal specificity and worked examples

Specific instructional strategies have been recommended by researchers to reduce both extraneous and intrinsic load. For example, instructional techniques such as goal specificity, worked examples, have proven to be some of the most effective ways to reduce extraneous load resulting from the instructional process (Stark, Mandl, Gruber, H., & Renkl, 2002).

2.8.2 Simultaneous presentation of text and images when teaching

In multimedia learning environments for example, Mayer and Moreno (2002) emphasised on using text and images presented simultaneously to enhance comprehension. In addition, they stressed on the importance of the principles in which words are presented as audible narrations than as written or on-screen text. In short, well-integrated, organised and elaborated instruction has proven to be an effective way to reduce extraneous cognitive load and increase germane cognitive load.

2.8.3 Using concept mapping

Concept mapping could also be a good strategy to reduce extraneous cognitive load. This is because it has the capacity to separate relevant concepts and information from irrelevant or chunk information. Meing-Lei (2012) conducted a study on the effect of concept mapping on cognitive load. In that study the results indicated a significant improvement in the reduction of cognitive load thus their mental load and frustrations. Concept mapping was successful in this case because it limited word counts in the text. The amount of element interactivities that could lead to extraneous cognitive load as shown by Gillmor et al., (2015) in this case was also reduced.

2.9 Effect of Reduced Cognitive Load on Students

2.9.1 Increase of students' performance

Cognitive psychologists have built a body of literature supporting the use of Cognitive Load Theory (CLT) to facilitate learning and problem solving. The earliest work, in the late 80s, introduced educational psychology as a set of guidelines to manage the cognitive load of instructional materials to increase performance. Some instructional presentations increase cognitive demands by splitting the attention of the student between two sources of information, while others reduce cognitive load such as providing worked examples. Recently, Clark, Ruth, Nguyen, and Sweller (2011) published a synthesis on cognitive load management techniques. The findings of their work were central to specifying the cognitive load item modifications used in the study. A series of recent studies tested the effects of modified items on the performance of students (Kettler, Stephen and Beddow, 2011). These researchers used modified items on cognitive load theory (CLT). Generally, those researchers found that reduced load items did improve student performance. Reducing the length of the item stimulus seemed to be particularly effective in reducing intrinsic cognitive load (Kettler et al. 2011).

2.9.2 Decrease of learning difficulties of concepts

They also found that reduced load items decreased item difficulty more dramatically for students. Miller (2011) similarly confirms that aesthetically improving test items decreases participant cognitive load while increasing participant satisfaction and performance.

2.9.3 Reducing the cognitive load can also reduce errors

A similar field of research in working memory and problem solving has shown that the limited working memory’s storage contributes to calculation errors during mental arithmetic (Miller, 2011). That is, the more one needs to store in the working memory, the more likely one is to forget bits of information and make errors. These research findings suggested also that test items could benefit from a reduction in numerical and arithmetic complexity (Gorin & Embretson 2006). These researchers also showed that in reading, as the amount of text increased so did the item difficulty due to the increased demands on the working memory. Therefore when text is filled with irrelevant concept, the load on the students increases. Removing the added demand on the working memory will likely improve students' performance.

2.9.4 Reduction of students' anxieties

In addition to improving performance, there are some evidences to suggest that reducing extraneous cognitive load may also alleviate student's stress or anxiety (Miller, 2011). Both anxiety and cognitive load are inversely correlated with student's performance because both factors consume the working memory's processing resources (Chen & Chang, 2009). Ashcraft and Kirk (2001) investigated this concept and found that the aspects of mathematics performance that rely heavily on working memory are the same aspects that are mostly affected by mathematics anxiety. One could therefore conclude that since there is a direct correlation between reduced cognitive load and student's performance, reducing the learning cognitive load would make students perform and achieve better.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter presents a description of the methodology that was employed in this study. It spelt out the techniques and methods of sampling, data collection procedures, analysis, and the area in which the study was carried out. The chapter also highlighted the limitations and problems encountered while collecting the data.

3.1 Research Design

Orodho (2003) defined a research design as the scheme, outline plan that is used to generate answers to research problems. This study was an Action Research which aimed at improving students' achievements in biology by using concept mapping as a strategy to reduce their cognitive loads. According to Alhassan (2009) an Action Research is a problem solving method devoted to the solution of a problem immediately. This involves identifying a problem in a school and using appropriate interventions to rectify it. Again an action research fosters an informed decision - making and systematic problem solving among practitioners. Action research has thus been found useful for this study due to these reasons.

This study was inclined to the use of qualitative methods of data collection and analysis. According to Sidhu (2009) a qualitative study is a study in which the description of observations is not ordinarily expressed in quantitative terms. In other words, qualitative research explores a social issue and build a complex and holistic approach analysing words rather than numbers and providing detailed information on the view of the participants and their natural settings. This information gathered reflects the experiences, feelings or judgement of the individuals taking part in the research. In collecting the qualitative data for the study, the Researcher used observations and reported the behavours, of the respondents.

The whole of the study was guided by the three research questions that were formulated by the researcher in chapter one.

3.2 Study Area

The study was carried out in St. Dominic's Senior High and Technical School. The school is located in Kwahu – Pepease, in the Kwahu East District of Ghana.

3.3 Population

A research population is a large well defined collection of individuals or objects having similar characteristics (Alhassan, 2009). According to him, there are two types of populations, accessible and target population. The target population is the group of individuals to whom the researcher is interested in generalising his research findings whiles the accessible population is the group the researcher can apply the findings.

The target population for this study was all biology students in the school. However, the data assembled in this study came from all the form one biology class as this was the class the Researcher teaches.

3.4 Sample and Sampling Technique

A sample is the sub group of the entire population studied (Sidhu, 2009). The process of selecting a sample for a study is sampling and the strategy used by the researcher to select samples of the population is the sampling technique. The sampling techniques available are categorised into probability, non - probability and purposive sampling (Creswell, 2005).

The work of Creswell (2005) stated that, probability sampling is the type of sampling in which participants are given equal opportunities to be selected at random. This strategy is categorised into simple random, systematic, stratified and cluster sampling techniques. Purposive sampling technique is the deliberate choice of participants in a research study due to the qualities and characteristics the participants possess and concentrate on those individuals to assist with the study (Sidhu, 2009).

Non probability sampling according to the researchers Blaxter, Hughes, & Tight, (2006) is that sampling type where the researcher select samples base on the subjective judgement of the researcher. This involves identification and selection of individuals that are well-informed with a phenomenon of interest. Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of their knowledge and experiences. Convenience sample and purposive sampling are examples of non – probability sampling technique. In this study, the Researcher used convenience sampling to select an intact class of 60 students for the study because the Researcher teaches that class and has found this peculiar problem of cognitive load among the students.

