UNIVERSITY OF EDUCATION, WINNEBA

COMPARING THE EFFECTS OF CONCEPT MAPPING AND CO-OPERATIVE INSTRUCTIONAL APPROACHES ON THE COGNITIVE ACHIEVEMENT OF SENIOR HIGH SCHOOL STUDENTS IN EXCRETION

MARY OKYER

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MARY OKYER

A Thesis 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 award of the Master of Philosophy in Science Education Degree.

OCTOBER, 2016

DECLARATION

STUDENT'S DECLARATION

I, Mary Okyer, declare that this Thesis, with the exception of the 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

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

Name of Principal Supervisor: Prof. Yaw Ameyaw

Signature: …………………………………………………………………………

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Signature: ………………………………………………………………………….

Date:………………………………………………………………………………..

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DEDICATION

To my son, Jil Siisi Bruce

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GLOSSARY

[Operational Definition of Terms]

The key terms: co-operative learning, concept mapping, misconception and performance used in the study have been operationalised as follows.

i. **Co-operative learning:** Co-operative learning as used in this study is the instructional strategy in teaching excretion. It involves the use of heterogeneous small groups of students who work together to maximize each other's learning (Igboanugo, 2013). It is also used as a tool to correct SHS2 students' misconceptions about excretion. Further, it is one of the independent variables which will influence the students' performance in excretion.

ii. **Concept mapping**: Concept mapping was originally developed by Joseph D. Novak in the 1960s**.** It is a visual tool for generating and organising ideas. In this study concept mapping is used as an instructional tool in teaching excretion. It is also used as a tool to correct SHS 2 students' misconceptions about the topic excretion. It is the other independent variable which is being verified if it has effect on students' performance in excretion.

iii. **Misconception**: Misconceptions are also called pre-conceptions, naïve conceptions, naïve theories, alternative conceptions and alternative frameworks (Blosser, 1987). In this study misconception is operationalised as inappropriate pre-existing ideas about excretion, held by students who entered this study which are not inaccordance with scientific explanations.

iv. **Performance**: Performance means using knowledge acquired in a very distinguished way rather than merely possessing it. It is a level of achievement or success. Performance in this study is operationalised as the level of achievement of students (by scores) in the teacher-made achievement test in excretion. That is, how well a student does in the test.

ABSTRACT

The primary focus of the study was to determine the effectiveness of concept mapping and cooperative learning as instructional approaches on students' performance in excretion. It was also to explore the extent to which concept mapping and cooperative learning as instructional approaches improved students' conception in excretion.The quasi-experimental design of non-equivalent pre-test-intervention-post-test with two intact biology classes was employed. Purposive sampling technique was used to select 76 SHS 2 students. The instruments used for data collection were Achievement Tests (General Knowledge in Biology Performance Test (GKBPT)) and Students' Performance Test in Excretion (SPTE) with K-R 20 reliability coefficients of 0.812 and 0.866 respectively, class exercises and homework/assignments. Point Biserial Correlation, Wilcoxon Signed Rank test, effect size, chi-square and ANCOVA test were employed to analyse the quantitative data collected through the students' achievement score. The study showed that the students taught with concept mapping approach and their counterparts taught with co-operative learning approach had significant improvement in the performance of the achievement test in excretion, however there was no significant difference in the performance of the two groups. The result rather indicated that the use of co-operative learning as an instructional approach made students perform homogenously in the post-test than the concept mapping instructional approach. The study indicated that there was no statistically significant relationship between the instructional approach the students received and their correct conceptions of excretion. Based on these results, educational implications for classroom practices as well as recommendations and suggestions for further studies were made.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter covers the background to the study, statement of the problem, purpose of the study, research questions, hypothesis, significance of the study, delimitations, limitations of the study and organisation of the study.

1.1 Background to the Study

Biology is a natural science subject comprising curriculum content from microscopic organisms to the biosphere in general, encompassing the earth's surface and all living things (Okwo & Tartiyus, 2004). Considering its fundamental characteristics and importance, it is now a standard subject of instruction at all levels of our educational system, from pre-primary to tertiary. Essentially, it could be considered as one of the core science subjects at Senior Secondary School Certificate Examination (SSSCE), whose study is very relevant to man's successful living (Akindele, 2009). Biology occupies a unique position in the school curriculum, and is central to many science related disciplines such as medicine, pharmacy, agriculture, nursing and biochemistry. The knowledge of biology, chemistry and physics which have been crystallised into concepts, empirical laws and theories form the basis of our material comfort. The knowledge of biology contributes to scientific literacy so that people can understand the world around them and enable them to make informed choices about their health care, their environment and the society in which they live (Karen, 2008). As we entered the 21st century and expected better health for all, abundant food for all, better knowledge of man, animals and plants, and less polluted environments with sulphur (IV) oxide and radioactive substances, there is the need to effectively teach and learn biology to meet these challenges.

The sensitive position biology occupies in medical sciences, environmental sciences and other related disciplines has informed several efforts geared toward studying biology at the secondary level of education in many parts of the world, including Ghana. Hence, it is one of the science subjects one must pass to qualify to pursue some science courses at the tertiary level of education. For these reasons, the Biology Teaching Syllabus (Ministry of Education, MoE, 2010) for senior high schools (SHS) in Ghana, aims at assisting the learner to appreciate the diversity of living things; understand the structure and functions of living things; develop scientific approach to solving personal and societal (environmental, economic and health) problems, develop practical skills required to work with scientific equipment, biological materials and living things; collect, analyse and interpret biological data and also present data graphically. It also focuses on making biology students aware of the existence of interrelationships between biology and other scientific disciplines; appreciate and understand the interrelationships between organisms and themselves and with the environment, and sustain their interest in studying biology.

Despite the importance of the knowledge of biology for socio-economic development of a country, it has been reported that performance in biology at SHS level has been poor in most parts of Sub-Saharan Africa and Ghana is no exception (Ahmed, 2008; Dzidzinyo, Bonney & Davis, 2014; Ministry of Education, Kenya, 2005). Ahmed (2008) reported that biology is popular among Nigerian students, yet their performance in it at the secondary school level is low. The situation is not different in Kenya. For instance, the Ministry of Education of Kenya in 2005 indicated that there is a decline in the performance of students in biology.

In Ghana, many students who sit the SSSCE in the sciences, specifically, biology, do not perform as expected (Dzidzinyo, Bonney & Davis, 2014). Dzidzinyo, Bonney and Davis further lamented that students' low performance in biology has been a constant source of worry to parents, teachers, educationists and those who have the advancement of science education in Ghana at heart. Again, it was indicated in the work of Dzidzinyo *et. al.* (2014) that the performance in biology has also not seen any significant difference over the years as evidenced by the general comments in the West African Examinations Council (WAEC) Chief Examiners' reports for July/August and November/December, 2000; July/August, 2001; July/August, 2002; July/August, 2004; May/June, 2005 and May/June, 2006 in both biology 1 and 2 papers.

The researcher believes that students' inability to deeply conceptualise the individual topics treated in biology could account for their low performance in the biology papers in general. For example, studies consistently showed that students have problems in understanding key topics of biology such as internal organs, organ systems and processes of their own bodies (Reiss, *et. al.,* 2002; Toyoma, 2000; Tunnicliffe, 2004). Toyoma (2000) evaluated students' awareness of biological transformations associated with eating and breathing and the result showed that students seldom refer eating and breathing to biological transformation. Results from an international study (Reiss *et. al*., 2002) indicated that about 15 year old students' understanding of different organ systems showed that the generally best known organs the students could identify belong to the digestive system, the gaseous exchange system and the skeletal system. It was evidenced in the study conducted by Reiss *et.al.* (2002) that students had better knowledge of their internal organs but most of them had little understanding of their organ system. Tunnicliffe (2004) reiterated that students had greater difficulties in understanding the excretory systems than the digestive.

The students' difficulties in understanding excretory systems are mainly caused by ineffective learning or poor teaching strategy employed in the classroom (Lawson, 1988). Lawson further indicated that when appropriate teaching and learning approaches are not employed in the classroom, students tend to develop certain misconceptions about the topic they learned, particularly those that are concerned with more complex or abstract phenomena such as cell division, ultrafiltration in nephrons and the mechanism of circulation, children are less likely to come into immediate and direct contact with more complex or abstract phenomena in daily life, and so they have little chance to develop their own 'naive' explanations (Barrass, 1984; Cho, Kahle, & Nordland, 1985; Veiga, Pereira & Maskill, 1989; Sanders, 1993).

Teacher-centred teaching approaches, inadequate mastery of subject matter by the teachers, and inadequate teaching and learning resources are among other contributing factors that impede students' conception and performance in certain topics in biology (Muraya & Kimamo, 2011). Muraya and Kimamo emphasised that the teaching approach employed by a teacher is one of the most important explanations of poor performance in science subjects. One teaching approach which has been identified to be dominant in secondary schools is lecture method (Kolawole, 2007). It is a teacher-centred teaching approach where a teacher presents information to students in a lecture and students complete assignments out of class and later take an examination to demonstrate their degree of understanding and retention of the subject matter. The lecture method instructional approach is characterised by heavy emphases on assessment, more notes being copied by the students, and students are less engaged in an activity. Kareem (2003) and Serwaa (2007) indicated that lecture method, which is predominant in the classrooms, does not stimulate students' thinking.

Brown, Oke and Brown (1982) opined that teaching and learning are attempts to help someone acquire or change some knowledge, skill or attitude. Ayot and Patel (1992) further argued that teaching and learning are processes where one person, the teacher intentionally passes information to another person, the learner. Hence, the goal of teaching is to bring about desirable learning in students. In this process, the learner is expected to receive information, understand it and use it later when the need arises. For effective teaching and learning to occur, the teacher must use an effective approach of conveying the information to the learner (Brown *et. al.*, 1982). He further noted that the way a teacher teaches is important in that with the right methods and techniques, students can grasp concepts and ideas while poor methods and techniques frustrate students and minimize their chances of success.

The instructional strategies that have been identified to aid students' conception and performance are concept mapping (Udeani & Okafor, 2012) and co-operative learning (Borich, 2004; Johnson, Johnson & Holubec, 1990) which are practically non-existent in the situation where the researcher conducted the study.

1.2 Statement of the Problem

Science contributes immensely towards the socio-economic development of a country. For this reason, the Government of Ghana is committed to improving the quality of science education at all levels but in particular at the basic and the SHS levels (Ministry of Environment, Science and Technology, 2009). However, performance in biology at Senior High School level in Ghana has not been encouraging over the past decades. Students obtained worse grades in biology than in other pure science subjects (West Africa Examination Council (WAEC), 2009). For example, Programme Reform and Alignment for increasing Competencies of Teachers and for Improving Comprehension and Application in Learning Science and Mathematics (PRACTICAL) project plan, showed that in 1999, 2000, 2001, 2002, 2003, 2004 and 2005, students who had grades A to D were 31.7%, 19.2%, 27.6%, 39.0%, 38.7% 39.4% and 40.9% respectively . This indicates that over a period of seven consecutive years less than 50% of candidates had passing grades in biology that could qualify them for further studies (Dzidzinyo *et. al.*, 2014).

The situation is not different at Aburaman Senior High School in the Abura-Asebu-Kwamankese District in the Central Region of Ghana. Table 1 shows how woefully the school had performed in biology at the May/June WASSCE from 2012 to 2015.

Table 1: Aburaman SHS 2012 to 2015 May/June WASSCE Result in Biology

Year	A1	B2	B3	C4	C5	C6	D7	E8	F9	No. Pass	No. Failed	% Passed	% Failed	% Absent	Total
2012	0	0	0	1	1	0	2	3	105	7	105	6.3	92.9	1	113
2013	0	1	2	5	3	22	12	24	81	69	81	46.4	53.6	1	151
2014	2	2	5	5	10	19	10	7	19	60	19	75.9	24.1	0	79
2015	0	0	9	0	4	14	16	25	38	68	38	64.1	35.9	0	106

Field source (2016).

Clearly, it is quite sad to learn from the Table 1 that only 1.7% (2 out of 113 students), 21% (33 out of 151 students), 54.4% (43 out of 79 students) and 25.5% (27 out of 106 students) who respectively sat 2012, 2013, 2014 and 2015 WASSCE biology obtained grades A1 to C6. This means that in 2012, 2013 and 2015 far more than half of the students could not qualify for tertiary level programmes.

The reason for the students' abysmal performance in biology could be that they harbour many misconceptions relating to basic biological concepts after teaching (Driver, Squires, Rushworth, & Wood-Robinson, 1994; Sanders, 1993; Songer & Mintzes, 1994; Westbrook & Marek, 1992). One area that continually causes learning problems is concerned with the concept of excretion. A particular case is many students are unable to distinguish between excretion and egestion even after deliberate instruction, and their ideas on excretory wastes are confusing (Soyibo, 1995).

The students' learning difficulties in most concepts have been attributed to teaching methods, which were teacher-centred approaches (Muraya & Kimamo, 2011) and are predominantly practised at secondary school level in Sub-Saharan Africa

(Kolawole, 2007; UNESCO, 2005). These methods promote students' passiveness in the classroom and decline students' interest in the subject (Organization for Economic Co-operation and Development [OECD] Global Science Forum, 2006).

Though, it has been identified that concept mapping and co-operative learning are instructional approaches that perk up students' performance in biology (Agashe, 2004; Ajaja, 2011; Nnorom, 2015), these are virtually non-existent in most of the classrooms in Ghana.

Most literature reviewed for this study often compared concept mapping, co-operative, experiential and technological instructional approaches to lecture method. Indeed, what is missing in most literature is the comparison of the effectiveness of two robust teaching approaches such as concept mapping and co-operative learning, each of which has been confirmed to be superior to traditional methods of teaching. Also, most of the studies on the effects of concept mapping and co-operative learning on the students' academic achievement were conducted outside Ghana. It is in the light of these that, the researcher aims at comparing the effectiveness of concept mapping and co-operative learning on students' cognitive achievement in excretion in the Ghanaian context particularly in Aburaman Senior High School. The researcher is also interested in exploring the extent to which students' misconceptions in excretion could be rectified by using the concept mapping and co-operative learning as instructional strategies.

1.3 Purpose of the Study

The purpose of this study was to determine the effect of using concept mapping and co-operative learning as instructional approaches on students' cognitive achievement and conception of excretion.

1.4 Objectives of the Study

Based on the purposes stated above, the following objectives were set to guide the study:

1. To identify misconceptions SHS 2 students had with the concept of excretion.
2. To determine the extent to which the use of concept mapping instructional approach improves students' cognitive achievement in excretion.
3. To determine the extent to which the use of co-operative instructional approach improves students' cognitive achievement in excretion.
4. To examine the difference in cognitive achievement between the students in concept mapping group and co-operative learning group on their conceptions of excretion.

1.5 Research Questions

The study focused on gathering data to help answer the following research questions:

1. What misconceptions do SHS 2 students hold about the concept of excretion?
2. To what extent does the use of concept mapping instructional approach improve students' cognitive achievement in excretion?

3. To what extent does the use of co-operative instructional approach improve students' cognitive achievement in excretion?
4. What difference exists in cognitive achievement between students in concept mapping group and co-operative learning group on their conceptions of excretion?

1.6 Null Hypothesis

The following hypothesis was tested in the study at 5% level of significance.

H_0: There is no significant difference in the cognitive achievement between SHS 2 students taught with concept mapping and those taught with co-operative learning instructional approaches in excretion.

1.7 Significance of the Study

The success of science education depends mainly on the methodologies used by science teachers to enhance the understanding of science concepts. This study aimed at investigating the effects of concept mapping and co-operative learning on the cognitive achievement of students in excretion. By emphasising the use of concept mapping and co-operative learning in the teaching of certain concepts in biology, the findings of the study will:

1. improve students' content knowledge and understanding of the concept of excretion in biology. It would also improve their performance in excretion,
2. build up the existing literature on concept mapping and co-operative learning as instructional approaches in biology,

3. offer teachers better understanding on how to use concept mapping and co-operative learning as alternative instructional approaches to assist students who have difficulty in learning biology,
4. draw curriculum developers' attention to the need to structure the curriculum materials in a way that could engage students in deeper construction of biological ideas, and
5. entreat future researchers to further compare the effectiveness of two similar robust instructional approaches on the performance of students in biology.

1.8 Delimitations of the Study

Delimitations are those characteristics selected by the researcher to limit the scope and define the boundaries of the study (Simon, 2011). The following delimitations were defined to help direct the assessors understand the focus of the research.

The study was delimited to second-year elective biology students in Aburaman Senior High School of Abura-Asebu-Kwamankese District to enable the researcher gain in-depth understanding of the effectiveness of concept mapping and co-operative learning on students' cognitive achievement in biology.

The webbing type of concept map was employed in this study because it forms the basis of all other types of concept mapping. When students learn any biological concept through webbing type of concept map, they could easily apply the idea to other types of concept mapping (Alpert & Grueneberg, 2001). Again, only the student teams achievement divisions (STAD) model of co-operative instructional approach was employed in this study though several models (such as three-step interview, round robin brainstorming, numbered heads together, team pair solo, teams-games tournament (TGT) and Jigsaw) have been developed by different educators (Kagan, 1994; Slavin, 1995).The STAD was used in this study because it enables students with mixed-ability to work in teams. Hence, below average performing students could have the opportunity to learn from high performing students.

Lastly, the study focused on excretion under the mammalian anatomy and physiology section of SHS biology syllabus. Two reasons motivated the choice of this topic. One, the students had been taught excretion in integrated science and two, excretion is a topic in the second-year elective biology syllabus. Further, the researcher believes that when the students fully understand the topic they could easily transfer their knowledge when they are treating excretion under plant structure and physiology.

1.9 Limitations of the Study

The study employed quasi-experimental research design which has the following limitations. First, the subjects were selected purposively hence the conclusion from the study cannot be generalised beyond the study population. Again, the teacher made achievement test, class exercises and assignments which were the instrument used in the study were developed by the researcher, so the interpretation of the results depends on the validity and reliability of the instrument.

Also, it was assumed that since the two intact classes were selected from the same school offering the same programme, their variances could be equal but the pre-test analysis indicated that they were unequal. Lastly, the poor performance of students in biology is national issue and calls for investigation nationally, it was not possible for the researcher to do so due to limited time frame (within one academic year) to complete the study. Despite these limitations, the findings were significant particularly in the use of concept mapping and co-operative instructional approach to enhance students' learning of excretion.

1.10 Organisation of the Study

The study is organised as follows. Chapter one covers the background to the study, statement of the problem, purpose of the study, research questions, hypothesis, significance, delimitations and the limitations of the study.

Chapter two consists of the review of related literature on theoretical framework of the study, science instructional strategies in Ghana, students' performance in biology in Ghana, students' misconceptions of excretion, the concept and theory of concept mapping, characteristics of concept maps, the potentials of using concept mapping as an instructional approach, the concept of co-operative learning, elements of co-operative learning approach, student teams achievement division model of co-operative learning approach, the potentials of using co-operative learning as instructional approach, and a summary of the literature reviewed.

Chapter three consists of methodology of the study. This comprises research design, population, sample and sampling technique, instruments, validity of the instruments, item analysis, reliability of the instruments, data collection procedure and data analysis.