3.5 Research Instrument

The instrument used was the student's observation. Observation is one of the instruments for collecting qualitative data where the researcher interacts with the participants in their natural settings to see and collect data (Bell, 2008). Observation can be categorised into two: systematic/structured observation and participant/ structured observation. In participant observation, the researcher spent more time with the participants in their natural settings to observe and record their ways of living. The Researcher in this study, spent time with the students in class and taught them how to construct concept maps correctly. The Researcher also taught classification of plants using teacher- made or expert-made concept map. The behaviour of the students in class during the lessons were observed and recorded as they constructed their own concept maps on classification of plants. The Researcher also marked the students' concept maps drawn in their exercise books by comparing it with that of the Researcher's or expert's or teacher's own to assess how well the students constructed their concept maps. This approach of making the Researcher an overt observer was to avoid ethical consents about participant's privacy and making the student more comfortable.

3.6 Scoring of the Concept Map

Linkage analysis was used to assess the concept map drawn by the students. Here the Researcher and an expert in the field constructed concept map on classification of organism. Comparisms were made between those constructed by the students and the Researcher's to check for misconceptions, wrong links and confused concepts. For instance, if a concept A in the student's map is linked to a set of concepts C while the Researcher's map contains a concept B that is mostly connected to most of the concepts in C, then the student may be confusing B with A. In this case, A is said to be a confused concept. If a student incorrectly links a concept A to a set of concepts C, while in the Researcher's map, a concept B is connected to the concepts in C, then it can be suggested to the student that A may have to be substituted to B. Linkage analysis can also identify less obvious misconceptions. For example, when a concept E is correctly linked to other concepts in set D, but the concepts in D, are incorrectly linked, then the student may have misunderstood E in the first place. The lesser the misconceptions and confused statements, the better the concept map constructed.

3.7 Data Collection and Analysis

The students sampled for the research were taught how to construct concept maps for the first period of the five intended period for the study. In the course of the study each period lasted 30 minutes. After the first period, the sampled students were then taken through lessons in classification of plants for the remaining four periods. All lessons were guided by a teacher-made concept map. In all, the lessons were undertaken in five days in order to minimise pressure on the students.

During the study, the Teacher provided the class with a chart showing different kinds of plant species. The Teacher again asked students to list some characteristics or features of the plants they observed. The students were made to construct detailed concept maps on classification of plants individually from their own observations which were marked using the linkage analysis. The results of the students were analysed to enable the Researcher know how well each student constructed his or her map.

To determine whether the method used in teaching, had any impact on the students' cognitive loads, the Researcher in the course of the lessons, observed the concept maps drawn by the students. Additionally the behaviours of the students in class were also observed and recorded. These observations that were done by the Researcher were discussed.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

This chapter presents the results or answers to the research questions in chapter one of this study. It also discusses the meanings of the results. The results obtained were observations made by the Researcher from all the concept maps drawn by the students and answers students gave to evaluation questions.

4.1 Research Question 1

How did students construct concept map on classification of Plants?

This question was posed by the Researcher to find out the processes that the students used to construct the concept maps after they had been taught the topic "classification of plants"

Activities

The students listed the following as words they remembered from their previous knowledge of Plants when the chart on Plants was shown to them in class: "*vascular bundles, flowers, leaves, stems, Corniferophyta, Angiospermophyta, Cycadophyta, Bryophyta and Filicinophyta, roots, leaves and fruits*"

The students linked the key word '*Plant'* with arrows which extended downwards to the next most important concepts *vascular bundles* and *flowers* with the phrases: "*presence or absence of vascular bundles and presence or absence of flowers"* Those words were also linked to concepts: *Corniferophyta, Angiospermophyta, Cycadophyta, Bryophyta and Filicinophyta.* The students again connected the words:

Monocotyledonae, and *Dicotyledonae* to *Angiospermophyta,* with characteristics of plants like *taproot, fibrous roots, and broad leaves. Needle-like leaves, cone bearing fruits, microscopic leaves* and *spore bearing leaves* were also linked to the concepts *Corniferophyta, Cycadophyta, Bryophyta and Filicinophyta* respectively as shown in fig.3 (appendix).

At each level, link words and linking phrases such as, *grouped as, classified as, divided into, presence of, absence* of etc. were used by students to connect concepts to each other until the specific examples: *beans, grass, moss, and ferns* were also connected. The Researcher then marked the concept map of individual students by comparing to the Teacher-made concept map.

Below were the results the Researcher observed from the students map:

The students were able to identify "*Plant*" as the broader concept, *Monocotyledonae, Dicotyledonae, Angiospermophyta, Cycadophyta, Bryophyta, Filicinophyta* and *"beans, moss, grass, cycads and fern"* as the specific concepts.

They were able to place the broader concept "*Plant*" at the top of the concept map with concepts *Monocotyledonae, Dicotyledonae, Angiospermophyta, Cycadophyta, Bryophyta, Filicinophyta* as the intermediate concepts and then the concepts "*beans, moss, grass, cycad and fern"* at the bottom of the map as specific examples.

The students were also able to arrange the concept hierarchically. The general concept '*Plant'* was linked to specific concepts: *beans, grass, moss, cycads* and *maize*.

Correct prepositions, linking words and linking phrases were connected to concepts making the whole concept map understandable as shown in Fig.1 and Fig. 2 and Fig.3.

Discussions

With reference to the results obtained from the students above, student constructed the concept maps correctly. This is because a correct concept map according to Novak and Cañas (2008) is one that has concepts enclosed in circles or boxes where the relationships between concepts are indicated by connecting lines linking two concepts. Also, words on the lines, called linking words or linking phrases, specify the relationship between two concepts. Additionally, all concepts must be arranged in a hierarchical fashion with the most general concepts at the top of the map and the more specific, less general concepts arranged below. Finally, to the researchers, specific examples of events or objects must be included in the maps that would help the students to clarify the meaning of a given concept.

One can conclude therefore that students in this study, constructed their maps well since all the maps by students had the features of a good concept map proposed by Akeju et al. (2011); Kinchin, (2000); Novak and Cañas (2008).

4.2 Research Question 2

What role did concept mapping play in reducing cognitive load of the students?

The Researcher posed this question to find out the roles concept mapping played in helping to reduce the cognitive load of the students. In doing so, the Researcher observed the concept maps that the students constructed and the responses the students gave during the study.

The following observations were made:

- **The numbers of words in the students' constructed concept maps were reduced**

Discussions

The concept maps constructed by students helped them to summarise the information they needed to learn even though all relevant concepts were present. For instance, Fig.1 and fig.4 (in appendix, which represented the concept maps of students NO.1, and NO. 4) used arrows with linking words or phrases to indicate relationships between concepts. The use of arrows instead of words, reduced the number of words and sentences that would have been used to explain these relationships. This then also reduced the number of words used to construct the concept maps and the amount of words that would have consumed the capacity of the working memory of the students. This could be the reasons why in the works of Kinchin (2000), the students who used concept mapping to learn were able to summarise the information that was given them.

- **Students were able to identify and correct their misconceptions**

Discussions

The concept maps constructed by the students were marked by comparing to that of the Teacher. In this case all confused and alternate concepts in the student's map were detected and corrected for them. This is in agreement to the works of Liu et al. (2005), who stated that when students compare their concept maps to their teacher's, their misconceptions are detected easily and corrected.

- **Students were able to recall learned concepts correctly**

Activity

Teacher asked students to list two characteristics of Class Monocotyledonae as an evaluation question at the end of the lesson.

Answers from students to question:

Student No 13: Monocotyledonous plants have one seed coat. They also have fibrous roots.

Student No 1: They are flowering plants with only one cotyledon.

Student No 23: Monocotyledonous plants have vascular bundles. They have one seed coat.

Discussions

The students above were able to answer the questions correctly because they were able to use concept map to present concepts (concrete and abstract) graphically and visibly. This helped the students to visualise the relationships between the concepts and understood them. This might be connected with the ideology that what is heard is often forgotten, whiles what is seen and what is practiced is easily remembered as described by Akeju et al. (2011). In this instance, the students constructed their maps well, and were able to visualise the concepts and remembered them when it was needed. This is in support of Ajaja (2011), who posited that students who used concept mapping as a study tool retained biological knowledge longer than those who used other methods and considered it to be a good learning tool.

- **Concepts were hierarchically arranged in the students' constructed concept maps**

Discussions

The concept map constructed by students presented concepts in a sequential and hierarchical manner that helped improved the understanding of the students. According to Clark et al. (2005), when information are arranged logically and sequentially for students, they are able to understand and make meanings from them. This is because concept do not exist in isolation but depend on others for clarity (Bennett, 2003). For instance, the students were able to identify "Plant" as the broader concept in their map, followed by Monocotyledonae, Dicotyledonae, Angiospermophyta, Cycadophyta, Bryophyta, Filicinophyta (being the Class of plants) as the intermediate concepts. Also "*beans, moss, grass, cycads* and *fern*" as the specific examples in that order. This orderly arrangement of facts with linking phrases used to connect concepts at each level, made concepts clearly understood.

4.3 Research Question 3

What is the effect of concept mapping on the performance of students?

This research question was asked to find out the effects concept mapping, as a teaching and learning methodology has on the academic achievements or performance of the students after the study.

Activity

The question: State two characteristics upon which plants are classified into their Divisions was posed by the Teacher.

The student's results from the above evaluation questions were collected as data and commented on as follows;

Question: State two characteristics upon which plants are classified into their Divisions?

Answers from students to question above:

Student No. 2: They are grouped into Division based on the present or absence of vascular bundles.

Student No.10: In my opinion it is based on the ability to produce flowers

Student No. 20: I also believe it is based on the structure of the plant such as having needle like leaves.

Student No. 21: Itcan also be based on the types of fruit produced. Example fruits with naked seeds.

Findings

- Concept mapping helped students to perform well in class.
- It also make students to participate actively in class.

➢ **Concept mapping helped students' to performance well in class**

Discussions

Students were able to answer majority of the evaluation questions posed to them correctly after the lessons. The reason was that concept mapping helped students to keep some facts into memory and reduced the rate at which they forget concepts because concepts were visually represented in their memories. According to Ajaja (2011), students who used concept mapping as a study tool retained biological knowledge longer than those who used other methods because of the visual presentation of facts. The works of Adeneye and Adeley (2011) showed also that students are able to differentiate salient concepts from series of concepts needed to study when they draw concept maps. This is because words that were likely to interfere with those salient points which could lead to the students forgetting the salient points were removed. In this case, students were able to concentrate on those salient points and study them well a reason why they were able to answer the questions correctly and as such they improved upon their performance in the class after one week of the study.

- **Concept mapping served as an opportunity for active involvement of students in their learning process**

Discussions

During the lesson, students constructed their own maps from their previous knowledge about plants. They also crossed checked their drawn concept maps with colleagues. By doing so, they share ideas amongst themselves. They again compared their maps to that of the Teacher and so corrected their wrong concepts and misconceptions.

In all these cases, students found knowledge for themselves with the teacher as their facilitator. This method of making the students the centre of the whole learning experience or the students' centred learning approach enhanced the thinking ability of students to enable them find for solutions themselves. These positions could be why Bennett, (2003) stated that concept mapping as a teaching methodology, actively engages students in the learning process.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, ND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the study, findings from the study and conclusions made by the Researcher. The chapter also looks at recommendations made by the Researcher to all stakeholders of science education and to biology teachers in particular. Suggestions for further research were also highlighted in this chapter.

5.1 Summary of the Study

The main reason for this study was to find out the impact concept mapping play in an attempt to reduce student's cognitive loads. The study also sought to find how well students constructed concept map on classification of plants.

In dealing with these issues students from St. Dominic Senior High School were used for the study. The instrument used was observation which lasted for one week. The data in this case came from the results of marked students' own drawn concept maps.

5.2 Summary of Key Findings from the Study

The major findings that came out from this study were as follows:

1. In an attempt to reducing students' cognitive loads, students were able to use concept mapping as a tool to summarise notes or information which reduced the amount of words needed to have been learned by the students. In this way

extraneous cognitive loads associated with learning is reduced to enable students perform better.

2. It was found out from the study that misconceptions and alternate conceptions associated with students learning were detected and corrected easily by the students when they used concept mapping as a learning strategy.
3. The study revealed that the students were able to keep facts and concepts in memory for longer periods when they learned with concept mapping. This was evident in the students' ability to recall and answer correctly the evaluation questions after the one week of the lesson.
4. Additionally, the study revealed that students were able to use concept mapping to arrange concepts in an orderly manner for easy learning and understanding.
5. The use of concept mapping as a teaching strategy engaged students in the teaching and learning process thereby making them acquire knowledge for themselves. This is because the students constructed their own maps, cross checked their maps with that of the teacher and colleagues and so corrected their wrong concepts.