Chapter four comprises the presentation of results and discussion of findings. Finally, Chapter five concludes the report with the summary of the entire research. It also contains the major findings, conclusions, recommendations and suggestions for further research study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter presents a review of literature related to the topic of study under the following sub-headings:

i. Theoretical framework of the study
ii. Science instructional strategies in Ghana
iii. Students' performance in biology in Ghana
iv. Students' misconceptions in excretion
v. The concept and theory of concept mapping
vi. Characteristics of concept maps
vii. The potentials of using concept mapping as an instructional approach
viii. The concept of co-operative learning
ix. Elements of co-operative learning approach
x. Student teams achievement division model of co-operative learning approach
xi. The potentials of using co-operative learning as instructional approach
xii. Summary of the literature reviewed

2.1 Theoretical Framework of the Study

A theory is a general statement that summarises and organises knowledge by proposing a general relationship between events. Thus, theoretical framework is a group of theories that underpin a research (Ofori & Dampson, 2011). The theory underpinning this study is constructivist's theory of teaching and learning. Constructivism as a learning theory is rooted in the works of Piaget and Vygotsky and it can be traced back to decades but its actual application is relatively new (Richardson, 2003). Active learning strategies obtain their roots from Constructivism. Research shows that a constructivist approach of pedagogy makes students more active compared to a mere traditional approach of teaching (Azzarito, 2003; DiEnno & Fall, 2005; Muller, Sharma & Reimann, 2008). In the constructivist learning theory, the learners are provided with tasks that give them an opportunity to discover and collaboratively construct meaning from the tasks. Here the learners are responsible for their own concept formation through discussion of work with peers. The learners verbalise the concept they are constructing when doing activities. Also, the learners are able to make connections between different aspects of biology, explain and justify their own solutions. In constructivist teaching and learning theory, learners do self and peer assessment, investigate their own errors and pose and solve their own problem. The teacher serves as a facilitator and only guides students to conceptualise (biological) knowledge. The teacher negotiates meaning with the student. Apawu (2011) indicated that the constructivist teacher sets up problems, monitors learner exploration, guides the direction of learner inquiry and promotes new patterns of thinking.

Fletcher (2007; 2010) pointed out that the best learning occurs when learners construct their own knowledge in learning. He went on indicating that constructivist learning, therefore, is a very personal endeavour, whereby concepts, rules, and general principles internalised may consequently be applied in a practical real-world context. “In constructivism, teachers and pupils are viewed as active meaning makers who continually give contextually based meanings to each other’s words and actions as they interact” (Fletcher, 2005, p. 4).

Science Education has its focus on preparing individuals with appropriate skills, abilities and competencies both mental and physical to live and contribute to the development of the society. Biology education is an integral part of Science, Technology, Engineering and Mathematics (STEM) education. To achieve creativity and overall national development, teaching strategies that capture interest of secondary school students in science concepts is imperative.

Many researchers agree that the conventional lecture method does not help students to construct their own understanding and opine that the uninspiring teaching methods adopted by science teachers lead not only to low achievement in science but also incapacitates students from developing required skills necessary for creative thinking (Igboanugo, 2013;Kolawole, 2007). The lecture method is a teaching method in which the teacher presents a verbal discourse on a particular subject, theme or concept to the learners. The teacher delivers pre-planned lessons to the students with little or no instructional aides (Nwagbo & Chikelu, 2011). Many Ghanaian classrooms are characterised by this instructional approach and the impact it leaves on students has been identified as woeful (Ametordzi, Osei-Poku & Eshun, 2012; Serwaa, 2007).

Therefore, there is the need for a paradigm shift in the instructional approaches used in the biology classroom. Danmole (2011) for instance noted that teachers need to employ different learning methods and strategies to ensure students' understanding of scientific concepts. A shift is therefore advocated by researchers to methods that will enable the learner construct his/her own understanding (Samba, Achir, & Ogbeba, 2010).

It is the lecture method instructional approach which is preponderant in biology classroom in Ghana, particularly in the district the study took place. Thus, the researcher used the constructivist teaching and learning theory as a lense in the context of concept mapping and co-operative learning instruction on excretion. Since the study has the focus of improving the students' conception and performance in excretion, it is essential to use instructional strategies which are deeply rooted in constructivism. Hence concept mapping and co-operative learning were employed as instructional tools in teaching excretion to SHS 2 students.

2.2 Science Instructional Strategies in Ghana

Despite evidence from literature suggesting that concept mapping (Akeju, Simpson, Rotimi & Kenni, 2011; Ulerick, 2000) and co-operative learning (Ning & Hornby, 2014; Pons, Prieto, Lomeli, Bermejo, & Bulut, 2014; Sears & Pai, 2012) have substantial positive impact on students' learning of biological concepts, the teaching strategy dominant in Ghanaian classrooms is the lecture (traditional method) method (Ametordzi, Osei-Poku & Eshun, 2012).

Damtse (2000) conducted a study on instructional strategies used in teaching biology. He found from his study that most of the biology teachers did not make use of student-centred approach such as inquiry, discovery and group work method of teaching biology. Lawson (2007) conducted a similar study in Akuapem North District and found out that only a few of the teachers used materials that they could gather from the environment for science teaching. She also found out that there were no hands-on activities during science lessons to allow students to interact with the materials at their disposal. Xedzro (1995) indicated in his study conducted in South Tongu District that the teachers were not using the recommended teaching approaches and for that matter various activities designed in the syllabus were left untreated.

The lecture method instructional approach has received a lot of criticism. For instance, Okwilagwe (2002) revealed that although the lecture method allows a great deal of information to be passed to the learner and favours handling of large classes, it does not stimulate students' innovation, inquiry and scientific attitudes. He went further to say that the teaching strategies that can help the development of reasoning, acquisition of skills as well as skills process through scientific approach, are conspicuously lacking. Rather, lecture method encourages students to cram facts which are easily forgotten. This method, according to Usman (2001) and Bichi (2002) has been found to be inappropriate and ineffective for achieving the high objectives of biology programmes. Therefore, there is the need to search and incorporate modern instructional strategies. Hence in recent years, educators are putting in efforts to improve science achievements through more effective, learner-centred instructional strategies (Danmole & Femi-Adeoye, 2004).

The current situation regarding the teaching of science particularly biology in Ghana needs to be addressed since it has been documented that the lecture method (a) makes students passive in the classroom, and (b) lays much emphasis on examination instead of making students develop deeper conceptual understanding of biological topics. It is based on these reasons that the researcher was enthused with comparing the efficacy of concept mapping and co-operative learning as instructional strategies within the context of Abura-Asebu-Kwamankese District. These instructional approaches were deliberately chosen for this study because they have been proven to be effective in other parts of the world. It is also ideal to investigate whether these methods could help improve the cognitive achievement of Aburaman SHS students who have difficulties in learning certain concepts in biology.

2.3 Students' Performance in Biology in Ghana

Biology is a natural science subject consisting of contents from microscopic organisms to the biosphere in general, encompassing the earth's surface and all living things (Okwo & Tartiyus, 2004). Considering its fundamental characteristics and importance, biology is today a standard subject of instruction at all levels of our educational systems, from pre-primary to tertiary. Despite its importance and popularity the failure rate has remained very high in most parts of Sub-Saharan Africa (Akubuilo, 2004). For instance, Ghanaian students' performance in the subject has been reported to be consistently poor (Dzidzinyo, Bonney & Davis, 2014).

Dzidzinyo *et. al*. (2014) reported in their study titled "an investigation into weaknesses exhibited by Senior High School biology students' in graph work in the Cape Coast Metropolis of Ghana" that with the passing of the years, many students who sit the SSSCE in the sciences, specifically, biology, do not perform as expected. They further lamented that this has been a constant source of worry to parents, teachers, educationists and those who have the advancement of science education in Ghana at heart. For instance, it was indicated in their work that the performance in biology has also not seen any significant difference over the years as evidenced by the general comments in the West African Examinations Council (WAEC) Chief Examiners' reports for July/Aug. and November/December, 2000; July/August, 2001; July/August, 2002; July/August, 2004; May/June, 2005 and May/June, 2006 in both Biology 1 and 2 papers.

Similarly, the May/June, 2007 biology 1 reports made it clear that candidates' performance still remained poor; in other words the performance was virtually low year after year without any marked positive deviation (with the exception of the reports on the November/December, 2000 Biology 2) which stated that "candidates in the well-endowed schools in the urban areas performed quite better than those in the rural areas" (p.132).That for the July/August, 2001 also clearly acknowledged an improvement in candidates' performance.

2.4 Students' Misconceptions in Excretion

Students who enter the classroom with inappropriate pre-existing ideas about the world, which are not in accordance to scientific explanations, are said to have misconceptions. Misconceptions are also referred to as pre-conceptions, naïve conceptions, naïve theories, alternative conceptions and alternative frameworks (Blosser, 1987). Driver *et. al*. (1994), and Garnett, Garnett and Hackling (1995) highlighted students' understanding of science subject matter and showed that students hold many informal ideas that deviate from proper scientific concepts even after teaching.

Misconceptions or erroneous ideas may come from strong word association, confusion, conflict or lack of knowledge (Fisher, 1985). They have certain characteristics in common as: (a) They are at variance with conceptions held by experts in the field; (b) A single misconception or a small number of misconceptions, tend to be pervasive (shared by many different individuals); (c) Many misconceptions are highly resistant to change or alteration, at least by traditional teaching methods; (d) Misconceptions sometimes involve alternative belief systems comprised of logically linked sets of propositions that are used by students in systematic ways; and (e) Some misconceptions have historical precedence; that is some erroneous ideas put forth by students today mirror ideas espoused by early leaders in the field.

The misconceptions interfere with students' learning when theyuse them to interpret new experiences. Also the learners are emotionally and intellectually attached to their misconceptions because they have actively constructed and that they bestow these misconceptions with great reluctance (Mestre, 1999).

An important outcome of the studies on children's misconceptions is to reveal possible causes of their problems in science learning (Din-Yan, 1998). This knowledge will provide clues for the device of effective teaching strategies that may prevent the development of misunderstanding and lead to conceptual changes. According to Din-Yan (1998), children's misconceptions can be put under the following categories: (a) informal ideas formed from everyday experiences which children bring into the classroom; (b) erroneous ideas developed during teaching due to lack of understanding; and (c) wrong concepts propagated by teachers and textbooks.

Barrass (1984) conducted a study on some misconceptions and misunderstandings perpetuated by teachers and text books of biology. The results showed a list of 15 commonly encountered misconceptions in biology related to the concepts of a cellular and multicellular, respiration and photosynthesis, egestion and excretion and homeostasis and homeothermy.

Studies on children's understanding of life science have revealed that students harbour many alternative conceptions relating to basic biological concepts after teaching (Songer & Mintzes, 1994; Westbrook & Marek, 1992). An area that constantly causes learning problem is concerned with the concept of excretion. For instance, many students fail to distinguish between excretion and egestion even after deliberate instruction, and their ideas on excretory wastes are confusing (Soyibo, 1995).

Considering that excretion is a fundamental concept in biology and is usually introduced to students at the very beginning of the biology courses in Ghana and other parts of the world such as Hong Kong (Chan, Chu, Kong, 1994; Pang, 1993), it is disappointing to see that most of the students, having completed the secondary curriculum, still fail to develop proper understanding of this concept, as demonstrated by the performance of students on a multiple-choice item on excretion and evaluation of their responses in a subsequent interview. What makes this basic concept so difficult for our children? What are the barriers to their conceptual development? Has anything gone wrong in the process of classroom instruction? Some aspects of these questions may be answered by examining the contexts in which the idea of excretion is introduced to our children from a constructivist point of view.

The problem with the concept of excretion is compounded by confusion about the meaning of metabolic waste. In everyday usage, the term "waste" refers to all unwanted, harmful substances. It is therefore natural for students to include undigested materials egested from the gut as a body waste and regard excretion and egestion as synonyms (Soyibo, 1995). Novak (2002) noted that though learners transfer knowledge from one context to another, many do so incorrectly. This is commonly observed in many examples of “misconceptions” in every field of study. The only solution to the problem of overcoming misconceptions is to help learners learn meaningfully, and using concept maps can be very helpful. Bello (1997) and Esiobu and Soyibo (2006) reiterated that using concept-mapping as an instructional strategy has a remarkable efficacy of enhancing meaningful learning in science. Further, Ulerick (2000) noted that graphic strategies, such as concept mapping and related techniques, can assist students in visualizing how key ideas are related to each other.

2.5 The Concept and Theory of Concept Mapping

The concept and theory of concept mapping had its root in education; and education and learning probably still constitute the bulk of its use (Canas, Hill & Lott., 2003). The idea of a concept map was developed in 1972 in the course of Novak's research program at Cornell where he sought to follow and understand changes in children's knowledge of science (Novak & Musonda, 1991). Novak and Gowin (1984) are cognitive psychologist who expanded the understanding of the uses and benefits of concept map with the publication of their book, *Learning How to Learn*. David Ausubel, a cognitive psychologist who was at the forefront of constructivist thought and whose research and findings strongly influence the work of Novak and Gowin explains that the acquisition of new materials is highly dependent on the relevant ideas already in the cognitive structure; and meaningful learning in humans occurs through an interaction of new information with relevant existing ideas in the cognitive structure.

Educational theorists such as Novak and Gowin (1984) believed that the key to meaningful learning is how a student organises and retrieves information or knowledge. Meaningful learning is based on the premises that knowledge is bundled in pockets called concepts and is retrievable on the basis of how the concepts are linked to one another (Passmore, Owen & Prabakaran, 2011). Again, Ajaja (2011) confirmed that the development of concept mapping as an instructional tool can be traced to the early work of Ausubel and others in the 1970s. He noted that since its introduction, concept mapping has become a very useful tool in teaching and learning and particularly in science education. Literature on concept mapping indicates that it has been used for instruction, assessment and learning (Johnson & Raven, 1998; Novak & Musonda, 1991; Power & Wright, 2008; Trowbridge & Bybee, 1996; Trowbridge, Bybee & Powell, 2000). Researchers are still impressed by its versatility in curriculum design (Edmondson, 1995; Ferry, Heldberg, & Harper, 1997; Moen & Boersma, 1997; Starr & Krajcik, 1990), teaching strategy (Briscoe & LaMaster, 1991; Nakhleh & Krajcik, 1994; Schmid & Telaro, 1990), and evaluation of teaching (Beyerbach & Smith, 1990; Goldsmith, Johnson, & Acton, 1991; Novak & Gowin, 1984; Ruiz-Primo & Schavelson, 1996).

Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts. A concept has been defined as a perceived regularity in events or objects, or records of events or objects, designated by a label. The label for most concepts is a word, an explicit symbol such as + or %, and sometimes more than one word is used (Novak & Canas, 2008; Passmore *et. al.,* 2011). Propositions are produced when two or more concepts are connected using linking words or phrases to form a meaningful statement.

When concepts are linked by defined linkages a concept map is produced. Concept maps are graphic organizers of multiple concepts that represent an individual's knowledge of a topic or process (Passmore, 1995). Concept mapping is also seen as a process that involves the identification of concepts in study materials and their organization from the most to the least general, more specific concept (Novak, 1979). In other words concept maps are pictorial ways of organising specific topics within a broad category or domain in order to show the relationships of one to another. The maps depict hierarchal relationships in a manner of organizing the most broad information "at the top of a tree-like figure" (Crandell, Naomi & Soderston, 1996) and branching off to more specific information; each branch links a more general concept to more specific concept. For example, the broad concept could be 'living things', the next branch may be 'animal', and the next could be 'insect' which may lead us to 'cockroach'.

To Passmore, Owen and Prabakaran (2011), meaningful learning requires a learner to become an active participant in the learning process. The process of generating a concept map by identifying relevant concepts and the relationship between them is active learning (metacognitive process). Two or more concepts and their linking relationships become meaningful statements about some object or event that an individual is trying to define or classify (Passmore *et. al.,* 2011). The characteristics linking relationship of a concept map is what makes this graphic organizer unique and separate the concept map from other organizational techniques such as flow chart or outlines (Passmore *et. al*., 2011).

2.6 Characteristics of Concept Maps

According to Novak and Canas (2008), one of the characteristics of concept maps is that the concepts are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below. The hierarchical structure for a particular domain of knowledge also depends on the context in which that knowledge is being applied or considered. Therefore, it is best to construct concept maps with reference to some particular question known as focus question.

Another important characteristic of concept maps is the inclusion of cross-links. These are relationships or links between concepts in different segments or domains of the concept map. Cross-links help us see how a concept in one domain of knowledge represented on the map is related to a concept in another domain shown on the map. In the creation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer. There are two features of concept maps that are important in the facilitation of creative thinking: the hierarchical structure that is represented in a good map and the ability to search for and characterize new cross-links. A final feature that may be added to concept maps is specific examples of events or objects that help to clarify the meaning of a given concept. Normally these are not included in ovals or boxes, since they are specific events or objects and do not represent concepts. Figure 1 shows an example of a concept map that describes the structure of concept maps and illustrates the above characteristics.

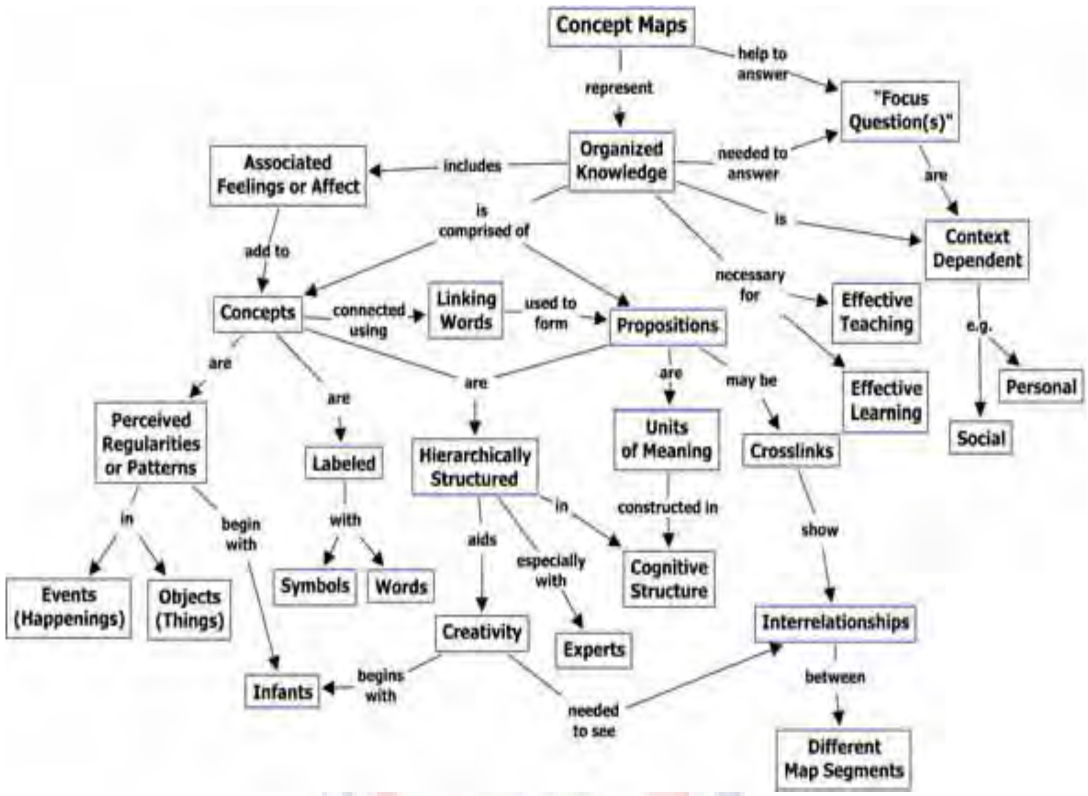

Figure 1: A Concept Map Showing the Key Features of Concept Maps

Source: Novak and Canas, (2008).