5.3 Conclusions

It can be concluded that concept mapping has helped form one biology students of St. Dominic Senior High School to reduce their cognitive loads by reducing the amount of words needed to be learned, reducing student's misconceptions and clarifying concepts. Also it has helped students arrange concepts in an orderly manner for easy understanding and recall of learned concepts.

St. Dominic Senior High School students were excited during the teaching periods especially when they constructed their own concept maps correctly. They claim they now feel confident and motivated to learn biology.

5.4 Educational Implications

The above conclusions show that concept mapping can help reduce the rate at which students forget concepts in class and in examinations thereby increasing performance. More so, more topics could be treated on time with the use of concept mapping since irrelevant information that often times waste time and consume the working memories of students are reduced drastically. Concept mapping also has proven to be a good strategy to help promote group discussions in class. It is therefore appropriate that science teacher especially biology teachers adopt concept mapping as a methodology to teach biology for conceptual understanding and improved performance.

5.5 Recommendations

The following were some recommendations of the Researcher;

1. Biology teachers of St. Dominic Senior High School should adopt the use of concept mapping as a teaching methodology to teach biology in the School to motivate the students to learn on their own and achieve better results.
2. It was evident from the study that concept mapping helped the students to summarise information to be learned. It is therefore recommended that biology teachers use concept mapping teaching strategy to summarise topics in biology for students to learn so as to reduce the learning loads on students.
3. It was found out from the study that the use of concept mapping helped students to remember fact better and reduce the rate at which they forget information.

It is recommended that biology teachers should use this approach to help student to remember what they learn to promote better results.

5.4.1 Recommendations for further studies

1. It is also recommended that further studies should be conducted on the same topic "Impact of concept mapping in reducing cognitive loads of students" where larger sample sizes would be used.
2. The same topic could be replicated in different schools to find out if the observations made and the effects on St. Dominic's students would be the same in different areas.