Making a concept map for a piece of scientific knowledge is the ability of the mapper to identify and relate its salient concepts to a general, super ordinate concept. Concepts may be defined as regularities in objects or events designated by some label, usually a term (Novak & Wandersee, 1991). Whether a process (e.g. precipitation), a procedure (e.g. titration), or a product (e.g. carbohydrate), concepts are what we think with in science. Concept mapping serves as a tool to help learners organize their cognitive frameworks into more powerful integrated patterns. In this way, it serves as a metaknowledge and a metalearning tool. The heuristic of concept mapping is a kind of a metacognitive strategy that assists learners to understand concepts and relationships between them. It also helps students to observe the hierarchical, conceptual and propositional nature of knowledge (Klausmeier, Ghatala & Frayer, 1974; Derbentseva, Safayeni & Canas, 2004; Hibberd, Jones & Morris, 2002; Novak, Gowin & Johanson, 1983). The proponents of the concept mapping strategy posit that meaningful learning ensues when a learner is aware of, and can control, the cognitive processes associated with learning. Indeed, some research on concept mapping seems to demonstrate that meaningful learning results from its use in science classrooms (Stewart, Vankirk & Rowell, 1979; Novak & Gowin, 1984; Ault, 1985; Cliburn, 1987; Okebukola & Jegede, 1988; 1989; Jegede, Alaiyemola & Okebukola, 1990; Markow & Lonning, 1998).The concept of excretion considered in this study is quite inter-related and one of the most appropriate strategies that could engage students' critical thinking is the use of concept mapping teaching method. It is expected in this study that students' conception and performance in excretion could be enhanced when they are able to draw a concept map of structure and function of the kidney such as the one illustrated in Figure 2.

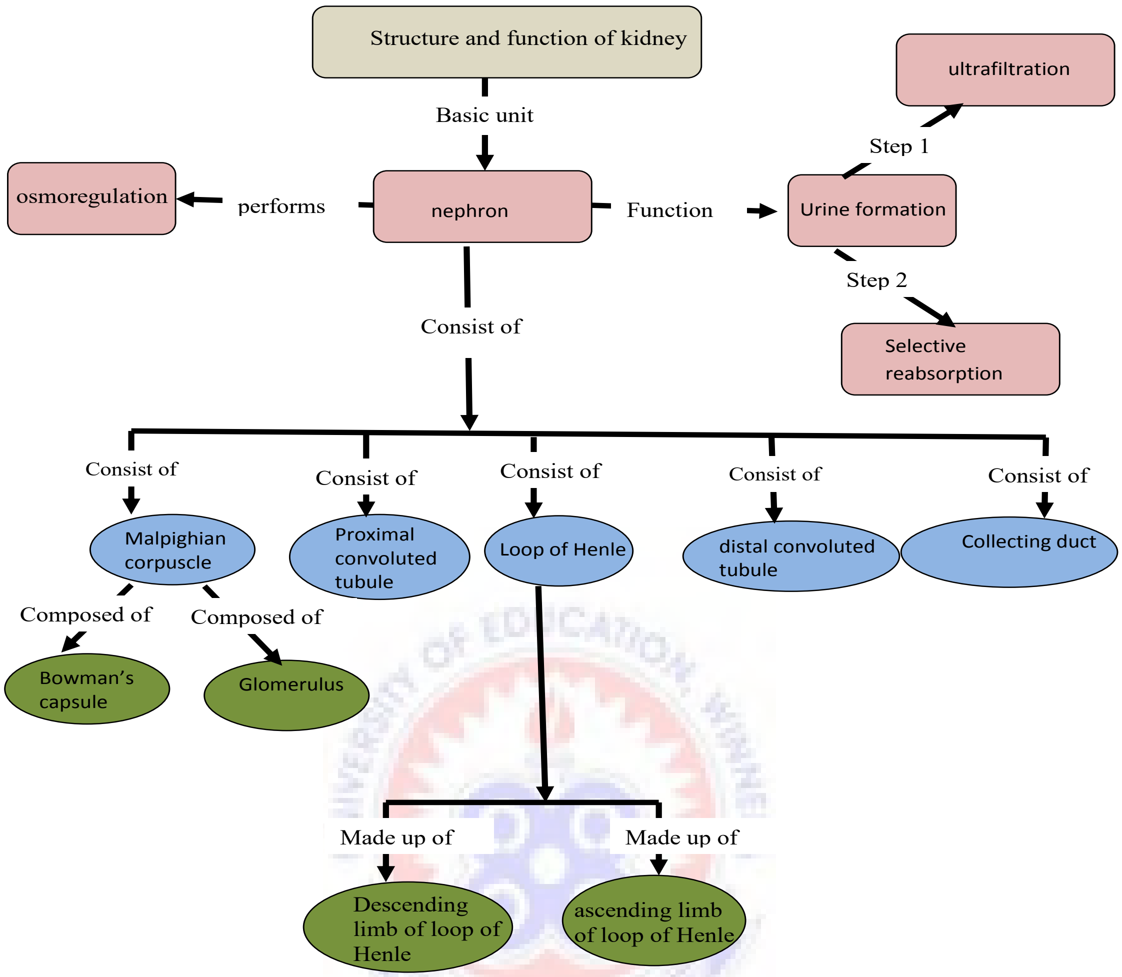

Figure 2: Concept Map of Structure and Function of the Kidney

Source: Adapted from Loo (2008).

2.7 The Potentials of using Concept Mapping as an Instructional Approach

Evidence from literature shows that students' understanding of biological concepts is fully enhanced when concept mapping is employed as an instructional approach. For example, concept map can be used for showing the topics/contents, in introducing a topic to the students and for evaluation or assessment (Rice, Ryan & Samson, 1998). Thus, Mintzes, Wandersee and Novak (2000), Novak (1990) and Novak and Gowin (1984) opined that one of the powerful uses of concept maps is not only as a learning tool but also as an evaluation tool, thus encouraging students to use meaningful-mode learning patterns. Concept maps are also effective in identifying both valid and invalid ideas held by students. To structure large bodies of knowledge requires an orderly sequence of iterations between working memory and long-term memory as new knowledge is being received and processed (Anderson, 1992). Novak and Canas (2008) believed one of the reasons concept mapping is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold that helps to organise knowledge and to structure it, even though the structure must be built up piece by piece with small units of interacting concepts and propositional frameworks. For example the following study conducted by Henno and Reiska (2008) confirms the potentiality of using concept mapping as an instructional approach on students' performance.

They acknowledged that the science topic "human body systems" is imperative for students academically and for understanding and upholding a healthy lifestyle. Henno and Reiska (2008) however indicated that teaching middle school students about the digestive and excretory system can be a challenge for a teacher when she/he wants to overcome rote learning of facts without a deeper understanding. It is in this regard that they conducted a study on how concept mapping as an assessment tool can improve the instructional practices and how it can be used to identify middle school students' misunderstandings about the human digestive and excretory system. The sample for their study was 9thgrade students in biology class. An analysis of the 29 concept maps created by students revealed that they demonstrated an understanding about the focus question:

how the nutrients are absorbed into blood, wastes leave the body and urine is formed by sixteen central concepts. Their study reported that students' basic knowledge about their internal body parts was good. Again, their findings showed that students' terminology for the identification of the organsand functions after studying this topic were quite good. They further highlighted that in creating the maps, students clarified concepts and became gradually aware about interconnections.

From the findings of the study Henno and Reiska (2008) conducted, it was argued that the use of concept map enables students to create interconnected ideas in biology, thereby expounding their conception in the topic learnt. It is also clear that using concept map facilitates meaningful learning and creates powerful knowledge frameworks that not only permit the students to utilise the knowledge in new contexts, but also enhances the retention of the knowledge for long periods of time (Novak, 1990; Novak &Wandersee, 1991). Bransford, Brown and Cocking (1999) and Tsien (2007) reiterated that concept mapping enhances the brain to process and organize knowledge in hierarchical frameworks.

Ajaja (2011) also used quasi-experimental pretest-posttest control group design to determine if the use of concept mapping as a study skill can influence students' achievement in biology. The data of the study was collected via biology achievement test and interviews. The major findings of his study include: a non-significant difference in immediate post achievement test scores between students who used concept mapping as a study skill and those who reviewed and summarized the content taught what in their studies; a steady, consistent and significant increase in test scores of students who used concept mapping as study skill across achievement tests 1-6; a significant difference in estimated retention between students who used concept mapping as study skill and those who summarized after review, and all the students interviewed agreed that concept maps helped them to determine relationships among concepts, sharpened their understanding and increased their critical thinking. It was concluded in Ajaja's study that concept mapping could serve as an appropriate alternative for studying biology since what is learned through it can be retained for a long time.

Moreover, it has been documented that concept mapping is a metacognitive instructional strategy that empowers the learner to take charge of his/her own learning in a highly meaningful fashion (Novak & Gowin, 1984). Because concept mapping relates directly to such theoretical principles as prior knowledge, subsumption, progressive differentiation, cognitive bridging and integrative reconciliation; it has the potential of improving the performance of slow learners in biology (Udeani & Okafor, 2012).

Udeani and Okafor (2012) investigated the comparative effectiveness of the expository and concept mapping instructional strategy of presenting secondary school biology concepts to slow learners. They used 124 biology slow learners. They randomly assigned 62 of the slow learners to the expository group and the other 62 to a concept mapping group. They taught both groups the concept of photosynthesis. The groups were post-tested after two weeks of teaching for any significant differences in their biology achievement. Analysis of post-test scores indicated that the group taught by the concept mapping instructional strategy performed significantly better than their expository group counterparts. One unique finding they identified was that female slow learners taught with the concept mapping instructional strategy performed significantly better than their male counterparts taught by the same method.

It could be learned from the findings of Udeani and Okafor (2012) that biology teachers could employ concept mapping as an effective instructional strategy to address the problem of slow learners and even female students who have learning difficulties in biology.

The use of concept mapping as an instructional strategy has shown significant improvement in students' achievement, not only in biology but in other disciplines such as accounting (Chiou, 2008), mathematics (Adeneye & Adeleye, 2011; Nwoke, Iwu & Uzoma, 2015), chemistry (BouJaoude & Attieh, 2008), ecology and genetics (Esiobu & Soyibo, 2006). For instance, Chiou (2008) examined whether concept mapping can be used to help students to improve their learning achievement and interests. The participants involved in his study were 124 students from two classes enrolled in an advanced accounting course at the School of Management of a university in Taiwan. The experimental data revealed two important results. First, adopting a concept mapping strategy significantly improved students' learning achievement compared to using a traditional expository teaching method. Second, most of the students were satisfied with using concept mapping in an advanced accounting course. The participants indicated that concept mapping could help them to understand, integrate and clarify accounting concepts and enhance their interests in learning accounting. They also thought that concept mapping could be useful in other curriculum areas.

BouJaoude and Attieh (2008) conducted a study that focused on (a) examining whether the construction of concept maps by students improves their achievement and ability to solve higher order questions in chemistry, (b) investigating the differential effect of the treatment by gender and achievement level, and (c) exploring the relationships between performance on concept maps and chemistry achievement. They pre-and post-tested 60 students using a teacher-constructed chemistry test on acid-base titration and equilibrium in weak acids. They found that while there were no significant differences in the achievement total score, there were significant differences favouring the concept mapping group for scores on the knowledge level questions.

Akeju, Simpson, Rotimi and Kenni (2011) in a study discovered a significant effect of concept mapping instructional strategy on students' learning achievements. The strategy had a lingering effect that prompts 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 that, there was a significant difference between the mean scores of experimental and control groups but gender had no significant influence on their understanding. Esiobu and Soyibo (2006) investigating the effects of concept and vee mappings on students' cognitive achievement in ecology and genetics, discovered that, the experimental groups performed better than the control group.

From the studies reviewed so far, 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 (Edmondson, 2000). Concept mapping has been demonstrated to help students make cross-curriculum connections to better enable them to understand their main field of learning. It was found that people pursuing a Registered Nursing Bachelor's Degree in Australia had better knowledge and understanding of the nursing field after incorporating concept mapping into the curriculum to enable them to link concepts in science with concepts in nursing.

These connections allowed the student nurses to gain fuller understanding of how the two fields intertwine. By incorporating this learning procedure, the nurses were also better able to educate their patients about their various conditions (Wilkes, Cooper, Lewin, & Batts, 1999). This demonstrates how concept mapping can be a helping tool for the students as learning enhancement and for the teacher as a tool for explanation to promote understanding.

Gold and Coaffee (1998) found that the use of concept maps can be spread across a variety of situations, but all uses contribute to learner comprehension. They also found that there are several "understandings" that must be put into place before success will be achieved. First, the concept map must allow for the identification and presentation of key ideas and concepts relating to the subject matter while it disregards superfluous material. Second, the student must be able to gain an understanding of concept mapping through teacher modeling, but to truly become proficient in concept mapping they must be allowed to apply the process in their own examples. Lastly, the student must be forewarned of the pertinent information and goal of the task in order to direct them in the same path that the teacher desires (Gold & Coaffee, 1998; Sungur, Tekkaya, & Geban, 2001).

From the foregoing discussion, it is clear that most researchers on concept mapping ascribeto it having the potential of making learners remember information longer and to be able to use it more effectively because the information was moved into the long-term memory. In situations (such as the schools that participated in this study) where the dominant method of teaching science in general and biology in particular is the lecture method because of inadequately equipped laboratories, it becomes necessary to look for alternative methods of instruction and study which will guarantee effective learning. Concept mapping is one such method, based on research findings on its usefulness. Also, the researcher believes that the use of concept mapping could mitigate most of the learning difficulties students encountered in biology, if teachers effectively employed concept mapping in their instructional practices.

2.8 The Concept of Co-operative Learning

The term 'Co-operative Learning' refers to an instructional method in which students at various levels of performance or ability work together in small groups toward a common goal (Gokhale, 1995). Igboanugo (2013) also refers to co-operative learning as a deliberate instructional strategy which involves the use of heterogeneous small groups of students who work together to maximise each other's learning. Co-operative learning is theoretically based on the work of psychologists like Levi Vigotsky, Jean Piaget among others, who proposed that children actively construct knowledge in a social context (Conway, 1997). Individual performance is deemphasized while team work is promoted. Students are not simply taking information or ideas; they are creating something new with the information and ideas. These acts of intellectual processing of constructing meaning are crucial to learning.

Olarewajuthe (2012) remarked that in co-operative learning students are responsible for one another's learning as well as their own. Therefore, the success of one student helps another student to be successful. Through cross modeling and role playing, students are encouraged to draw on their individual experiences and background knowledge to create a common product. The social context created by the co-operative approach allows students to shape ideas, modify them by listening to peers, question, express doubt, and jointly design and implement plans.

When students are in a co-operative learning environment, it is assumed that they seek information and understanding through active mental search without discrimination in gender or ability and the learning is long term (Lefrancois, 1994). Proponents of co-operative learning claim that the active exchange of ideas within small groups not only increases interest among the participants but promotes critical thinking. According to Johnson and Johnson (1986), there is persuasive evidence that co-operative teams achieve higher levels of thoughts and retain information longer than the students who work quietly as individuals.

2.9 Elements of Co-operative Learning Approach

Several definitions of co-operative learning have been formulated. The one most widely used in higher education is probably that of Johnson and Johnson of the University of Minnesota. According to Johnson and Johnson (1994), co-operative learning is instruction that involves students working in teams to accomplish a common goal, under conditions that include the following elements:

2.9.1 Positive interdependence. Team members are obliged to rely on one another to achieve the goal. In traditional classrooms, where the emphasis is on competition, students experience negative interdependence, competing with one another for educational resources and academic recognition. Competition encourages better students to hoard knowledge and to celebrate their successes at the expense of other students. In co-operative learning classrooms, students work together to ensure the success of each student. Positive interdependence teaches students that school life for each one of them is enhanced when everyone succeeds. Students must see that their success is dependent on the contributions, inclusion, and success of the other students in the group. Creating positive interdependence requires a teacher to craft tasks that require the insights and efforts of more than one person. Positive inter-dependence can also be promoted by linking the grades given on an assignment not just to an individual performance on the test but to the performance of the other group members. If any team members fail to do their part, everyone suffers the consequences.

2.9.2 Individual and group accountability. All students in a group are held accountable for doing their share of the work and for mastery of all of the material to be learned. In co-operative learning settings, each student is held accountable for his or her own academic progress and task completion, apart from the accomplishments of the group as a whole. Individuals may also be held accountable by means of grades based on their academic achievement. Students must be accountable both for contributing their share of the work as well as for the group reaching its common goal. The aspiration of co-operative learning is to enable all students to benefit from the insights and skills of their colleagues and thus each improve their own learning. Individual and group accountability is achieved by grading students both on their individual work and on the work of the group, for example, both on an individual test and on a group performance.

2.9.3 Face-to-face promotive interaction. Although some of the group work may be parcelled out and done individually, some must be done interactively, with group members providing one another with feedback, challenging reasoning and conclusions, and perhaps most importantly, teaching and encouraging one another. In co-operative learning situations, students interact, assist one another with learning tasks, and promote one another's success. The small group setting allows students to work directly with one another, to share opinions and ideas, to come to common understandings, and to work as a team to ensure each member's success and acceptance. Students must have time and opportunity to exchange ideas orally and discuss the concepts at hand. This occurs as structured time for discussion during class, often with the discussion scaffolded by a series of questions or controversies posed by the teacher. To ensure student discussion, the groups may be required to report to the rest of the class and have individual students make summaries of the discussion. In addition, promotive interaction can be achieved through assigning, each student in the group a specific role such as facilitator, recorder, time keeper, etc. This provides every member of the group an entry point for participation and begins to generate individual responsibility within the group.

2.9.4 Appropriate use of collaborative skills. Students are encouraged and helped to develop and practice trust-building, leadership, decision-making, communication, and conflict management skills. Co-operative learning offers students a chance to develop the interpersonal skills needed to succeed at school, work, and within the community. Examples of co-operative skills include: Active listening to all members of the group; allowing all members of the group to verbally participate in discussion; being critical yet supportive of alternative views; maintaining opinions until convincing contrary evidence is provided; learning how to ask clarifying questions; effective communication; understanding and appreciation of others; decision making; problem solving; conflict resolution and compromise among others.

2.9.5 Group processing. Team members set group goals, periodically assess what they are doing well as a team, and identify changes they will make to function more effectively in the future. Here, students need to evaluate and discuss how well they are meeting their goals, what actions help their group, and what actions seem to hurt group interaction. They may articulate these evaluations during class discussion or provide the teacher with written progress reports. Students should also have a way of alerting the teacher to know the group's problems. The teacher must develop plans for engaging students in problem-solving and conflict resolution. Students must have the opportunity to discuss how the work of the group is going, what has been successful, and what could be improved. Engaging in group processing enables students to improve their skills in working co-operatively, learn to address difficulties or tensions within the group, and experience the process of conflict resolution that are essential in any workplace.

Similarly, Trowbridge and Bybee (1996) and Trowbridge, Bybee, and Powell (2000) stated that co-operative learning is an instructional strategy which organizes students in small groups so that they can work together to maximize their own and each other's learning. Specifically, the co-operative learning approach to instruction is where students are arranged in pairs or small groups to help each other learn assigned material. Interaction among students in co-operative learning groups is intense and prolonged (Borich, 2004). In co-operative learning groups, unlike self-directed inquiry, students gradually take responsibility for each other's learning. Borich (2004) and Trowbridge *et. al.* (2000) identified four basic elements in co-operative learning models. Small groups must be structured for positive interdependence; there should be face-to-face interactions, individual accountability, and the use of interpersonal and small group skills.

Co-operative learning has been found to be useful in several areas such as helping learners acquire the basic co-operative attitudes and values they need to think independently inside and outside the classroom (Borich, 2004; Johnson, Johnson & Holubec, 1990); promoting the communication of pre-social behaviour; encouraging higher order thought processes; and fostering concept understanding and achievement (Borich, 2004; Johnson *et. al.,* 1990; Trowbridge & Bybee, 1996; Trowbridge et al, 2000). Agashe (2004) further noted that co-operative learning is a teaching approach involving students' participation in group learning that emphasizes positive interaction. He again states that there has been great interest in the effects of social interaction on students' achievement, and co-operative learning has been found effective across various academic levels and subjects.

Student interaction makes co-operative learning powerful. To accomplish their group's task, students must exchange ideas, make plans, and propose solutions. Thinking through an idea and presenting it in a way that can be understood by others is intellectual work and the exchange of alternative ideas and viewpoints enhances intellectual growth and stimulates broader thinking.

According to Johnson, Johnson and Smith (1991), co-operative learning environment involves students' sense of responsibility, job division, students' interaction and communication, and mutual connection which are beneficial for each team member. Communication and interaction provide the possibility for exchanging information which helps students enhance their thinking skills and create new ideas. Lie (2002) stated that thinking skill empowerment can occur because the small groups consist of students with heterogeneous academic ability and background. Therefore, for the purpose of achieving successful learning process, students are indirectly required to have the willingness and skills to work together, as well as thinking skills. A mix of different abilities, ethnic backgrounds, learning styles, and personal interests works best for productive student teams.

Again, among 101 reasons for the use of co-operative learning proposed by Lord (2001), and on the basis of the reviews on the studies, there has been a reason stating that co-operative learning improves learners' thinking skills and that co-operative learning improves learners' reasoning ability (Johnson & Johnson, 1989). Co-operative learning develops scientific problem-solving ability among learners. According to Corebima (2011), it is possible that some types of co-operative learning may potentially empower higher thinking skills than others, for example Student Teams Achievement Division (STAD).

2.10 Student Teams Achievement Divisions (STAD) Model of Co-operative Learning Approach

The STAD model of co-operative learning was developed by Slavin (1983), as cited in Arends (1997). In this model, students are divided into four or five member teams with each member given a specific role to play. The teacher presents academic information to students each week using verbal presentation or text. Team members use work sheets or other study devices to master the academic materials and then help each other learn the materials through tutoring, quizzing one another and discussions. Teams then present reports of their work to the other students. Individually, students take weekly or biweekly quizzes on the academic materials which are scored, and each individual is given a score. A team average score is calculated and an announcement is made of the teams with the highest average scores. Students with highest improvement scores and students who have perfect scores on the quizzes are applauded.

Therefore, to improve students' social skills and co-operative skills, the researcher of this study encouraged the students to observe the following rules in co-operative learning lessons:

i. Call the group members by their names during lesson interaction.
ii. Interact physically and verbally to be able to maximize the benefits of co-operative learning.
iii. Listen to each other when talking.
iv. Constantly check their work with other students in their groups and agree.
v. Help each other and as such help themselves learn better.
vi. Discuss their work with one another so as to improve individual and group performance.
vii. Realize that the goal of the strategy was for every student in the group to learn the excretion.

2.11 The Potentials of using Co-operative Learning as Instructional Approach

The major concern in secondary school biology teaching is to improve student's achievement and interest in the subject. Strategies used in the teaching of biology have been identified as some of the factors contributing to low achievement and a negative attitude towards learning biology. However, one particular instructional approach which has distinguished itself in improving students' learning in biology is co-operative learning. Co-operative learning has been a well-used tool by teachers all over the world and it has had a long and successful history of research. Johnson, Johnson and Holubec (2008) have extensively researched co-operative learning and they have found encouraging results about its efficiency. For instance, it has been identified that co-operative learning enhances academic achievement, thought process, interpersonal relationships and psychological health (Duxbury & Tsai, 2010; Haiyan, 2014; Hossain & Ahmad, 2013; Jiang, 2014; Johnson, Johnson, & Smith, 2014; Johnson, Johnson & Holubec, 2008; Slavin, Sheard, Elliot, Chambers & Cheung, 2013).

Concerning academic achievement, research has revealed some advantages in co-operative learning when it is compared to competitive and individualistic learning (Ahmad & Mahmood, 2010; Herman, 2013; Johnson *et. al*., 2014; Ning & Hornby, 2014; Pons, Prieto, Lomeli, Bermejo, & Bulut, 2014; Sears & Pai, 2012). Also, research has proven advantages in some particular areas such as reading comprehension (Khan & Ahmad, 2014; Zuo, 2011), writing (AbdelWahab, 2014), biology (Muraya & Kimano, 2011) and mathematics (Lavasani & Khandan, 2011).

A number of instructional strategies have been successfully used to improve students' achievement in science. Henderson (1994) affirmed that sensitive and controversial issues in science could be most appropriately taught when co-operative group approach is utilized. Recent findings suggest that sixth-grade students who were in co-operative groups for their science class showed higher achievement levels and indicated higher levels of satisfaction than students in whole group conditions (Maheady, Harper & Sacca, 1988). More brilliant contributions to scientific knowledge take place whenever pupils talk together (Solomon, 1994); hence, the practice of group work for effective science teaching is an important feature of any science teaching strategy.

The studies on co-operative learning techniques which have repeatedly shown increased academic performance include those of McClintock and Sonquist (1979); Hertz-Lazarowitz, Sharan and Steinberg (1980); Madden and Slavin (1983); Slavin and Karweit (1984); Sharan, Hertz-Lazarowitz, and Ackerman (1980); and Potthast (1999).

Primary studies performed outside African countries report the positive effects of co-operative learning instruction and student academic achievement in science. In a study performed in Taiwan, Chang and Mao (1999) reported no effect on student achievement in earth science for co-operative learning in comparison to control groups for overall achievement ($F = 0.13$, $p > 0.05$), knowledge-level test items ($F = 0.12$, $p > 0.05$), or comprehension-level test items ($F = 0.34$, $p > 0.05$) but reported a statistically significant difference in student performance on application-level test items ($F = 4.63$, $p < 0.05$) for students in co-operative groups. Bilgin and Geban (2006), in a study performed in Turkey, reported a statistically significant difference in students' understanding of chemical equilibrium in co-operative groups compared to control groups (multivariate analysis of covariance results: Wilk's lambda = 0.483; $F(2,83) = 44.344$, $p < 0.05$) with treatment groups showing higher achievement. Using co-operative learning in Israel, Shachar and Fischer (2004) reported a statistically significant main effect of co-operative learning compared to the control groups on student achievement in chemistry (multivariate analysis of variance results: $F(1,162) = 28.6$, $p < 0.001$).

Studies in co-operative learning in Africa include that of Bukunola and Idowu (2012) from Nigeria. Bukunola and Idowu employed quasi experimental pretest-posttest research design to investigate the effectiveness of co-operative learning strategies on the academic achievement of 120 South-west Nigerian Junior Secondary students in basic science. Achievement Test for Basic Science Students (ATBSS), and Basic Science Anxiety Scale (BSAS) were the main instruments used to collect data from students. Descriptive statistics and Analysis of Covariance (ANCOVA) were used to analyse the data collected. Also, Multiple Classification Analysis (MCA) was used to determine the magnitude of the mean achievement scores of students exposed to the different treatment conditions. The results of their study indicated students in the two co-operative learning strategy (Learning Together and Jigsaw II) groups had higher immediate and delayed academic achievement mean scores than the students in the conventional-lecture group. Further, they found that learning together and Jigsaw II co-operative teaching strategies were more effective in enhancing students' academic achievement and retention in basic science than the conventional/lecture. They remarked that when friendliness is established through co-operative learning, students are motivated to learn and are more confident to ask questions from one another for better understanding of the tasks being learnt.

Another study in co-operative learning in Africa is that of Keraro, Wachanga, and Orora (2007) from Kenya. They investigated the effects of using the co-operative concept mapping teaching approach on secondary school students' motivation in biology. A non-equivalent control group design under the quasi-experimental research was used in which a random sample of four co-educational secondary schools was used. The four schools were randomly assigned to four groups. Each school provided one Form Two class. The study sample comprised of 156-second grade students in the four second cycle schools in

Gucha District, Kenya. Students in all the groups were taught the same biology content but two groups, the experimental groups, were taught using the co-operative concept mapping approach while the other two, the control groups, were taught using regular teaching methods. Both the experimental and the control groups were pre-tested prior to the implementation of the co-operative concept mapping intervention. After four weeks, all four groups were post-tested using the student's motivation questionnaire (SMQ). Data were analysed using the t-test, ANOVA and ANCOVA. The results showed that students exposed to the co-operative concept mapping approach had significantly higher motivation than those taught through regular methods. The results further indicated that there was no statistically significant gender difference in motivation towards the learning of biology among secondary school students exposed to co-operative concept mapping. The researchers concluded that co-operative concept mapping is an effective teaching approach, which teachers need to incorporateto their teaching.

Nnorom (2015) examined the effect of co-operative learning instructional strategy on one hundred and eleven (111) Senior Secondary School students' achievement in biology in Anambra State, Nigeria. She used quasi-experiment pretest-posttest non-equivalent control group design. An instrument known as Biology Achievement Test (BAT) with a reliability coefficient of 0.79 was used for data collection. She used mean and standard deviation and Analysis of Covariance (ANCOVA) and the results revealed that students taught using co-operative learning instructional strategy performed better in Biology Achievement Test than those taught using lecture method of instruction.

Also, Muraya and Kimamo (2011) carried out an investigation to determine the effect of co-operative learning approach on mean achievement scores in biology of secondary school students. Solomon-four-non-equivalent-control-group design was used and the target population comprised 183 form two students in four secondary schools. Students were taught one biology topic for five weeks and co-operative learning approach was used in experimental groups while the regular teaching method was used in control groups. Pre-test was administered before treatment and a post-test after treatment. A biology achievement test was used to measure students' achievement and it attained a reliability coefficient of 0.84 (*N*=59) at pilot testing. Data were analysed using t-tests, ANOVA and ANCOVA. The co-operative learning approach resulted in significantly higher mean achievement scores compared to the regular teaching method. Additionally,gender had no significant influence on achievement. They concluded that the co-operative learning approach was an effective teaching approach which biology teachers should be encouraged to use.

Co-operative learning instructional approach is not only robust over traditional method of instruction (lecture method) in biology but also over other well-structured instructional approaches. Ajaja (2013) compared the achievement of students taught with co-operative learning, concept mapping, 5E learning cycle and lecture methods with the intention of identifying which one among them could be most suitable for teaching biology. To guide his study, four research questions were raised and tested at 0.05 level of significance. The design of the study was pre-test, post-test, delayed post-test, quasi experimental repeated measures design. The samples of the study consisted of four mixed Secondary Schools, 259 students and eight biology teachers. The major findings of his study included: significant effect of the four instructional methods on achievement and retention; students in the 5E learning cycle and co-operative leaning groups significantly outscored those in the concept mapping and lecture groups on achievement and retention tests; students in concept mapping outscored those in lecture group both on immediate achievement and retention tests; students in 5E learning cycle and co-operative learning groups did not significantly differ on achievement and retention tests; males and females in all the four groups did not significantly differ on the achievement tests; and a non-significant interaction effect between sex and method of instruction on achievement. From these findings, he therefore concluded that the adoption of either 5E learning cycle or co-operative learning strategies may be appropriate for the teaching and learning of biology. From his conclusion, it could be learned that co-operative learning instructional approach is very effective on students' achievement in biology.

Findings from the various studies conducted on co-operative learning as an instructional approach in biology has proved very positive in different settings. Therefore this study focused on comparing the effectiveness of concept mapping and co-operative learning instructional approaches rooted in constructivism teaching and learning theory on the students' performance in excretion. None of the above studies reviewed specifically compared the efficacy of concept mapping and co-operative learning strategies on students' performance in excretion. Besides, this study was in a different environment. Therefore, it was intended in the present study to compare concept mapping and co-operative learning strategy rooted in constructivism teaching and learning theory to see the effects on the performance in the learning of excretion concepts by second year biology students in Abura-Asebu-Kwamankese District in the Central Region of Ghana.

2.12 Summary of the Literature Reviewed

Literature reviewed covered many previous works done relating to the problems which students have with the learning of biological concepts particularly, excretion. Of particular interest is the failure of the traditional method of teaching to enhance students' learning and achievement. Many research works have been done on the use of co-operative learning strategy to help learning and retention of science concepts including biology in other parts of the world. Also, it has been found that concept mapping has significant impact on students' performance in biology. However, the difficulties students go through in learning biology concepts like excretion persists. From the literature reviewed, concept mapping and co-operative learning strategies, among others, facilitate students' academic achievement regardless of grade level or subject matter. They have been found to be helpful in students' retention of the concepts learned, and they also improve relational learning. However, most of the research works done on the use of concept mapping and co-operative learning strategies to assist learners, were at the international level. Also, comparing the efficacy of concept mapping and co-operative learning strategies rooted in constructivist teaching and learning theory on students' conception and performance in excretion is less. Therefore, there is the need to fill these gaps. Hence, the purpose of this study was to compare the effectiveness of concept mapping and co-operative learning strategies on students' conception and cognitive achievement in excretion in Aburaman SHS in the Abura-Asebu-Kwamankese District in the Central Region of Ghana.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter presents the methodology employed for the study. The sub-headings considered under this chapter include the research design, population, sample and sampling procedure, research instrument, pilot test, validity, discrimination and difficulty indices, reliability of the instrument, data collection procedures and data analysis.

3.1 Research Design

This study was meant to determine the effect of concept mapping and co-operative learning approach on cognitive achievement of Senior High School students in excretion. Therefore, quasi-experimental research design involving non-equivalent pre-test,intervention, post-test with two intact classes was considered appropriate.

According to Creswell (1994), non-equivalent pre-test and post-test design model is a popular approach to quasi-experiments. Gall, Gall, and Borg (2003) noted that a quasi-experimental pre-test and post-test research design was the most powerful research method for establishing cause and effect relationships between two or more variables. Ofori and Dampson (2011) confirmed that this method has the "goal of providing evidence about causal relationship" (p. 150). That is, it tries to find out what leads to what. Another reason for the use of this method was that the participants were not randomly selected and assigned to the groups (Creswell, 1994; McMillan, 2000). The use of the intact classes was preferred because randomisation was impractical since all the lessons were conducted during the school instructional time. Wambugu and Changeiywo

(2008) and Wachanga and Mwangi (2004), similarly confirmed that quasi-experimental design has been used successfully in research studies to determine the effect of teaching approaches on student performance in countries like Kenya.

3.2 Population

The target population in this study was SHS elective biology students in Aburaman SHS in Abura-Asebu-Kwamankese District in the Central Region, while the accessible population was second-year elective biology students in Aburaman Senior High School. The factors that were considered for the selection of the school included: 2011, 2013, 2014 and 2015 WASSCE results in biology which were not encouraging.The school had nine elective biology classes, science laboratory and a library stocked with elective biology textbooks. Finally, the school is located in the district capital and it is attended by student from both rural and urban areas. The researcher looked at these and ascertained its suitability for the study.

In all, there were nine intact elective biology classes in the school, totalling 328. Three intact classes for General Science programme (N = 109) and six intact classes for Home Economics programme (N = 209) in the school. SHS 2 elective biology students were considered appropriate for this study because the topic (excretion) considered in the study is in the second year of the biology syllabus.

3.3 Sample and Sampling Procedures

The two SHS 2 Home Economic intact classes were purposively selected for the study. Creswell (2009) and Fraenkel and Wallen (2000) stated that purposive sampling is employed because of the special characteristics of the school in facilitating the purpose of the research. In purposive sampling, the units of the sample are selected not by a random procedure, but they are intentionally picked for the study because of their distinctive characteristics.These two intact classes were intentionally chosenfrom the same year level, offering the same programme and thus follow the same time table. Also, the intact classes were used for the study so that the contents treated would be beneficial to all students in the selected classes. Further, the entire class was used to avoid disruption of lessons during the school session.

The two SHS 2 Home Economic students totalled eighty (N = 80) were made up of thirty eight (N = 38) students in one class and forty two (N = 42) students in the other class. The intact class with the lesser number of students (N = 38) was assigned to the concept mapping group and labelled X while the other intact class with the larger number of students (N = 42) was assigned to the cooperative learning group and labelled Y.

To ascertain the effectiveness of each instructional approach (i.e. concept mapping instructional approach and co-operative learning instructional approach), the students in each group were pre-tested to ascertain their entry level. The pre-test helped the researcher to determine the striking difference in the performance of the two groups in terms of distance they travelled after the execution of the interventions.

3.3.1 Number of students in each instructional approach group. Eighty students participated in the study: 38 in the concept mapping group and 42 in co-operative learning group. However, during the data entry, it was found that four students (three from concept mapping group and one from the co-operative learning group) did not have both the pre-test and the post-test scores. The distribution of students who had complete scores in the various instructional groups is illustrated in Table 2.

Table 2: Distribution of Students in the Two Instructional Approach Groups

Instructional Approach	Male	Female	Total
Concept Mapping Group (CMG)	1	34	35
Co-operative learning Group (CLG)	-	41	41
Total	**1**	**75**	**76**

From Table 2, the actual number of students used for data analysis was 76 comprising 35 students for concept mapping group and 41students for the co-operative learning group. In all, there were seventy-five (98.7%) females and one (1.3%) male. Thus, majority of students involved in the study were females. The activities each group undertook are described as follows:

3.3.2 Group X: Concept mapping instructional approach group. The concept mapping group was taught using concept mapping instructional approach. First, the researcher explained the meaning of concept mapping to the students. As an introductory activity, the researcher illustrated a simple concept map on parts of a tree on the white board. Students were then asked to construct a simple concept map on the organs of excretion in man for the first time in their practice using the biology textbooks. The students were guided to use graphic organisers to demonstrate relationship between concepts in excretion. They were then guided to choose/list key concepts and organise the concepts orderly (hierarchy). This was followed by assisting them to use valid links (propositions), cross-links, and examples (events or objects) to construct the map of rank-ordered concepts (usually lead to “rework” maps). After that was done, the students were given the opportunity to evaluate their work by inviting individuals to present their maps on the white board for whole class discussion. The discussion was meant to improve their work and also to initiate them into further critical thinking, reconstruction and re-evaluation of their work. An illustration of a simple concept map on excretion is shown in Figure 3.