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APPENDIX A

STUDENTS' CONSTRUCTED CONCEPT MAPS ON CLASSIFICATION OF PLANTS

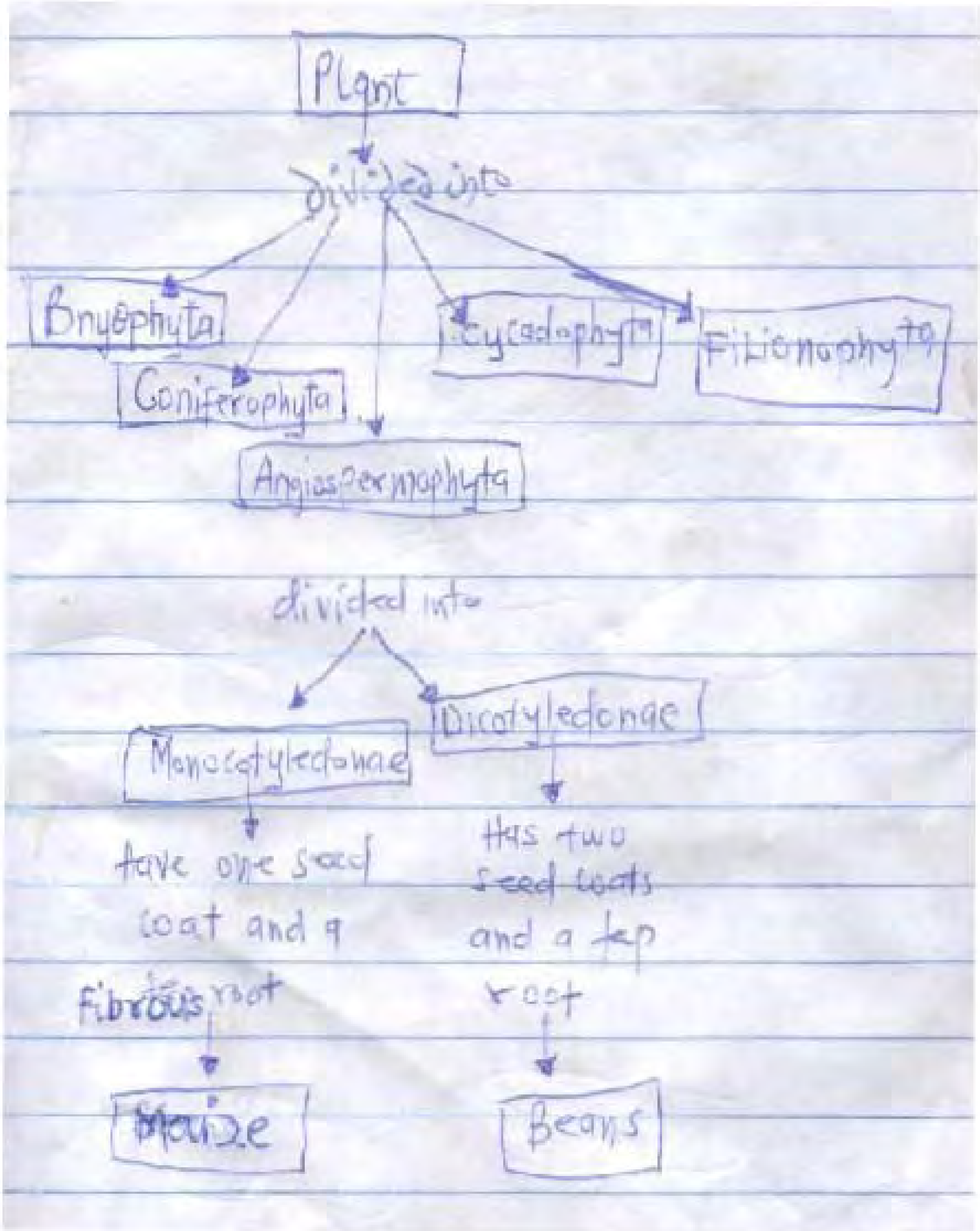


Fig. 1 Concept map of student NO. 1

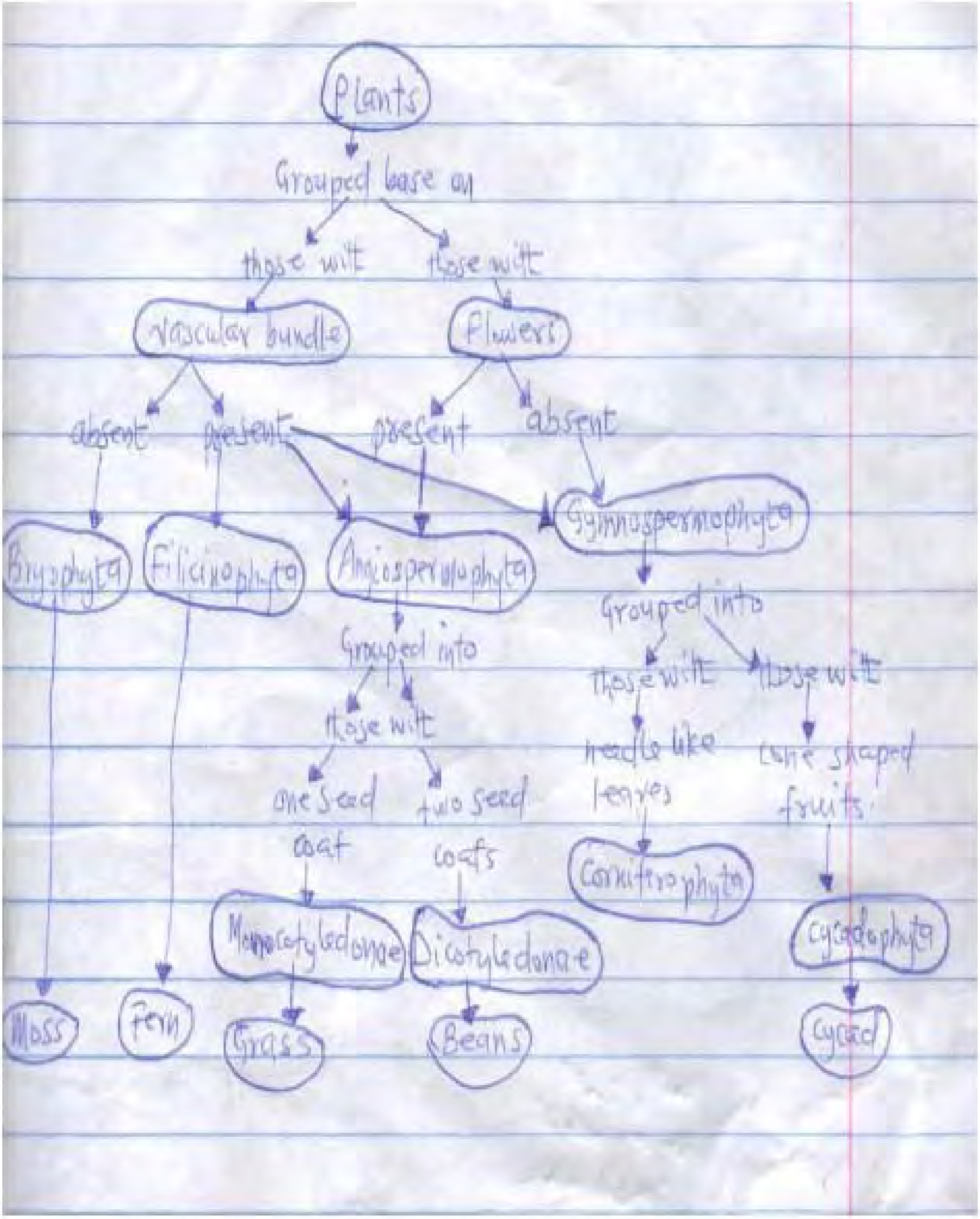


Fig.2 Concept map of student NO.2

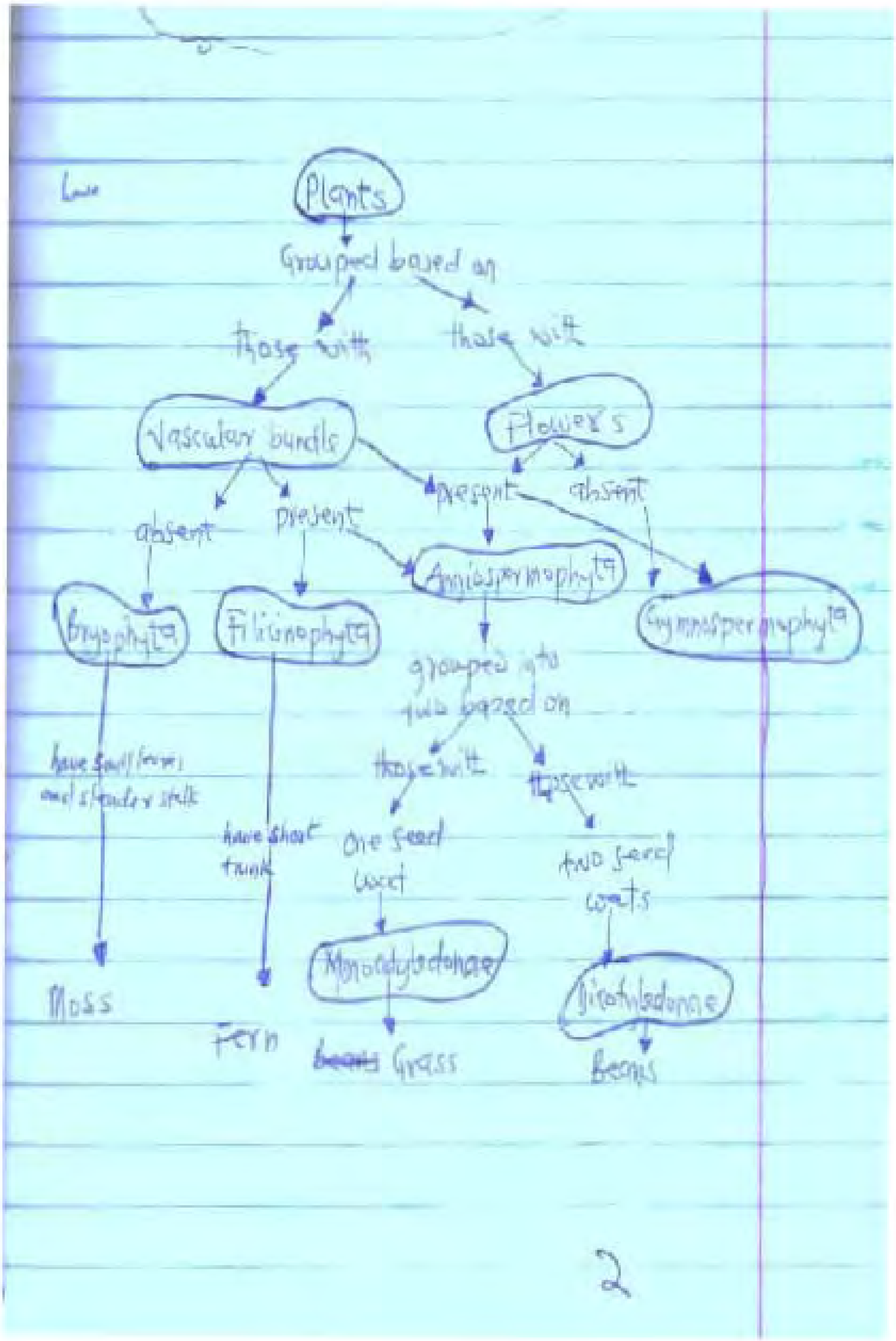


Fig.2 Concept map of student NO.3

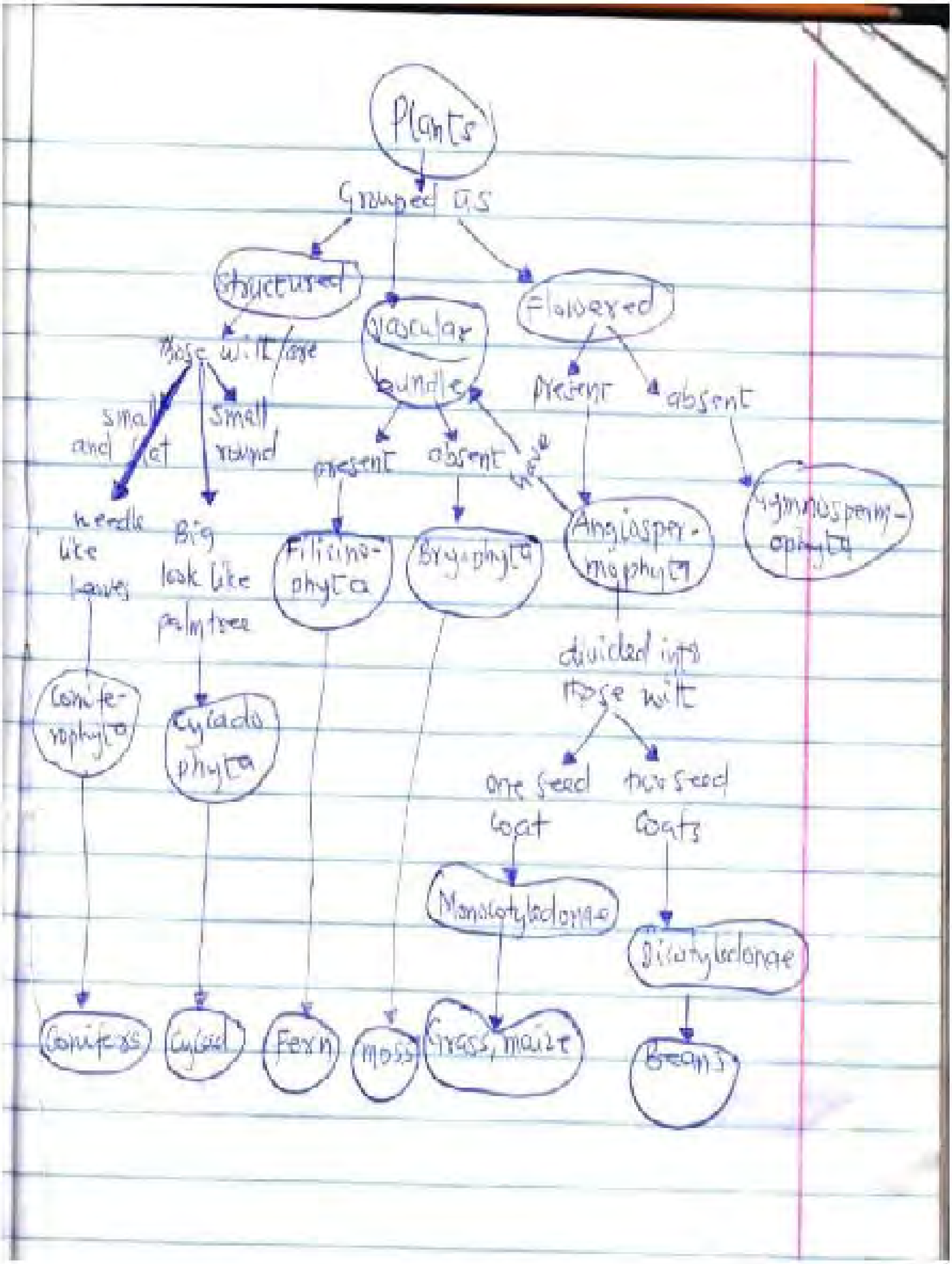


Fig. 4 Concept map of student NO. 4

APPENDIX B

TEACHER- MADE CONCEPT MAP

APPENDIX C

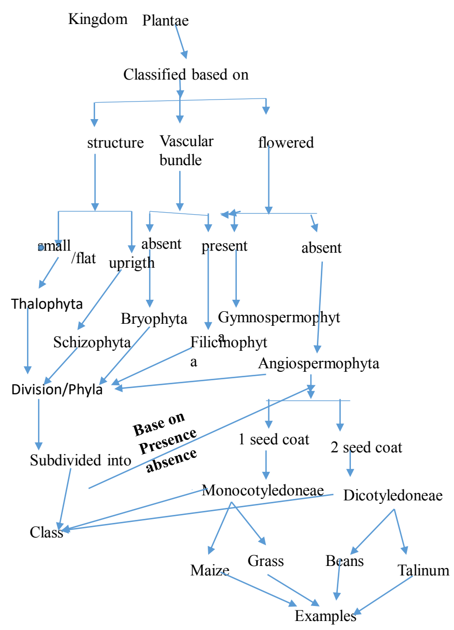
LESSON PLAN 1

THE IMPACT OF CONCEPT MAPPING ON REDUCING COGNITIVE LOAD OF STUDENTS

SUBJECT: BIOLOGY **CLASS SIZE:** 60
CLASS: FORM 1 **AVERAGE AGE:** 17 YRS
REFERENCE: Mader, S. S.(1958). *Biology: Evolution, diversity and the environment*. Iowa, Wm. C. Brown Publishers.
DATE: 20/09/2016 and 22/09/2016

DAY/ DURATION	**TOPIC/ SUBTOPIC**	**RPK/ OBJECTIVES**	**TLM'S**	**TEACHER LEARNER ACTIVITIES**	**CORE POINTS**	**EVALUATION/ REMARKS**
DAY MONDAY/ WEDNESDAYS	**TOPIC** Classification of Plants	**R.P.K (RELEVANT PREVIOUS KNOWLEDGE)**		**INTRODUCTION**		**EVALUATION**
TIME 12-30pm	**SUBTOPIC** Kingdom Plantae	Students are aware that Living organisms are things that can respire, grow, reproduce, move, excrete They also know that organisms are place into five kingdoms namely Plantae, Animalia, Prototista, Prokaryotae and Fungi	Pictures Charts Grass *Talinum* Ants, Moss, Fern	**a**. Teacher uses questioning and answering technique to help the student to brainstorm on what living things are.	**a**. Living organisms perform all life activities. Eg, plant and animals	1.What is a living organism?