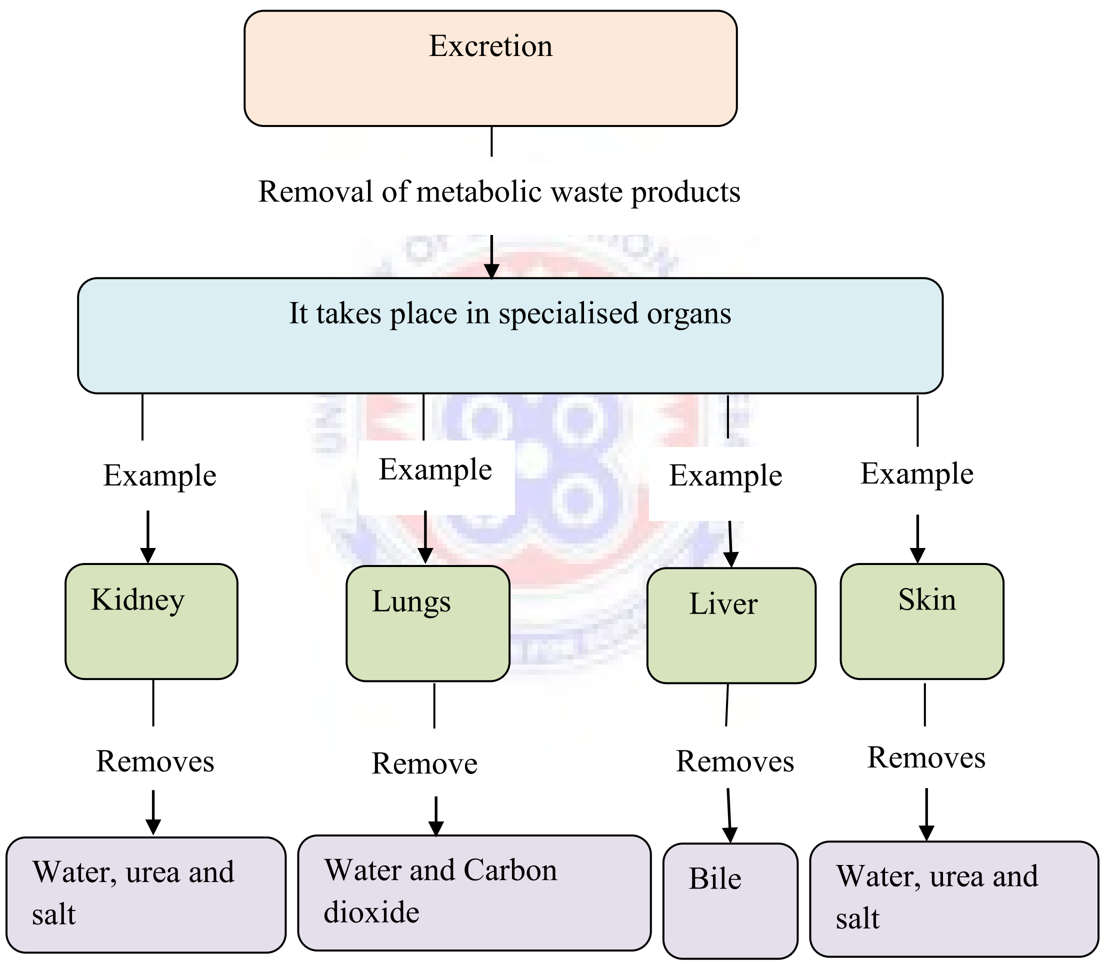

Figure 3: Concept Map of Excretion

Further, the researcher used a concept map to provide activities that helped to assess and consolidate students' understanding of the concept of excretion. For instance, a concept map on urinary system was devised by leaving out the labels of certain key concepts or steps for students to complete (Figure 4).

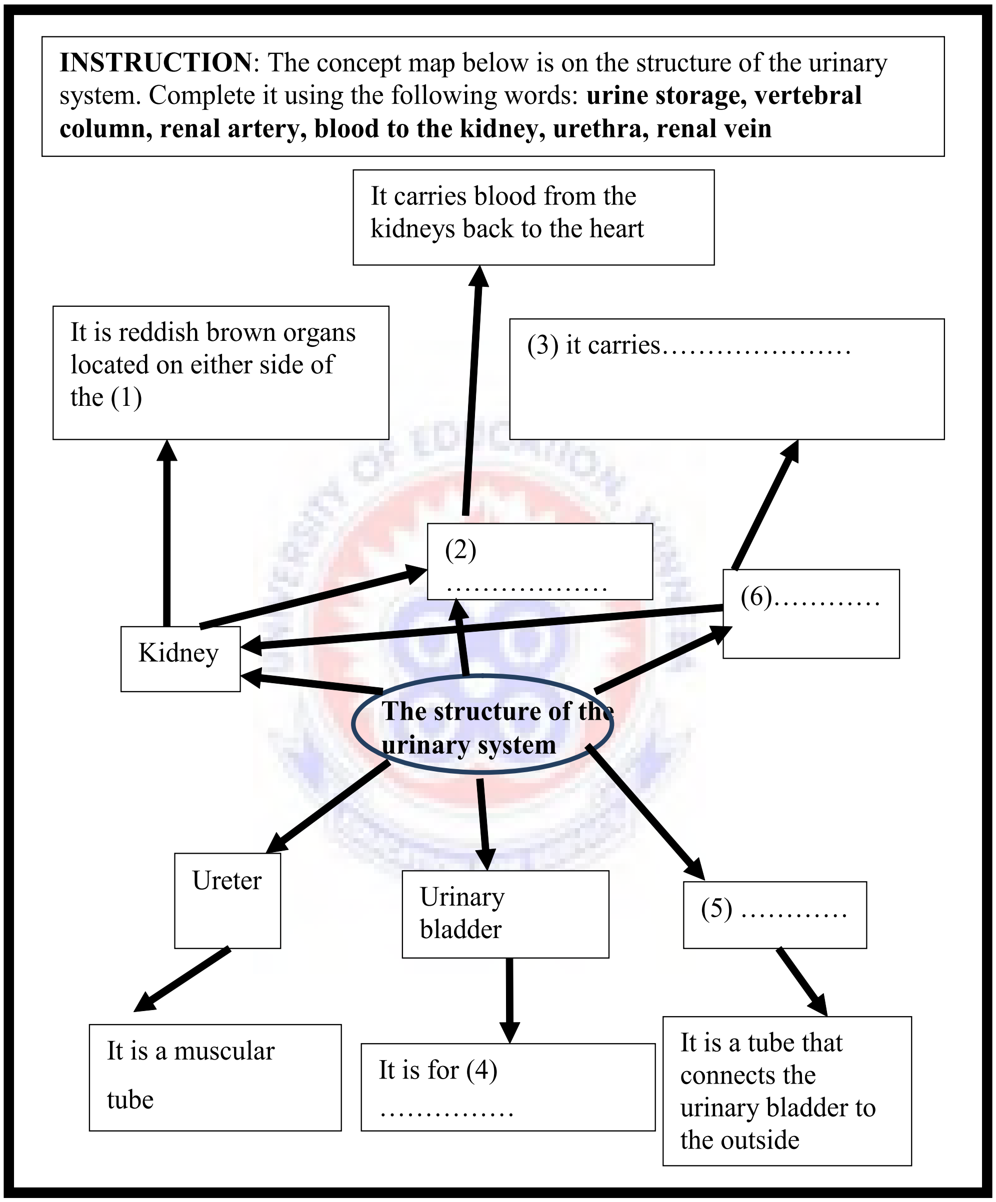

Figure 4: Worksheet on Urinary System for the Concept Mapping Group (Developed by the Researcher)

3.3.3 Group Y: Co-operative learning instructional approach group. The co-operative learning group was taught using co-operative learning instructional approach. In this study, Student Teams Achievement Divisions (STAD) model of co-operative learning was employed. It is a very easy model to implement in the science classroom. STAD operates on the principle that students work together to learn, and are responsible for their teammates' learning as well as their own (Kutnick, 1990).

The learners were grouped into permanent learning groups of five members each; where members were taught in co-operative manner (Guskey, 1990). Each member had a specific role in the group: leader, monitor, recorder, resource manager and reporter. The group leader facilitated group discussions, by ensuring that the team remained focused on the set academic goals and worked to meet them; the monitor ensured that everyone got equal opportunity to participate and also monitored the time spent on each task; the resource manager gathered and organized materials for the team activities; the recorder kept written records of team reports and answers; and the reporter shared team reports and answers during whole class discussions.

The grouping was heterogeneous in terms of ability as students' scores from the pre-tests were used as measures of their individual abilities during the team formation. This means that each group consisted of members with high, average and low scores.

Lessons began as a whole class instruction for 10 minutes. The researcher then made an exposition, focusing on what the students were expected to do during the lesson. The students then went into their co-operative teams for 50 minutes where they were provided with worksheets that directed them on what to do. In these co-operative teams, students read selected texts from approved biology textbooks or carried out activities while the researcher went round the groups and offered assistance, where necessary. They finally discussed and answered questions on the work sheets. A case in this study was when the students in their small groups were asked to complete the task on urinary system as shown in Figure 5.

INSTRUCTION: Use the following words to complete the sentences on the urinary system: **urine storage, vertebral column, blood to the kidney, urethra, renal vein.**

1. The reddish brown organs located on either side of the ………………are the kidneys.
2. ………………carries blood from the kidneys back to the heart.
3. Renal artery carries…………….
4. The urinary bladder is for ………………………..

Figure 5: Worksheet on Urinary System for Co-operative Learning Group (Designed by the Researcher)

The students in a team had to discuss the questions on the worksheet and come to a consensus about the answer to put down. Upon completion of the worksheets, the last 20 minutes of the lesson were spent by the entire class discussing the correct answers to the questions in the worksheets. The researcher read a question aloud and randomly picked a team and the reporter in that team responded to the question. Correct response was applauded by the whole class and if the response was not satisfactory, the question was presented to another team for correct response.

3.4 Instruments

The instruments used in the study were achievement tests, class exercises and homework/assignments. The achievement tests were classified into two: General Knowledge in Biology Performance Test (GKBPT) and Students' Performance Test in Excretion (SPTE). Both tests were developed by the researcher.

The GKBPT (see Appendix A) comprised 20 multiple choice test items, 5 true or false test items and 5 fill-in the blanks. The questions were constructed from the treated topics drawn from the elective biology syllabus. The GKBPT was used for the pre-test and its marking scheme is shown in Appendix B. The purpose of the pre-test was to determine students' level of understanding of some of the biology topics treated and to determine the striking difference in the performance of the two groups in terms of distance they travelled after the execution of the interventions.It was also to ensure the equivalence of the selected groups and consequently the credibility of the study findings (Cohen, Manion & Morrison, 2000).

The Students' Performance Test in Excretion (SPTE) also consisted of 20 multiple choice test items, 5 true or false test items and 5 fill-in the blanks but the questions were constructed based on the lessons taught and the learning objectives of the SHS biology curriculum. The SPTE and its marking scheme can be seen in Appendices C and D respectively. The SPTE was used as a post-test to assess students' performance and conception in excretion after the instructional period.

The teacher made-achievement tests (GKBPT and SPTE) were preferred in this study to other types of tests for the following reasons. It reflects instruction and curriculum; it is sensitive to student's ability and needs; it provides immediate feedback about student progress; and finally, it can be made to reflect small changes in knowledge (O'Malley, 2010).

On the other hand, teacher-made achievement test has been criticised that it may not reflect content standards; it has little variety in types of assessment used; it is informal or unstandardised; and it has concerns about validity and reliability. In this study, the following measures were taken to address these concerns. The principles of test construction provided by Etsey (2008) and O'Malley (2010) were followed strictly to construct the test items; table of specification was prepared and used for the construction of the test items; content and face validity were ascertained by supervisors of this study; and finally, the achievement tests were pilot tested to ascertain their validity and reliability.

Finally class exercises and homework/assignments were used to monitor students' progress and understanding of the concept thought during the instructional period. Also, some of the exercises were in the form of worksheets which entailed the guided activities the students followed through to enhance conceptual development and understanding of the topic (excretion). Copies of the students' worksheet were provided for each instructional group.

3.5 Pilot Test

A school that had similar characteristics as one that the main study took place in was purposively and conveniently selected for the pilot test. The reason for pilot testing of the pre and post-tests were to ascertain the validity and reliability of the test items. It was also to determine whether the test items were appropriate or too complicated. Again, the pilot test was conducted to mainly improve the internal validity of the achievement tests.

Teijlingen and Hundley (2011) confirmed that administering the instruments to pilot subjects in exactly the same way as it will be administered in the main study helps to ask the subjects for feedback. This helps to identify ambiguities and difficult questions.

The pilot test helped to record the time taken to complete the pre and post-tests and decided whether it was reasonable. It helped to discard all unnecessary, difficult or ambiguous questions. It gave opportunity to assess whether each question gave an adequate range of responses. It provided an opportunity to re-word or re-scale any question that was not answered as expected. It helped establish the characteristics of the test items such as the item analysis, item difficulty, and discrimination indices.

3.6 Validity

In this study, face and content validity were used to ascertain the validity of the instrument. Face and content validity are qualitative measures of validity and are often employed in educational research because they are the easiest to ascertain.

Further, item analysis was performed to determine whether an item functions as intended. The item analysis provided information whether the item was of the appropriate level of difficulty or whether it distinguished between high achievers and low achievers or whether the options were working.

3.6.1 Face Validity. Burton and Mazerolle (2011) defined face validity as the evaluation of an instrument's appearance by a group of experts and/or potential participants. It establishes an instrument's ease of use, clarity, and readability. The face validity points out that the instrument is pleasing to the eye and applicable for intended purpose. That is the face validity indicates the extent to which the instrument appears to measure what it is meant to measure. In this study the two teacher-made achievement tests were given to experts in science education particularly the principal supervisor and the co-supervisor of this thesis to read for necessary corrections and suggestions.

3.6.2 Content Validity. Content validity refers to the appropriateness of the content of an instrument (Biddix, 2009). That is, content validity determines whether the questions accurately assess what one wants to know. This is particularly important with achievement tests. It involves taking representative questions from each of the sections of the unit and evaluating them against the desired outcomes. To ensure the content validity in this study, the test was constructed based on the instructional objectives of the lessons taught and the specific objectives in SHS biology syllabus and past questions on excretion from the WASSCE biology papers 1 and 2. Also, the content of the test items was assessed by the supervisors of this thesis and were found to be satisfactory. This method of validation of the instrument is supported by Apawu (2011). He explained that validity of the instrument refers to intended curriculum level and the validity is usually measured using what is called an expert analysis.

3.7 Discrimination Index

The discrimination index was calculated for each test item of the GKBPT and SPTE (Appendix E). The discrimination index is the difference between the percentage of students in upper and lower groups who got the items correct. Generally, students who did well on the test should select the correct answer to any given item on the test. Thus, discrimination index distinguishes for each item between the performance of students who did well on the test and students who did poorly.

To calculate the discrimination index, first the marked papers were arranged from highest score to the lowest score. The papers ($N = 60$) were grouped into three: upper, middle and lower groups using top 27% (16 students) and the bottom 27% (16 students).

The formula used to calculate the discrimination index is

$$D = \frac{RU - RL}{\frac{1}{2}N}$$

Where D = discrimination index, RU = number among the upper 27% of respondents who scored the item correct, RL = number among the lower 27% of respondents who scored the item correct and N= total number of respondents.

For examination with a normal distribution, discrimination index of 0.3 and above is good; 0.6 and above is very good. Values close to zero mean that most students performed the same on an item. The index should never be negative (Oosterhof, 1990). The indiscrimination indices for all the items in the GKBPT were found to be within the acceptable range. However, items Q19, Q22, Q26, and Q27 of the SPTE had low discrimination indices and were carefully examined for possible presence of ambiguity and clues.

3.8 Difficulty Index

The difficulty index for each item of the GKBPT and SPTE (Appendix F) was calculated. The difficulty index is the percentage of the total number of students who got the item correct. Difficulty index can also be interpreted as how easy or how difficult an item is. This was calculated using the following formula

$$DI = \frac{R}{T}$$

Where $D1$ = difficulty index, R = number of correct responses, T = total number of students.

Santos (2007) suggested a benchmark for interpreting the difficulty index. He suggested that items with difficulty index of 0.00 to 0.25 means the item is difficult and needs to be revised or discarded, 0.26 to 0.75 means the item is appropriate and needs to be retained and 0.76 to 1.0 means the item is too easy and the item needs to be revised or discarded.

From the calculation, items 14, 17, and 30 of SPTE were too easy (see Appendix F). These items were revised and maintained. In all, the results from the difficulty index helped to carefully examine the options for each item and the necessary corrections were then made.

3.9 Reliability

The Kuder-Richardson 20 formula (K-R 20) was used to determine the reliability coefficients of the achievement test items. The reason for choosing K-R 20 test statistics is it measures the internal consistency of items with dichotomous choices. It is analogous to Cronbach's alpha, except that the Cronbach's alpha is use items that are non-dichotomous (continuous) (Kuder& Richardson, 1937; Cortina, 1993). Table 3 provides the reliability coefficients of the achievement tests.

Table 3: The Reliability Coefficients of the Achievement Tests

Test	Number of students	Number of items	K-R 20
GKBPT	60	30	0.812
SPTE	60	30	0.866

From Table 3, the K-R 20 reliability coefficients of the achievement test items for GKBPT and SPTE were found to be 0.812 and 0.866 respectively. The reliability coefficient of 0.866 means that 86.6% of variability in scores is due to true score differences among examinees, while the remaining 14.4% (1.00 - 0.866) is due to measurement error. Therefore, the reliability coefficients of 0.812 and 0.866 obtained in this study confirmed that the achievement tests used in the main study were within the acceptable benchmark of instruments being reliable (Leedy & Ormrod, 2005; Johnson & Christensen, 2000; Wiseman, 1999; Thorndike & Hagen, 1997).

3.10 Data Collection Procedure

Introductory letter (see Appendix G) issued by the Department of Science Education, University of Education, Winneba and signed by the head of department was collected. The letter helped the researcher seek permission to collect data from the school. Before the introductory letter was given, the researcher visited the school where the study was intended to take place for familiarisation. This was done to establish good working relationship with both students and the teachers. An arrangement was made with the class teacher for a double-period (80 minutes) per week for six weeks.

In the first week, a pre-test was administered, marked and analysed to determine the entry level of each group. The actual teaching spanned over four weeks. Each week the researcher met each instructional group for a lesson. All the classes worked on various activities on the topic (excretion). Students were made to understand that though they were learning the same topic, different approaches were used to see which class comes out as the best at the end of the programme so they should not discuss homework with their colleagues in the other class.

The post-test which lasted for 40 minutes was administered at the end of the four weeks of lessons. The class teacher was engaged to help in the invigilation of the test to ensure that the students did not cheat. The researcher did the scoring of the achievement test and the scores were analysed.

3.11 Data Analysis

The study was meant to provide answers to the following questions: (1) What misconceptions do SHS 2 students hold about the concept of excretion? (2) To what extent does the use of concept mapping instructional approach improve students' cognitive achievement in excretion? (3) To what extent does the use of co-operative instructional approach improve students' cognitive achievement in excretion? (4) What difference exists in the cognitive achievement between students in concept mapping group and co-operative learning group on their conceptions of excretion? Also, the study was meant to test the hypothesis: "There is no significant difference in the cognitive achievement between SHS 2 students taught with concept mapping and those taught with co-operative learning instructional approaches in excretion" at 5% level of significance.

The research question 1 was meant to explore the students' misconceptions in excretion before the interventions were executed. Point Biserial Correlation was used to analyse the three objective questions meant to explore their misconceptions. Also, students' written responses to questions on excretion were analysed qualitatively. Again, since the sample was selected purposively, Wilcoxon Signed Rank Test which is non-parametric test for paired sample *t*-test and effect size statistics were used to answer the research questions 2 and 3. Box plot was also used to give pictorial representation of the performance of the students in the achievement test. The Wilcoxon Signed Rank Test statistic was used to find whether the performance of students within each group improved or not while the effect size was used to determine magnitude of improvement in each group. The choice of the Wilcoxon Signed Rank Test statistic was essential because two observations (i. e. pre-test scores and post-test) were made on each student in the concept mapping and co-operative learning groups. The dependent variable for research questions 2 and 3 was the achievement scores the students obtained in both pre and post-tests. The independent variable in these research questions was the teaching method (categorised into concept mapping instructional approach and co-operative instructional approach).

For research question 4, the students' written responses of homework/assignment and class exercises were analysed qualitatively to bring out the extent to which the use of each instructional approach (concept mapping and co-operative learning) helped improve students' conception of excretion. Also, the chi-square statistic was used to establish whether there was a significant relationship between the students in concept mapping group and co-operative learning group on their conceptions of excretion.

The ANCOVA was used to test the hypothesis. The pre-test scores from the teacher made achievement test served as the covariate to control for pre-existing differences between the groups. Also, this test statistic is very useful in situations when the difference existing between the two groups has small or medium effect size.

Finally, Cohen *d* statistic was used to determine the effect size. Since the difference in the performance of excretion by the two groups could occur by chance, the effect statistic provides an indication of the magnitude of the difference within groups and among the two groups The benchmark for interpreting Cohen *d* values are 0.20= small effect, 0.50 = moderate effect, 0.80 = large effect and 1.30 = very large (Ellis, 2009). Therefore, the Cohen *d* value determined in this study was compared with these standard values and conclusion drawn thereafter.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

In this study, the researcher employed pre-test and post-test of non-equivalent groups quasi-experimental design to determine the effect of using concept mapping and co-operative learning as instructional approaches on the students' performance in excretion. It was to explore the extent to which concept mapping and co-operative learning as instructional approaches improved students' conception of excretion. This chapter presents and discusses the main results of the study where both descriptive and inferential statistics were used for the analysis in response to the research questions.

4.1 Research Question 1: What Misconceptions do SHS 2 Students hold about the Concept of Excretion?

In Ghana, the concept of excretory system is not captured as a full topic in the Junior High School (JHS) integrated science syllabus (Ministry of Education, Science and Sports, 2007). However, this is captured in both integrated science (Ministry of Education, 2010) and elective biology (Ministry of Education, Science and Sports, 2008) at the SHS level.

In this study, the researcher concentrated on the contents needed to be treated in elective biology. However, since the students in this study had earlier received instruction in excretory system in the integrated science lessons, the researcher was interested in identifying whether the students held any misconceptions from their previous lessons.

To verify students' misconceptions of excretion, they were asked to provide responses to questions on excretion (Figure 6) prior to the execution of the interventions and their responses were analysed as follows.

Name of student:……………………………………………………

Instruction: choose the correct option for questions 1 to 3.

1. The lung is responsible for ………………………………………………………..
   A. recycling worn out red blood cells and urea
   B. producing carbon dioxide only
   C. excreting carbon dioxide and water
   D. removing water, salt and urea

2. Which of these organs is concerned water regulation in the mammal?
   A. Liver
   B. Skin
   C. Lung
   D. Kidney

3. Which of the following processes is not a function of the mammalian skin?
   A. Protection
   B. Temperature control
   C. Excretion
   D. Absorption

4. Differentiate between excretion and egestion. Give one example of each.
   ……………………………………………………………………………
   ……………………………………………………………………………
   ……………………………………………………………………………
   ……………………………………………………………………………

Figure 6: Test Items Assessing the Students' Conception of Excretion

The items 1 to 3 are low level questions requiring the students to recall the functions of the various excretory organs-lungs, kidney and skin. The point biserial correlation was used to calculate the item-test correlation, which serves as the discrimination index. As a rule of thumb, a discrimination index greater than or equal to 0.2 is usually considered as acceptable (Table 4).

Table 4: Students' Performance on the Excretion Test Items (N = 76)

Item No.	Number of students who chose Option				Discrimination Index
	A	B	C	D	
1	13(17.1%)	22(29.0%)	32(42.1%)*	9(11.8%)	0.41
2	25(32.9%)	6 (7.9%)	11(14.5%)	34(44.7%)*	0.52
3	16(21.1%)	21(27.6%)	6(7.9%)	33(43.4%)*	0.42

The correct option is marked with asterisk *

From Table 4, the frequency of choices made by the students on the distracters for the various test items (items 1 to 3) divulged the prevalence of certain misunderstandings on excretion. The pattern of responses across ability groups provided some insight into the nature of the misconceptions. According to their overall performance in this test, the students (N = 76 comprising 34 concept mapping group, CMG, and 41 co-operative learning group, CLG) were divided into five ability groups of equal numbers; the first 20% ability group included students with the lowest scores while the top 20% ability group was made up of those with the highest scores. The number of candidates in the five ability groups choosing each option are presented in the form of a line graph. The patterns of performance thus obtained illustrated how well an option, whether it is the correct answer or a distracter, discriminated the high-ranking and low-ranking students. For instance, the students' overall performance on item 1 is illustrated in Figure 7.

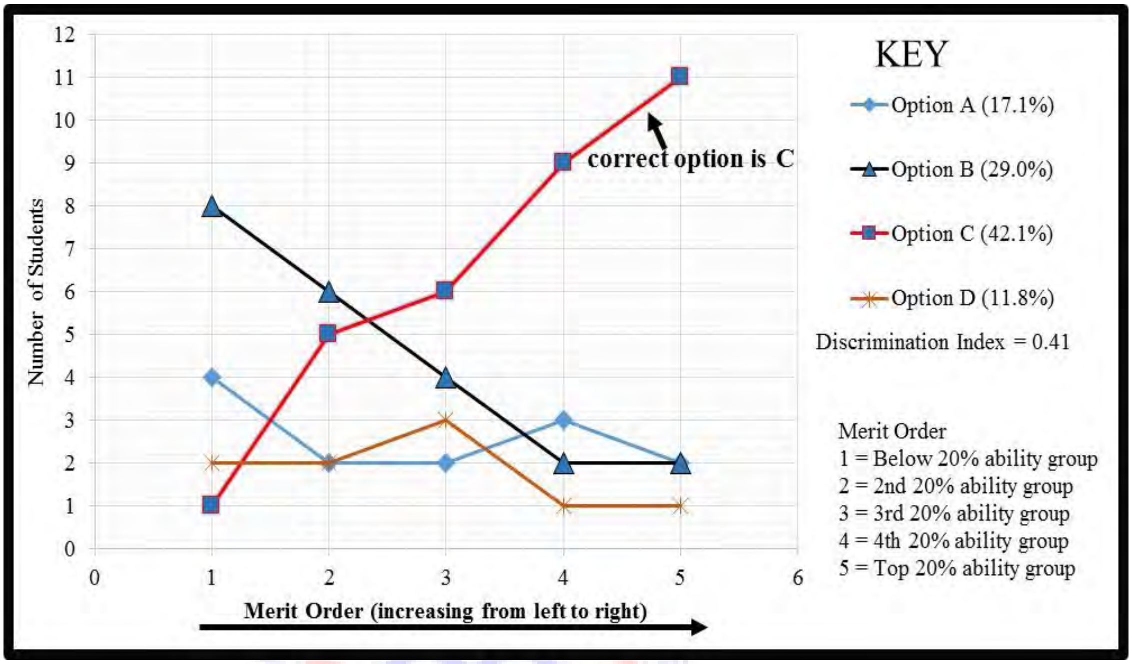

Figure 7: Students' Performance on Item 1 on Excretion

The concept of excretion is elementary to the SHS biology curriculum and is usually introduced to students at a very early stage of the course when teaching about the characteristics of living organisms while the mechanisms of excretion are elaborated on, at a later stage. The poor performance on this item is therefore rather startling as it was correctly answered by less than half of the candidates (42.1%, comprising 15 out of 35 CMG and 17 out of 41 CLG); most students did not recall that the lung is responsible for releasing carbon dioxide and water. One possible reason for the low success rate is that many students were not able to relate the removal of carbon dioxide during exhalation to an excretory role the lungs play. It could also be that the students did not have in their repertoire that the lung removes carbon dioxide and water (waste products of cellular respiration). These waste products are expelled in the form of gas during the process of exhalation. Also, 15 out of 35 CMG and 17 out of 41 CLG who correctly answered that the lung is responsible for releasing carbon dioxide and water is an indication that majority of the students in both group did not have the correct conception of excretion though they had been taught in the integrated science before this study.

Option B was a very strong distracter as it attracted a significant number of students (29.0% comprising 10 out of 35 CMG and 12 out of 41 CLG). These students wrongly considered carbon dioxide as the only metabolic waste removed by the lung. The line graph for this option demonstrates that this flawed view was prevalent among the middle- and low-ability groups. This pattern suggests that the idea of metabolic waste is a difficult and abstract concept for the average student and is not well conceptualised even after formal instruction.

Option D attracted the least number of students (11.8% comprising 4 out of 34 CMG and 5 out 41 of CLG). It is the skin but not the lung that is responsible for the release of water, salt and urea. It is quite unfathomable that students who had received formal instruction in excretion could erroneously think that the lung is responsible for releasing water, salt and urea.

Furthermore, the students' written responses to item 4 (*Differentiate between excretion and egestion. Give one example of each.*) indicated that most students provided scientifically acceptable definitions for excretion and egestion. The distribution of the students' responses were categorised into correct definition with example, correct definition but wrong example, wrong definition but correct example and wrong definition and wrong example (Figure 8).

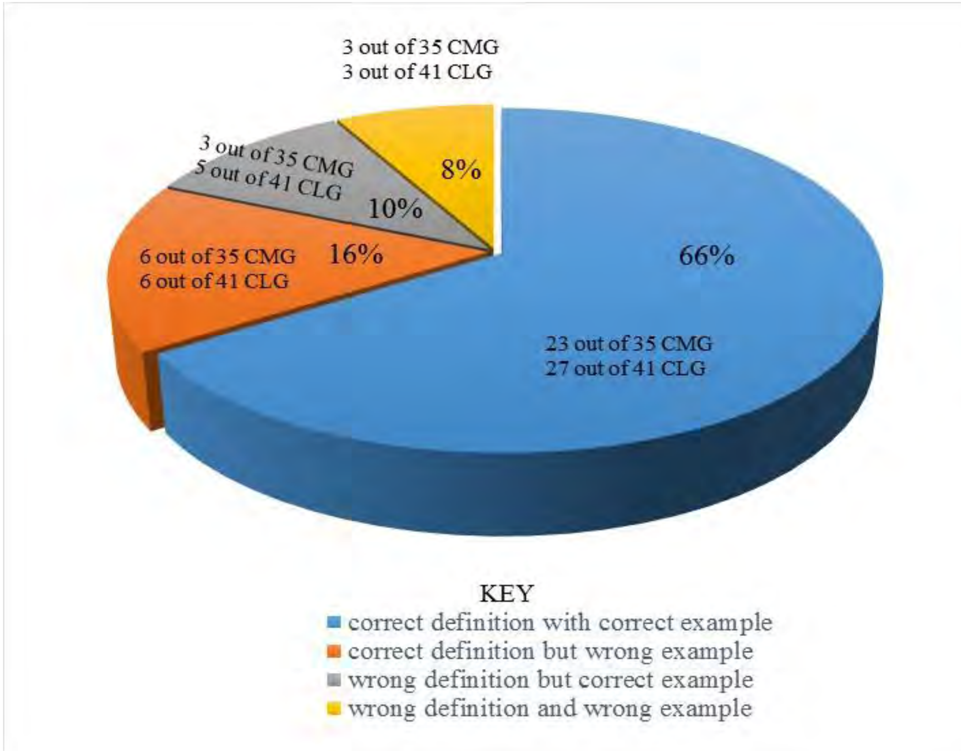

Figure 8: Students' Performance in the Written Response of Excretion Test Item

The results in Figure 8 show that the students (66% comprising 23 out of 35 CMG and 27 out of 41 CLG) were able to define excretion and egestion with one correct example of each. Excretory wastes of the body include; carbon dioxide, urea, water and salt while indigestible food substances (faeces) as egestion. Though majority of the students were able to demonstrate an adequate level of understanding of the meaning of excretion and egestion, the 34% of students (comprising 12 CMG and 14 CLG) who were unable to provide correct response is very significant and alarming.

To recap, the erroneous response these students provided to the test items on excretion clearly shows that there are some misconceptions and misunderstanding perpetuated by the students after they had received formal instruction. Therefore, a robust instructional approach is really needed to address the students' misconceptions and performance in excretion.

4.2 Research Question 2: To What Extent does the Use of Concept Mapping Instructional Approach Improve Students' Cognitive Achievement in Excretion?

To verify the extent to which the use of concept mapping as an instructional approach improve students' cognitive achievement in excretion, the mean, standard deviation, effect size and Wilcoxon Signed Rank Test statistics were used to analyse the students' pre-test and post test scores (Table 5). Also, box plot (Figure 9) was used to give pictorial illustration of the performance of the students in the achievement of both pre-test and post-test scores.

Table 5: Comparison of Pre-test and Post-test Scores of Students Taught with Concept Mapping Instructional Approach (N = 35)

Test	*M*	*SD*	Wilcoxon Signed Rank Test (Z statistic)	*p*-value	Effect Size (Cohen *d*)
Pre-test	13.17	2.16	-5.16	0.001	3.07
Post-test	22.09	3.50			

Significance level, $\alpha = 0.05$, *M* = Mean, *SD* = Standard Deviation

From Table 5, the students' mean scores of the achievement test before and after the use of the concept mapping instructional approach are 13.17 (*SD* = 2.16) and 22.09 (*SD* = 3.50) respectively. There has been an increase in the achievement test scores from pre-test (prior to the intervention) to post-test (after the intervention). Also, it can be seen from the result in Table 5 that there was a mean difference of 8.92 between the pre-test mean scores and post-test mean scores. The Wilcoxon Signed Rank test was conducted at

5% significant level to find out if the mean difference of 8.92 was significant. This revealed a statistically significant difference in the learners' achievement in excretion ($Z = -5.16$, p-value = 0.001 < 0.05) .The effect size statistic (Cohen $d = 3.07$) indicated large effect size which implied that concept mapping instructional approach had a positive effect on the learners' achievement. That is, there was a substantial difference in the students' achievement test scores after the teaching of excretion through concept mapping. Pictorially, the difference between the students' pre-test and post-test scores in terms of distance travelled is shown in Figure 9.

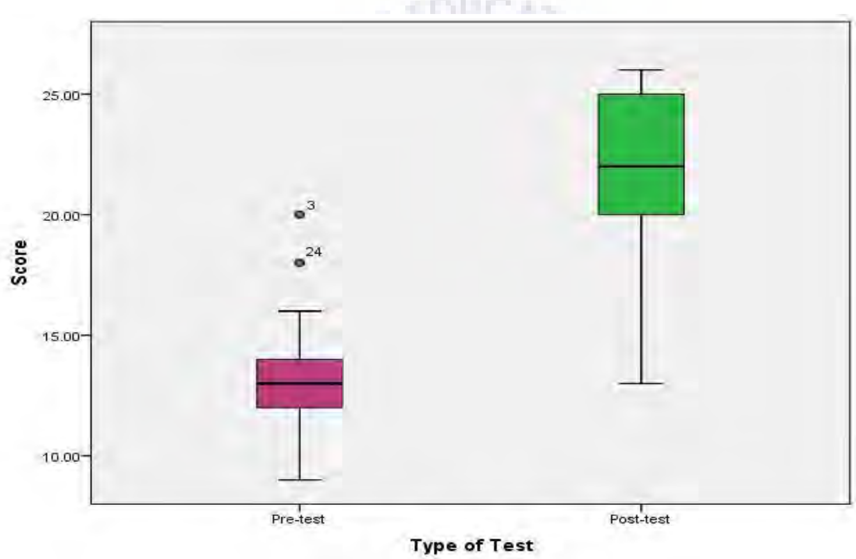

Figure 9: Performance of Concept Mapping Learning Group in the Pre-test and Post-test

From Figure 9, it can be observed that the learners improved tremendously in their achievement and understanding of excretion through the use of concept mapping. For instance, it can be seen from the box plot that the minimum score the students obtained in the post-test is approximately equal to the mean score they had in the pre-test.

This seems to suggest that using the concept mapping as an instructional approach could enhance students' performance greatly.

4.3 Research Question 3: To What Extent does the Use of Co-operative Instructional Approach Improve Students' Cognitive Achievement in Excretion?

To determine the extent to which the use of co-operative learning as an instructional approach improve students' cognitive achievement in excretion, the mean, standard deviation, effect size and Wilcoxon Signed Rank Test statistics were used to analyse the students' pre-test and post test scores (Table 6). Also, box plot (Figure 10) was used to illustrate the students' performance in excretion in terms of distance travelled.

Table 6: Comparison of Pre-test and Post-test Scores of Students Taught with Co-operative Instructional Approach (N = 41)

Test	*M*	*SD*	Wilcoxon Signed Rank Test (Z statistic)	*p*-value	Effect Size (Cohen *d*)
Pre-test	15.27	3.29	-5.56	0.001	2.56
Post-test	24.49	2.24			

Significance level, $\alpha = 0.05$, *M* = Mean, *SD* = Standard Deviation

The results in Table 6 show that the improvement in students' cognitive achievement in excretion is statistically significant (Pre-test: *M* = 15.27, *SD* = 3.29; Post-test: *M* = 24.49, *SD* = 2.24; Z = -5.56, *p*-value = 0.001). Thus, the use of co-operative learning as an instructional approach significantly enhanced students' mean score achievement in excretion. To ascertain whether the students' improvement in mean achievement score did not occur by chance, an effect size statistic was computed using the Becker's effect size calculator online. The effect size statistic of 2.56 indicates large effect size. This implies that the use of co-operative learning as an instructional approach significantly improved the students' cognitive achievement in excretion.

Furthermore, the illustrations in the box plot (Figure 10) confirm the extent to which the students had improved in terms of performance in excretion because of the use of co-operative learning instructional approach.

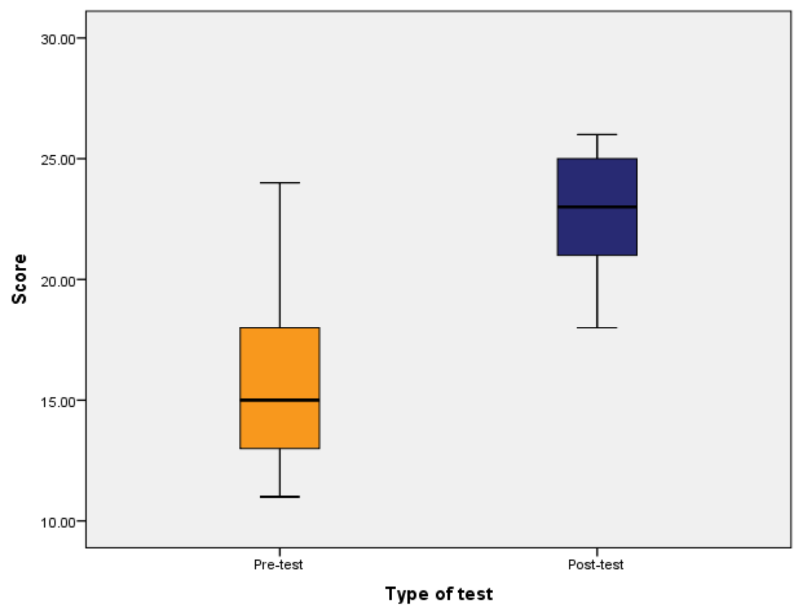

Figure 10: Performance of Co-operative Learning Group in the Pre-test and Post-test

Noticeably, it can be seen from the box plot (Figure 10) that the students' performance in excretion was enhanced massively due to the use of co-operative learning instructional approach. From Figure 10, the minimum score recorded in the pre-test was 11 while the maximum score was 24. Thus, as a result of the intervention the minimum score the students had in the post-test which is 18, is almost twice the one obtained in the pre-test. This implies that when co-operative learning is effectively employed it could perk up students' achievement in biology.