		OBJECTIVES By the end of the lesson, the student should be able to		**DEVELOPMENT**	Ants, grass, *Talinum*, etc	
		1.Explain classification		1. Teacher put students into six groups of ten each and ask them to go and sample organisms from school compound. 2. Teacher asks students to separate their organism into groups based on their common features and characteristics. Teacher explain to student that they are doing classification. 3. The teacher then explain the reasons for classifying organisms to the student.	The placing of organisms into groups base on their common characteristics and differences between them is classification **Importance** A. easy communication between scientist. B easy identification C show a trend in evolution. Etc.	1.List three examples of living things. 2 a. What is classification of organism? b. State two importance of classification
		2. List at least two characteristics of the Kingdom Plantae		1. Teacher again ask students to further separate those classified as plants into other groups base on their common characteristics and features and state the basis of their groupings.	The features used are , structure of plant, presence or absence of flowers, nature of seed if present, presence or absence of vascular bundles	4.a. List with examples the divisions of Plantae.

		3.Construct a concept map of classification of Plants showing crosslinks, linking words or phrases		2. Teacher then construct concept map to show how organisms are classified under the various divisions and how they are related to each other with reference to plantae.			
					**<u>Characteristics of Kingdom Plantae</u>** . They are multicellular . Have cell wall . Have a definite shape . Vascular bundles may be present . May be flowering or non-flowering **<u>Division of Kingdom Plantae</u>** **1.Cycadophyta** a. Look like a palm tree b. Lack fruits c. Stem is very short Eg. Cycad 2.Coniferophyta	5.State three characteristics of Plantae 6. State three characteristics of Angiosper-mophyta **REMARKS** **Lesson was Successful..**

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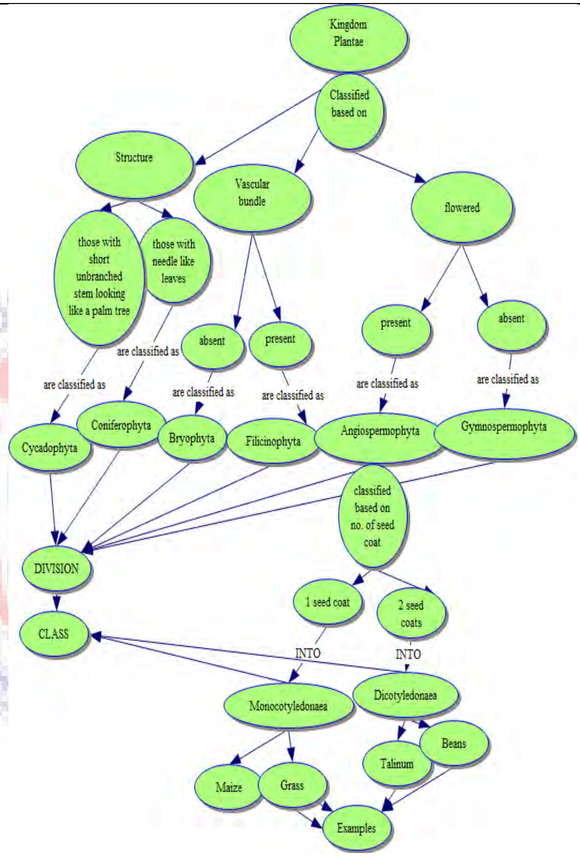
<td>
</td>
<td>a. Have needle like leaves
b. Lack fruits
Eg. Pines, Cedar
3.Bryophyta
a. Body is flat
b. Lack vascular bundles
c. Have rhizoids
Eg. Moss
4.Filicinophyta
a. Has vascular bundles
b. Have (spores) sporangia under mature leaves
Eg. Fern
5.Angiospermophyta
a. Bear flowers
b. Have vascular bundles
Eg. Beans
Talinum
6.Gymnospermophyta
a. Lack flowers
b. Have vascular bundles.
Eg. Maize, grass</td>
<td></td>
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</table>

				CLOSURE Students were able to explain classification. They were able to classify a known plant *(Talinum)* to its Class and list some characteristics at each taxonomic rank.		

LESSON PLAN 2

SUBJECT: BIOLOGY **CLASS SIZE:** 60

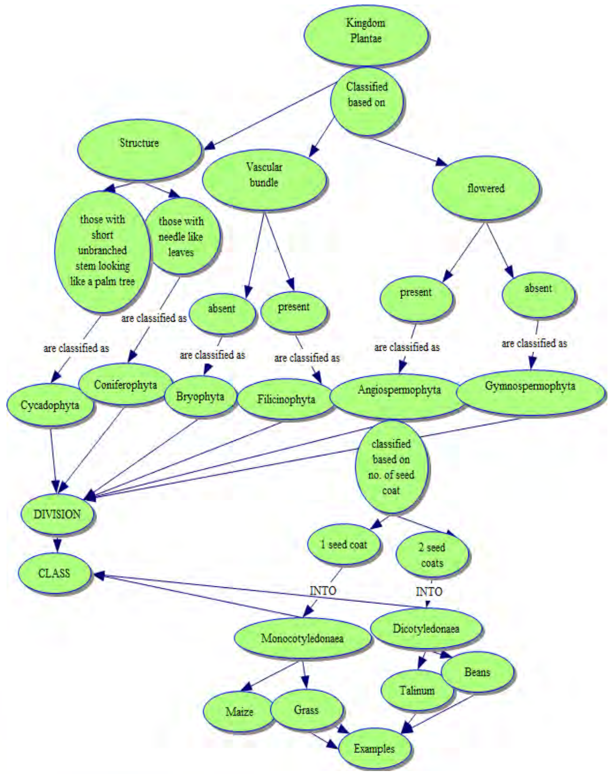
CLASS: FORM 1 **AVERAGE AGE:** 17 YRS

REFERENCE: Mader, S. S.(1958). *Bology: Evolution, diversity and the environment*. Iowa, Wm. C. Brown Publishers.