4.4 Research Question 4: What Difference exists in Cognitive Achievement between Students in Concept Mapping Group and Co-operative Learning Group on their Conception of Excretion?

After the students had received instructions in their respective groups, the researcher was interested to know whether they had developed correct conception of excretion or otherwise. This investigation was premised on studies that indicated that students harbour many misconceptions relating to basic biological concepts after teaching (Songer & Mintzes, 1994; Westbrook & Marek, 1992). In this study, the relationship of students' conception of excretion in terms of particular instructional approach they received was determined through the written responses the students gave to the questions on excretion. The students' responses to each item consisted of two parts. The first part required the students to highlight the part(s) of the statement that is/are incorrect by underlining the relevant words or phrases. The second part was a justification of the students' choice. An item was considered to be answered correctly only when the incorrect part is highlighted, together with a proper explanation. Thus a wrong response for an item would suggest that the student held an erroneous or inaccurate idea of the concept concerned. The elaboration provided by the students also revealed the students' thinking processes and the causes of misconception. Most questions asked tested students' knowledge/comprehension and application/analysis skill levels. The analysis of the students' response to the items on excretion is illustrated in the following paragraphs.

Definition of deamination: The statement was "*Deamination is the removal of the amino group from urea to make ammonia*". This question was purposively asked to test whether the students in each instructional group could recall the definition of the term *deamination* after they had received instruction in excretion. The statement is incorrect because of the word *urea*. The students needed to recall that *deamination is the removal of the amino group from amino acid to make ammonia* and therefore they were required to underline the word *urea* and replace it with *amino acid*. In the human body, surplus amino acids are normally deaminated to form ammonia and a-keto carboxylic acids; the ammonia then combines with carbon dioxide to form urea through the ornithine cycle while the carboxylic acids are metabolised as carbohydrates or lipids. It was found that most students in the two instructional groups gave satisfactory response. The frequency count of the students' responses on the definition of deamination according to their instructional groups is shown in Table 7.

Table 7: Frequency Count of Students' Responses on the Definition of Deamination

Instructional Group	Number of student who provided		Total
	Correct response (%)	Wrong response (%)	
Concept mapping group ($N = 35$)	27 (77.1)	8 (22.9)	35 (100.0)
Co-operative learning group ($N = 41$)	30(73.2)	11(26.8)	41 (100.0)
Total	**57(75.0)**	**19 (25.0227)**	**76 (100.0)**

Chi-square (χ^2) = 0.159, *df* = 1, *p*- value = 0.690

The study showed that most of the students across the two instructional groups could define the term *deamination* satisfactorily. This was derived from the fact that 77.1% of students taught with concept mapping and 73.2% of students taught with co-operative learning groups provided the right definition of *deamination*. It can be seen from this results that, a greater proportion of students in the concept mapping group could define *deamination* as compared to co-operative learning group. However, there was no significant difference in cognitive achievement between the instructional approach the students received and their ability to define the term *deamination* (Chi-square (χ^2) = 0.159, *df* = 1, *p*-value = 0.690). This means that the students' ability to define a conceptin biology is independent of whether he/she received instruction in concept mapping approach or co-operative learning approach.

The excretory organ of insects: This question consists of the statement that "*The intestine and rectum are the main excretory organs in insects*". There was fallacy embedded in the statement and therefore the statement is incorrect. This question sought to test students' knowledge and comprehension of the function of malpighian tubules in insects. Here, the students were expected to conceptualise that malpighian tubules are found in the posterior regions of insects, where they (malpighian tubules) work with glands in the rectum to excrete waste and maintain osmotic balance (Figure 11).Therefore, the intestine and the rectum are not the main excretory organs of insects, it is rather malpighian tubules.

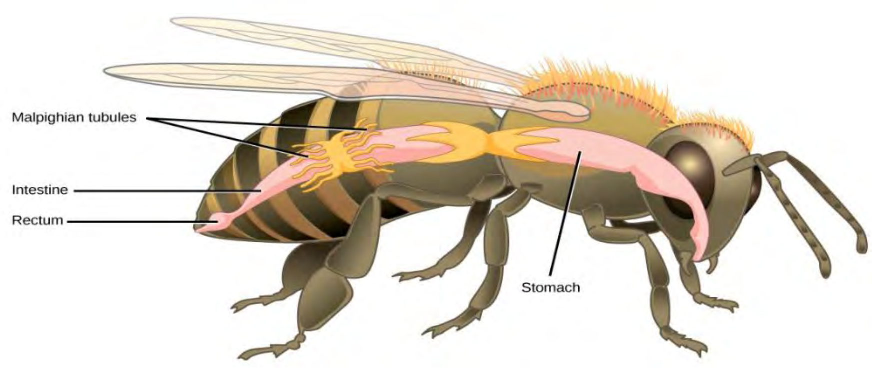

Figure 11: The Excretory Organ of an Insect
Source: Boundless Biology (2016).

The analysis of the students' response to this question indicated that while a greater number of students across the two instructional groups impressively did well, other students erroneously underlined either intestine or rectum or both and replaced it with words such as *lungs*, *amino acid* and *skin*. The distribution of students' responses according to their instructional group is illustrated in Table 8.

Table 8: Frequency Count of Students' Responses on the Excretory Organ of an Insect

Instructional Group	No. of students who provided		Total
	Correct Response (%)	Wrong Response (%)	
Concept mapping group (N = 35)	28 (80.0)	7 (20.0)	35 (100.0)
Co-operative learning group (N = 41)	32 (78.0)	9 (22.0)	41 (100.0)
Total	**60 (78.9)**	**16 (21.1)**	**76 (100.0)**

Chi-square (χ^2) = 0.043, *df* = 1, *p*-value = .835

The result in Table 8 indicated that 80% of concept mapping group and 78% of the co-operative learning group had correct conception that malpighian tubules are the main excretory organ in insects. Once again slightly more students in the concept mapping had correct conception of excretion than their counterparts in the co-operative learning group though the relationship was not significant (Chi-square (χ^2) = 0.043, *df* = 1, *p*- value = 0.835). Thus, irrespective of the instructional approach the students had, they held similar conception of excretory organ of insects.

Osmoregulation and Excretion: Because osmoregulation is a conceptual process that involves an understanding of biochemistry, form and function, and environmental constraints, students were asked free-response question to ascertain their understanding on osmoregulation and excretion. The question asked read "*A marine sea star was mistakenly placed in freshwater instead of sea water and it died shortly afterward. What is the most likely explanation for its death?*" This item was a high order level question which required the students to apply and analyse the concept they had learned on osmoregulation and excretion to explain why the marine sea star died shortly after it had been placed in freshwater. Here, the students needed to conceptualise that water is more likely to move into the cell through osmosis in a cell membrane or other living membrane-bound structure which has a higher concentration of solutes than its surroundings (i.e. hyperosmotic). Osmoregulation on the other hand is the active regulation of the osmotic pressure of an organism's body fluids to maintain the homeostasis of the organism's water content; that is, it maintains the fluid balance and the concentration of electrolytes (salts in solution) to keep the fluids from becoming too diluted or too concentrated. Therefore, having grasped these concepts the student was expected to explain that "*The sea star died because it is hyperosmotic to the freshwater, and it could not osmoregulate*". The tabulation of students' responses into correct explanation, wrong explanation and no attempt is shown in Table 9.

Table 9: Frequency Count of Students' Responses on the Osmoregulation and Excretion

Instructional group	No. of students who provided			Total
	Correct explanation (%)	Wrong explanation (%)	No attempt (%)	
Concept mapping group (*N* = 35)	18 (51.4)	10 (28.6)	7 (20.0)	35(100.0)
Co-operative learning group (*N* = 41)	23 (56.1)	8(19.5)	10 (24.4)	41(100.0)
Total	**41 (53.9)**	**18 (23.7)**	**17(22.4)**	**76 (100.0)**

Chi-square (χ^2) = 0.893, *df* = 2, *p*- value = 0.640

The analysis of the students' responses from the two instructional groups indicated that the students in the concept mapping group (51.4%) and co-operative learning (56.1) group on average provided satisfactory explanation to the problem. Some students across the two instructional groups erroneously indicated that (i) *the sea star died because the temperature in the fresh water was higher than that of the sea (*student 1*), (*2) *the sea star was stressed and needed more time to acclimate to new conditions* (student 2), and (3) *the cells of the sea star dehydrated and lost the ability to metabolise* (student 3). Also, from the results indicated in Table 9, there was no statistically significant relationship between the instructional approach the students received and their correct explanations of why the marine sea star died shortly after it had been placed in freshwater (Chi-square (χ^2) = 0.893, *df* = 2, *p*- value = 0.640). That is, the students' ability to apply the concept of osmoregulation and excretion to answer real life problem is independent of the type of instructional approach they were taken through.

4.5 Null Hypothesis: There is no Significant Difference in the Cognitive Achievement between SHS 2 Students Taught with Concept Mapping and those Taught with Co-operative Learning Instructional Approaches in Excretion

It has been identified from the post-test results that all the two instructional approaches: concept mapping and co-operative learning significantly improved students' cognitive achievement in excretion. Therefore, it is important to establish whether the performance in excretion differs significantly between the two instructional groups. The ANCOVA statistic was conducted to ascertain whether there is significant difference in students' cognitive achievement in excretion between the concept mapping group and co-operative learning group. The result of ANCOVA test conducted at 5% significance level is indicated in Table 10.

Table 10: Comparing the Cognitive Achievement of Concept Mapping Group (CMG) and Co-operative Learning Group (CLG)

	Pre-test		Post-test					
Group	Mean	*SD*	Mean	*SD*	ANCOVA (*F*ratio)	*p*-value	*df*	Effect size
CMG	13.17	2.16	22.09	3.50	0.118	0.732	1	0.002
CLG	15.27	3.29	24.49	2.24				

An ANCOVAtest in Table 10 showed that there is no statistically significant difference in the students' cognitive achievement in excretion between the two instructional approaches (F (1) = 0.118, p = 0.732, effect size = 0.002). Thus, the students taught with concept mapping instructional approach and their counterparts taught with co-operative learning instructional approach approximately exhibit equal performance. More so, it can be seen from Table 10 that the standard deviations for pre-test and post-test for the two groups differ significantly. While the standard deviation for concept mapping group increased from 2.16 to 3.50 that of co-operative learning group decreased from 3.29 to 2.24. This suggests that the use of co-operative learning as an instructional approach made the students perform more homogenously than their counterparts in the concept mapping group. That is,the variability among students was reduced when they were taught with co-operative learning instructional approach. Though students in both instructional groups exhibited equal performance in the post-test, the co-operative instructional approach is more hopeful of producing students with uniform performance compared to the concept mapping instructional approach. The implications for all the results found in this study will be discussed in the next section.

4.6 Discussion

The focus of research in science education is to detach the appropriate methods and strategies which may lead to effective teaching and cause effective learning by students from those that make students less engaged during instruction. The literature reviewed in this study indicated that concept mapping and co-operative learning approaches are periodically recommended for science teaching and learning. For each of these instructional approaches, there are convincing proofs of their effectiveness in science teaching and learning. However, in the case of Aburaman Senior High School, these instructional approaches appeared to be missing in most of the biology lessons the researcher observed prior to the study. The obvious instructional approach one was likely to observe in biology lesson was lecture method. Though, there was no evidence that the school's low performance in 2012, 2013, 2014 and 2015 WASCE biology was as result of this instructional approach, one could easily suspect that it could be one of the major contributing factors. It is based on these reasons that the researcher contextualised the usage of concept mapping and co-operative learning on students' performance in excretion in the school. The study mainly focused on determining the effectiveness of concept mapping and co-operative learning as instructional approaches on the students' performance in excretion. It was also to explore the extent to which concept mapping and co-operative learning as instructional approaches improve students' conception of excretion. The most significant findings identified in this study are discussed under the following topics in relation to the research questions.

4.6.1 Some Common Misconceptions SHS 2 Students hold about Excretion. It is evidenced in the literature reviewed for this study that students normally held some misconceptions in certain biology concepts after they had received some formal instruction (Driver, Squires, Rushworth, & Wood-Robinson, 1994; Sanders, 1993; Songer & Mintzes, 1994; Westbrook & Marek, 1992). Therefore, the researcher of this study was interested to verify whether this is the case with Aburaman Senior High School students. For instance, Yip (1998) indicated that diagnosing students' misconceptions before and after instruction is essential because it helps the teacher to monitor students' learning problems, which will provide continuous feedback on the effectiveness of the teaching strategies used.

The question that guided this investigation was ***"What misconceptions do SHS 2 students hold about the concept of excretion?"*** The data collected through students' responses to three multiple-choice items and one open-ended question on excretion confirmed that students held to certain degree some misconceptions in excretion. For instance, it was evidenced in this study that less than half of the students (42.1%) did not recall that the lung is responsible for releasing carbon dioxide and water. Rather, a significant number of students (29%) wrongly considered carbon dioxide as the only metabolic waste the lung produces. Again, it was shown in this study that though majority of the students (66%) could demonstrate an appreciable level of understanding of the meaning of excretion and egestion with correct examples, the 34% of students whocould not write agreeable response is very significant and disquieting. This resultis consistent with the findings of the studies conducted by Chan, Chu and Kong (1994), Pang (1993), Soyibo (1995), Songer and Mintzes (1994), Westbrook and Marek (1992), and Novak (2002). For example, Soyibo (1995) found that many students failed to distinguish between excretion and egestion even after deliberate instruction, and that their ideas on excretory wastes were confusing. Chan, Chu and Kong (1994) and Pang (1993) reiterated in their studies that most students having completed the secondary curriculum, failed to develop a proper understanding of excretion.

More so, the researcher of this study found that 9.3% of the students who had received instruction on excretion prior to the study could not conceptualise that the skin is responsible for the release of water, salt and urea. It is quite unfathomable that students who had received formal instruction in excretion could erroneously think that the lung is responsible for releasing water, salt and urea. It was also interesting to observe from this study that this conceptual quandary was shown by both high ability and low ability group students.

The students' inability to recall that the skin is responsible for the release of water, salt and urea is a clear indication that students had misconceptions in basic biological knowledge after they had received instruction (Soyibo, 1995). As it has been indicated earlier the students' misconceptions in excretion is verified with the aim of gaining in-depth understanding on the subject and use instructional approaches that would help students to learn effectively. Hashweh (1996) illuminated that designing instructional strategies that are rooted in constructivist approach of teaching is a key to tackling students' misconceptions. Among some of the instructional approaches he recommended for honing students' conceptual changes and development include: the use of examples and analogies, cognitive conflicts, concept maps, demonstrations and student activities. Co-operative learning is another constructivist teaching approach which provides opportunity for students to engage in dialogue and critical thinking during knowledge construction (Lord, 2001; Johnson & Johnson, 1989). Therefore, the concept mapping and cooperative learning were employed as instructional approaches to enhance students' performance and conception in excretion.The following sections (4.6.2, 4.63 and 4.6.4) provide the discussion on the effectiveness of concept mapping and co-operative learning as instructional approaches on students' performance and conception in excretion.

4.6.2 The Effects of Concept Mapping Instructional Approach on Students' Cognitive Achievement in Excretion. The research question 2 of this study guided the exploration of the effects of concept mapping instructional approach on students' cognitive achievement in excretion. The results of the data collected through students' achievement test scores in excretion indicated an increasemean score. The students' mean score before and after the use of the concept mapping instructional approach are 13.17 (SD = 2.16) and 22.09 (SD = 3.50) respectively. The difference of 8.92 between the pre-test scores and post-test mean scores was statistically significant (Z = -5.16, p-value =

$0.001 < 0.05$). This implies that there was a substantial difference in the students' achievement test scores after the teaching of excretion through concept mapping. This result agrees with the previous studies which indicated that students' understanding of biological concept is fully enhanced when concept mapping is employed as instructional approach (Ajaja, 2011; Mintzes, Wandersee & Novak, 2000; Novak & Canas, 2008; Henno & Reiska, 2008; Udeani & Okafor, 2012; Akeju, Simpson, Rotimi & Kenni, 2011; Rice, Ryan & Samson, 1998; Novak, 1990; Novak & Gowin, 1984).

Ajaja (2011) for instance concluded in his study that the use of concept mapping as an instructional approach does not only improve students' achievement in biology course but it enables students to retain the concept learned for longer period. Again, Henno and Reiska (2008) illuminated in their study that the use of concept mapping enables students to create interconnected ideas in biology thereby expounding their conception in the topic learnt. They added that using concept mapping facilitates meaningful learning and creates powerful knowledge frameworks that not only permit the students to utilise the knowledge in new contexts, but also enhances the retention of the knowledge for long periods of time (Novak, 1990; Novak & Wandersee, 1991). Bransford, Brown and Cocking (1999) and Tsien (2007) highlighted that concept mapping enhances the brain to process and organize knowledge in hierarchical frameworks. Akeju, Simpson, Rotimi and Kenni (2011) in a study discovered a significant effect of concept mapping instructional strategy on students' learning achievements. They asserted that concept mapping instructional strategy had a spun-out effect that prompts recall of learned materials.

4.6.3 The Effects of Co-operative Learning Instructional Approach on Students' Cognitive Achievement in Excretion. The research question 3 of this study was meant to ascertain the efficacy of co-operative learning on students' cognitive achievement in excretion. It was evidenced in the students' achievement test scores in excretion that the use of co-operative instructional approach significantly improved students' performance in excretion. (Pre-test: $M = 15.27$, $SD = 3.29$; Post-test: $M = 24.49$, $SD = 2.24$; Z = -5.56, p-value = 0.001). Thus, the use of co-operative learning is robust in enhancing SHS 2 students' achievement in learning the concept of excretion.

This result is in agreement with the findings of Maheady, Harper and Sacca (1988). They found that sixth-grade students who were exposed to co-operative learning instructional approach for their science class showed higher achievement levels and indicated higher levels of satisfaction. Studies by Okebukola (1984) and Okebukola and Ogunniyi (1984) both claimed a greater utility of co-operative learning strategies both to foster some aspects of student's individual differences and to enhance students' achievements. Aniashi, Anake, and Ayuk (2008) assert that how much one learns and remembers is a matter of how strong the personal involvement felt by the child is, in one case, and the absence of it in the other. With the use of co-operative learning rooted in constructivism teaching and learning theory, students were more actively involved in the learning and therefore achieve better. The use of co-operative learning stimulates discussions and better interaction among the students.

4.6.4 Comparing the Effectiveness of Concept Mapping and Co-operative Learning Instructional Approach on Students' Cognitive Achievement and Conception of Excretion. The result of this study showed that the performance of the students who received instruction in both concept mapping approach and co-operative learning approach improved significantly with large effect size. Apart from the unique and significant effects of concept mapping and co-operative learning on students' achievement, there are several specific observations that were made about the findings in relation to the two various instructional methods.

First, the analysis indicated that both instructional methods had significant effects on students' achievement in excretion. Since the post-test scores of all the students in all the groups were significantly greater than their pre-test scores, it therefore follows that the post achievement test scores were earned not by chance but as a result of treatment with the prescribed instructional methods. This implies that both instructional methods compared in this study had the potential to cause learning to take place but at varying degrees which is the bases for this study. This study was to establish a cause and effect relationship as found, agrees with the recommendations by Borich (2004), Johnson and Christenson (2000), and Wiseman (1999). They all established that in experimental research, a treatment must be confirmed to be responsible for any difference noticed.