DATE: 24/09/2016 and 27/09/2016

DAY/ DURATION	**TOPIC/ SUB-TOPIC**	**RPK/ OBJECTIVES**	**TLM'S**	**TEACHER LEARNER ACTIVITIES**	**CORE POINTS**	**EVALUATION/ REMARKS**
DAY **THURSDAY/FRIDAY**	**TOPIC** Classification of organisms	**R.P.K (RELEVANT PREVIOUS KNOWLEDGE)**		**INTRODUCTION**		**EVALUATION**
TIME 12-30pm	**SUB TOPIC** Kingdom Plantae	Students are aware that Living organisms are things that can respire, grow, reproduce, move, excrete They also know that organisms are place into five kingdoms namely Plantae, Animalia, Prototista, Prokaryotae and Fungi	Pictures Charts Grass *Talinum* Ants, Moss, Fern	1. Teacher uses questioning and answering technique to help the student to brainstorm on what the characteristics of living things are.	**a**. Living organisms perform all life activities. Eg, plant and animals	1.What is a living organism?

		OBJECTIVES By the end of the lesson, the student should be able to		**DEVELOPMENT**	Ants, grass, *Talinum*, etc	
		1.List all the Divisions of Plantae		2. Teacher uses questioning and answering technique to help the student to brainstorm on the divisions of Plantae with a chart showing kinds of Plants.	a. tress b. grass.	1. State three characteristics of Angiosper-mophyta
		2. State the characteristics of the various Divisions of Plant		3. Teacher again ask students to list two characteristics of the plants named above.	**Characteristics of Kingdom Plantae**	2. Construct concept map on classification of Plant.
		3.Construct a concept map of classification of Plant with the students gave characteristics		4. Teacher then taught students to construct concept map on Plants to show how they are classified under the various Divisions with the characteristics students observed from above.	• . They are multicellular • . Have cell wall • . Have a definite shape • . Vascular bundles may be present • . May be flowering or non-flowering	

				 	**<u>Division of Kingdom Plantae</u>** **1.Cycadophyta** Example; Cycad 2.Coniferophyta Example Pines, Cedar 3.Bryophyta Example. Moss 4.Filicinophyta Example Fern 5.Angiospermophyta Example Beans and *Talinum*	

				CLOSURE Students were able to explain classification. They were able to list all the Divisions of a plant.	**6.Gymnospermophyta** Example. Maize, grass	**REMARKS** **Lesson was Successful.**

LESSON PLAN 3

SUBJECT: BIOLOGY **CLASS SIZE:** 60

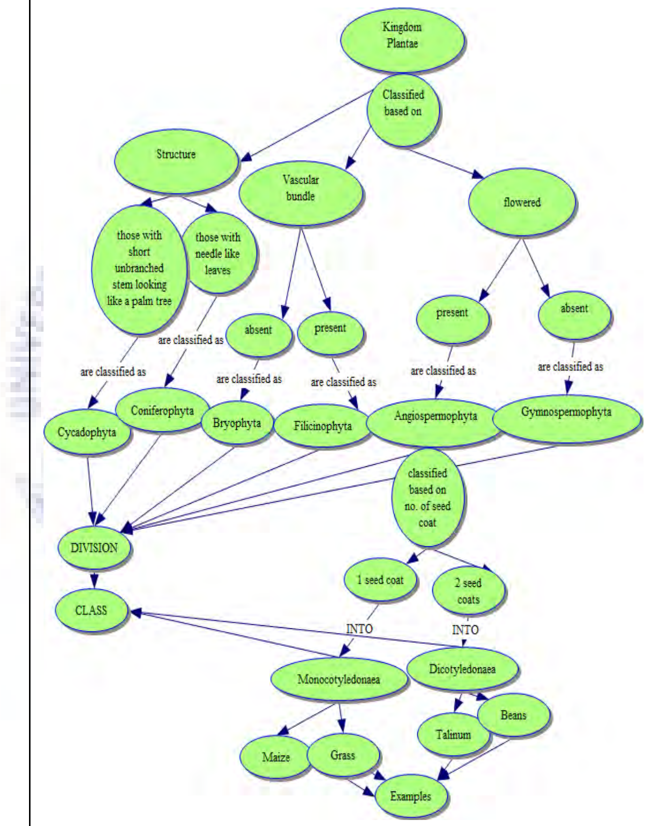
CLASS: FORM 1 **AVERAGE AGE:** 17 YRS

REFERENCES: GAST, AKIOLA

DATE: 30/09/2016

DAY/DURATION	TOPIC/ SUBTOPIC	RPK/ OBJECTIVES	TLM'S	TEACHER LEARNER ACTIVITIES	CORE POINTS	EVALUATION/ REMARKS
DAY TUESDAY	**TOPIC** Classification of organisms	**R.P.K (RELEVANT PREVIOUS KNOWLEDGE)**		**INTRODUCTION**		**EVALUATION**
TIME 12-30 pm	**SUBTOPIC** Kingdom Plantae	Students are aware that organisms are place into five kingdoms namely Plantae, Animalia, Prototista, Prokaryotae and Fungi	Pictures Charts Grass *Talinum* Ants, Moss, Fern	1. Teacher uses questioning and answering technique to help the student to brainstorm on the divisions of Plantae.	**a**. 1.Cycadophyta 2.Coniferophyta 3.Bryophyta 4.Filicinophyta 5.Angiospermophyta 6.Gymnospermophyta	1. What is a living organism?

		OBJECTIVES By the end of the lesson, the student should be able to ;		**DEVELOPMENT**		
		1. List all the Divisions of Plantae 2. List at least two characteristics each of the Division of Plantae 3.Construct a concept map of classification of Plants		2. Teacher guides students to use concept map drawn to answer the evaluation question on the various divisions of Plantae and how they are related to each other.	<u>**Division of Kingdom Plantae**</u> **1.Cycadophyta** a. Look like a palm tree b. Lack fruits c. Stem is very short Eg. Cycad **2.Coniferophyta** a. Have needle like leaves b. Lack fruits Eg. Pines, Cedar **3.Bryophyta** a. Body is flat b. Lack vascular bundles c. Have rhizoids Eg. Moss **4.Filicinophyta** a. Has vascular	1. State three characteristics of Angiosper-mophyta.

					bundles b. Have (spores) sporangia under mature leaves Eg. Fern **5.Angiospermophyta** a. Bear flowers b. Have vascular bundles c. Have one or two seed coat Eg. Beans Talinum **6.Gymnospermophyta** a. Lack flowers b. Have vascular bundles.	**REMARKS** **Lesson was Successful.**