Secondly, the ANCOVA test conducted in this study showed that there was no significant difference between the performance of the co-operative learning group and the concept mapping group in the post-test. This finding is consistent with the results of the study conducted by Ajaja (2013). In his study, he compared the achievement of students taught with concept mapping, co-operative learning, 5E learning cycle and lecture methods with the intention of identifying which one among them could be most suitable for teaching biology. He found that there was no significant difference between the students taught with concept mapping and co-operative learning groups. On the other hand, the students who were taught with concept mapping, co-operative learning and 5E learning cycle outperformed their counterparts taught with lecture method. Similar results were also found in the studies conducted by Udeani and Okafor (2012), BouJaoude and Attieh (2008), Candan (2006), Esiobu and Soyibo (2006), and Olarewajuthe (2012).

Though, this study did not indicate any significant difference in the performance of the students taught with concept mapping and co-operative learning instructional approaches, it was evidenced that the use of co-operative learning as an instructional approach made students perform more homogenously as compared to the concept mapping instructional approach. The students in the co-operative learning group recorded the lower standard deviation (2.24) as compared with concept mapping group (3.50). That is, the variability among students is reduced when students are engaged in co-operative learning. On the other hand, concept mapping instructional approaches increases students' variability. The variations in achievement scores among the groups may be due to the diversity in the teaching strategies adopted in each of the groups and their comprehension of the methods of instruction. The diversity in each instructional approach might have translated into influencing the students' scores in the achievement test. Furthermore, the dissimilarity in the levels of achievement among students taught with the different strategies was a direct reflection of the theoretical framework under which the methods evolved. Apparently, the result of this study confirms that any instructional approach (such as co-operative learning) rooted in social constructivist teaching and learning approach provides flourish environment for the students to engage in creative dialogue which in effect enhances meaningful learning (Borich, 2004; Johnson *et al.,* 1990; Trowbridge & Bybee, 1996; Trowbridge *et. al.,* 2000; Olarewajuthe, 2012). For instance, it was observed in this study that though students in the concept mapping groupimproved their learning achievement and interests (Chiou, 2008), they were not actively engaged in communication as compared with their counterparts in the co-operative learning group. Trowbridge and Bybee (1996), Trowbridge, Bybee and Powell (2000) reiterated that co-operative learning is an instructional strategy which organizes students in small groups so that they can work together to maximize their own and each other's learning.

In addition, both concept mapping and cooperative learning instructional approaches have the potential to assist students to recall facts and build their conceptual understanding of biological concepts (Edmondson, 2000; Candan, 2006; Chiou, 2008) (Olarewajuthe, 2012; Borich, 2004, Johnson, Johnson & Holubec, 1990). For instance, it was found in this study that majority of the students in the concept mapping group (80%) and co-operative learning group (78%) had correct conception of excretion after they had received instruction. The students in both instructional groups provided an appreciable definition and correct explanation of biological concepts. It was observed in most cases that the students in the concept mapping group though not significant, slightly outperformed their counterparts in the co-operative learning group on questions related to definitions (Chi-square, (χ^2) = 0.159, df = 1, p-value = 0.690) and explanations (Chi-square (χ^2) = 0.043, df = 1, p- value = 0.835) of key concepts in biology. This slight difference in the correct conception might have resulted because of the unique characteristics that underlie each instructional approach. For instance, in the concept mapping instructional approach students had the opportunity to organise interconnected ideas and present them on a mind map and this might have enhanced their recall ability as compared with the students in the co-operative group. Lim (2008) reiterated that concept mapping is designed to help learners conceptually develop the content by generating relationships among different concepts and refining their schema for the related domain. Thus, when students are able to select relevant information and organise them into a coherent structure, meaningful learning could occur (Mayer, 1984).

On the other hand, students taught with co-operative learning approach (56.1%) though not significant slightly outperformed their counterparts in the concept mapping group (51.4%) on questions related to real life settings. (Chi-square (χ^2) = 0.893, $df = 2$, p- value = 0.640). This result seems to confirm that concept mapping approach may not work equally well under all conditions (Grabowski, 2003), especially where students are required to relate their learning to realistic settings. This result suggests that students are able to apply the concept learned to real life problem when they receive instruction characterised by social constructivist perspective. For example, it was observed in this study that students in the co-operative learninggroup were able to engage in meaningful dialogue and this might have deepened their understanding in the concept of excretion and hence they were able to apply to realistic settings as compared with their counterparts in the concept mapping group.

Finally, notwithstanding the slight differences the students in both instructional groups exhibited in terms of conceptual development and performance in excretion, both instructional approaches are very useful in biology teaching because they offer the learners the opportunity to meaningfully construct their biological ideas. Moyer, Hackett and Everett (2007) opined that science is the dynamic interaction of thought processes, skills and attitudes that help learners develop a richer understanding of the natural world and its impact on society. This implies that any instructional approach in science teaching that does not engage students actively in thought process could hamper their conceptual development and hence they would not be able to apply the concept learned in different setting.

4.6.5 Implications of the Study Findings for Science Education. Despite the study sample being small and purposively selected which make the generalisation of the findings impracticable, the results that emanated from the study have much to offer in classroom practices, curriculum development and research in science education.

First, for any instructional intervention meant to enhance students' conceptual changes and development, it is important teachers examine the students before and after instruction. Knowing students' entry behaviour could guide the teacher to orchestrate lessons devoid of partial explanation of concepts which could lead to students' misunderstanding. For instance, the students' misconception in excretion identified in this study before the enactment of the intervention offered the researcher the needed insight and feedback to direct the teaching instruction. It also helped the researcher to use appropriate words, examples and analogies to clarify concepts that could have generated into students' misconception. Exploring students' misconception after the intervention is also crucial in effective classroom practices because it engages the teacher in reflective thinking. In this study, the concept mapping and the co-operative learning instructional approaches were used as a means but not an end to improve students' conception and performance in excretion. Thus, examining the students' misconception after the execution of lessons helped the researcher gain better appreciation of these two instructional approaches.

Again, it was found that the students taught using concept mapping and co-operative learning strategies rooted in constructivism teaching and learning theory had significantly higher post-test mean score. However, there was no significant difference in the performance of the students in concept mapping group and co-operative learning group. This implies that the use of concept mapping and co-operative learning strategies could equally enhance students' academic achievement in biology concepts. One thing that became obvious in this study was that students in both instructional groups got much engaged anytime the worksheet was used to mediate instruction but the students in the co-operative learning group was observed to be higher. Thus, it was not much surprise that the performance of the students in the co-operative group was more homogeneous than their counterparts in the concept mapping group. This implies that when teachers use worksheet in a social constructivist learning environment, their students are likely not only to perform well but it will bring homogeneity among the students.

Therefore, based on the outcome of this research, the use of concept mapping and co-operative instructional strategies are essential in the learning of science concepts. Students were actively involved in the process of learning and knowledge construction in both groups but it was more prevalent in the co-operative learning groups. It could be hypothesised from this study that co-operative learning enhances homogeneous performance among students as compared with concept mapping instructional approach. To build up the literature on concept mapping and co-operative learning with aim of enhancing students' learning in biology, there is the need to verify and ascertain this hypothesis through the use of randomly selected large sample size participants.

In Chapter five, the snapshot of the whole thesis will be provided. This will include summary of the study, key findings, conclusions, recommendations and suggestions for future research.

CHAPTER FIVE

SUMMARY, CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

5.0 Overview

This chapter provides summary of the study, major findings, conclusions and recommendations based on the findings of the study. Suggestions for further research have also been provided.

5.1 Summary of the Study

The primary focus of the study was to determine the effectiveness of concept mapping and co-operative learning as instructional approaches on the students' cognitive achievement in excretion. It was also to explore the extent to which concept mapping and co-operative learning as instructional approaches improve students' conception in excretion.

The quasi-experimental design of non- equivalent pre-test, intervention post-test was employed. The data used in the study were achievement test scores with reliability coefficients of 0.812 and 0.866, class exercises and home work. This was collected from second year Senior High School students of Aburaman Senior High School in Abura-Asebu-Kwamankese District by purposive sampling technique. Two intact biology classes from the school were used. The classes were assigned as concept mapping group and co-operative learning group.

Point Biserial Correlation, Wilcoxon Signed Rank test, effect size, chi-square and an ANCOVA test were employed to analyse the quantitative data collected through the students' achievement scores. Pictorially, line graph, pie chart and box plot were used to present the data collected. The students' conception of excretion was ascertained through qualitative analysis of their written responses to tasks on excretion.

5.2 Major Findings

The major findings were:

1. The preliminary analysis of the students' conceptions in excretion confirmed what has been established in literature that students held misconceptions in basic biological knowledge after they had received instruction through conventional instructional approach.
2. The study showed that the use of concept mapping and co-operative learning as instructional approaches enhanced students' performance in excretion achievement test significantly. However, the ANCOVA test indicated that there was no significant difference between the performance of the co-operative learning group and the concept mapping group in the post-test ($F(1) = 0.118$, $p = 0.732$, effect size = 0.002).
3. It was also observed that use of co-operative learning as an instructional approach made students perform more homogenously in the post-test than the concept mapping instructional approach.
4. It was found that majority of the students in the concept mapping group (80%) and co-operative learning group (78%)were able to provide correct conceptions of excretion after they had received instruction. However, there was no statistically significant difference between the instructional approach the students received and their correct conception of the concept of excretion. Thus, irrespective of the instructional approach the students had, they held similar conception of excretion.

5. Though, slightly over half of the students in the concept mapping group (51.4%) and co-operative learning (56.1%) were able to apply the concept of excretion to answer questions relating to real life settings, the impact of the instructional approach was not statistically significant (Chi-square (χ^2) = .892, *df* = 2, *p*- value = .640).

5.3 Conclusion

It can be concluded from the above findings and result that students actually hold misconceptions in certain biological concepts in which excretion is no exemption but with the use of an effective instructional approach, students' correct conceptions can be enhanced. Concept mapping and co-operative learning which are both rooted in constructivist teaching had positive effect on students' achievement in excretion. Also, the use of co-operative learning helped the students to perform homogeneously as compared to concept mapping. Lastly, there is no statistically significant relationship between the instructional approach the students received and their correct conceptions of excretion.

5.4 Recommendations

Based on the findings, the following recommendations were made:

1. It was evidenced in this study that students taught with co-operative learning produced high scores, homogeneous performance and ability to apply concept learned to real life situation. In a school where large classes exist, the teacher should make an effort to sub-divide the students into smaller groups and teach the

groups using co-operative learning instructional approach. This will help students to fully participate in the lesson and gain deeper understanding of the topic treated.

2. Teachers should do well to find out misconceptions students bring to class in order to use appropriate words, examples and analogies to correct them and help students to develop the right conceptions.
3. Educators need to review principles of instructional design to re-emphasise the necessity of incorporating concept mapping and co-operative learning in teaching and learning as found to enhance students academic achievement.

5.5 Suggestion for further research

The research should be repeated in other Senior High Schools to make it more concrete.

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APPENDICES

APPENDIX A

General Knowledge in Biology Performance Test (GKBPT) for the Pre-test

UNIVERSITY OF EDUCATION WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

Dear students,

This test is aimed at assessing your general knowledge in biology. This is to enable your teacher adopt the most appropriate teaching approach to help you get best tuition in Biology in subsequent days. The result of this test will be treated confidentially.

Thank you.

Number of student: ………………………………………………………..

School: ………………………………………………………………………

Form: …………………………………………………………………………

Date: …………………………………………………………………………

TIME: 40 minutes

SECTION A [MULTIPLE-CHOICE OBJECTIVE TEST]

Instruction: Each question in this section is followed by four options lettered ‘A’ to ‘D’. Choose the most appropriate option for your answer by circling around the letter that corresponds to the chosen option with a pencil. **If you decide to change your answer, erase the first one completely and re-circle your new choice.**

1. Biology is the study of

    A. Living and non living things

    B. Living things

    C. Plants

    D. Animals

2. The basic unit of life is

    A. A cell

    B. A tissue

    C. An organ

    D. An organelle

3. An organelle associated with the release of energy in a cell is the

    A. Lysosome

    B. Ribosome

    C. Nucleus

    D. Mitochondrion

4. Eukaryotic cells differ from prokaryotic cells in that eukaryotic cells

    A. Lack organelles

    B. Have DNA, but not ribosomes

    C. Are single-celled

    D. Have a nuclear membrane

5. Cell exists in the following forms except

    A. Independent form

    B. Mass

C. Colony

D. Filament

6. The term “cell” was first used by Robert Hooke in

A. 1628

B. 1665

C. 1668

D. 1672

7. Organelles that are present in plant cells but absent from animal cells include the

A. Chloroplast and central vacuole

B. Flagellum and cell wall

C. Mitochondrion and ribosome

D. Endoplasmic reticulum, cell wall and lysosomes

8. The spontaneous movement of any molecule from an area of high concentration to an area of low concentration is known as

A. Osmosis

B. Diffusion

C. Equilibrium

D. Active transport

9. A prepared slide to be observed under the microscope is placed on the

A. Condenser

B. Stage

C. Diaphragm

D. Eye piece

10. Distilled water is ……………… relative to a solution containing dissolved

A. Isotonic

B. Hypotonic

C. Hypertonic

D. Haemotonic

11. The structure for locomotion in *Amoeba* is called

A. Cilium

B. Flagellum

C. Rhizoid

D. Pseudopodium

12. The following are all branches of Biology except

A. Botany

B. Geology

C. Genetics

D. Ecology

13. A longitudinal section (L.S) is a section that

A. Passes crosswise through an organism

B. Runs diagonally through an organism

C. Makes an organism appear longer

D. Runs through the length of an organism

14. A drawing, 3cm in length was made of an insect, 1cm in length. The magnification of the drawing is

A. x3

B. x1

C. x2

D. x1/3

15. Which of the following is **not** a characteristic feature of all living things?

A. Respiration

B. Photosynthesis

C. Excretion

D. Reproduction

16. In which one of the following does alternation of generations occur?

A. Spirogyra

B. Rhizopus

C.Moss

D. Butterfly

17. Weevils are notorious pests because they

A. Play dead when they sense danger

B. Possess a long snout called a rostrum

C. Destroy large quantities of stored grain

D. Swarm together and destroy vegetation

18. What name is given to a plant which completes its life cycle in one growing season?

A. Epiphyte

B. Herbivore

C. Annual

D. Perennial

19. Which of the following helps in controlling insect pests in plants?

    A. Adding fertilizer

    B. Mulching

    C. Cover cropping

    D. Rotating crops

20. All the following insects affect the farmer adversely except the

    A.Weevil

    B. Termite

    C. Bee

    D. Cotton stainer

INSTRUCTION: **In the blank space provided in each of the given sentences, write one most befitting word that will make the resulting sentences valid.**

21. The process by which green plants manufacture their food is known as…………
22. …….. is the main constituent of insect exoskeleton
23. The sucking mouth part of the housefly is the……………………
24. ……………….consists of cells with long extensions that transmits and co-ordinates messages
25. …………is used for movement in *Euglena*

INSTRUCTION: **Read each statement carefully and indicate whether it is true or false by underlying your choice of the two options given.**

26. The structure that contains spores in the reproduction of rhizopus is called the sporangium true/false
27. The cell wall of plants is made of chitin. True /false

28. The circulatory system of human is made of blood, blood vessels and the heart. True/false
29. The kidneys, liver, skin and lungs form the transport system that gets rid of some waste substances from the body. True/false
30. Antheridia produce the male gametes in mosses. True/ false

APPENDIX B

Marking Scheme for General Knowledge in Biology Performance Test (GKBPT)

1. B	16. C
2. A	17. C
3. D	18. C
4. D	19. D
5. B	20. C
6. B	21. Photosynthesis
7. A	22. Chitin
8. B	23. Proboscis
9. B	24. Nerve tissue
10. B	25. Flagellum
11. D	26. True
12. B	27. False
13. D	28. True
14. A	29. False
15. B	30. True

APPENDIX C

Student's Performance Test in Excretion (SPTE) for the Post-test

UNIVERSITY OF EDUCATION WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

Dear students,

This test is aimed at assessing your knowledge and understanding on the topic "excretion". All the sections of the test are equally important, and it is expected that you will pay attention to all of them so as to enable me have a fair assessment of your performance in the topic. Result of this test will be treated confidentially.

Thank you.

Number of student……………………………………

Form…………………………………..

Date…………………………………..

Time: 40 minutes

SECTION A (MULTIPLE-CHOICE) OBJECTIVE TEST

INSTRUCTION: Each question in this section is followed by four options lettered 'A' to 'D'. Choose the most appropriate option for your answer by circling around the letter that corresponds to the chosen option with a pencil. **If you decide to change your answer, erase the first one completely and re-circle your new choice.**

1. Which of the following functions is performed by the liver?
   A. Deamination of amino acids
   B. Secretion of serum

C. Storage of bile

D. Storage of glucose

2. The kidney will produce less volume of urine when

A. Anti diuretic hormone is not secreted

B. The temperature of the body rises above 38^{O} C

C. Beer is taken into the body

D. A large volume of fruit juice is drunk

3. Which of these organs is concerned with waters regulation in the mammal?

A. Liver

B. Skin

C. Lung

D. Kidney

4. Malfunctioning of the kidneys will result in the

A. Accumulation of the excess water in the bladder

B. Accumulation of urea in the blood

C. Reduction of mineral salts in the blood

D. Accumulation of ammonium salts in the urine

5. Which of the following processes is **not** a function of the mammalian skin?

A. Protection

B. Temperature control

C. Excretion

D. Absorption

6. Which of the following process is **not** regarded as a homeostatic process in mammals?
    A. Vasodilation to remove excess heat from the body
    B. Vasoconstriction to conserve heat in the body
    C. Hydrolysis of starch to maltose by ptyalin
    D. Deamination of protein in the liver
7. Deamination in the liver produces
    A. Blood sugar
    B. Glycogen
    C. Bile
    D. Urea
8. Homeostasis can be defined as
    A. Control of water and NaCl levels
    B. Maintenance of a constant body temperature
    C. Maintenance of a steady internal environment
    D. Independence of the external environment
9. The unit structure of the kidney is the
    A. Glomerulus
    B. Loop of Henle
    C. Nephron
    D. Pyramid
10. The liver manufactures urea from
    A. Roughage

B. Starch

C. Protein

D. Fats

11. Deoxygenated blood is removed from the kidneys through the

A. Renal veins

B. Renal arteries

C. Collecting duct

D. The cortex

12. The two major processes involved in the functioning of the kidney are ultrafiltration and

A. Photofiltration

B. Photoreabsorption

C. Selective reabsorption

D. Active transport

13. Glucose passing out through the urine of human is a condition known as diabetes

A. Glucolase

B. Insipidus

C. Mellitus

D. Nephritus

14. The layer of the skin that continuously divides to produce new cells is called…. layer

A. Cornified

B. Cranular

C. Hory

D. Malpighian

15. The following are significance of excretion and osmoregulation except

A. Regulation of PH

B. Regulation of body weight

C. Regulation of water content of body fluid

D. Removal of toxic waste

16. The excretory organ that removes CO_2 from the body is the

A. Skin

B. Liver

C. Lung

D. Kidney

17. The excretory product of birds is mainly

A. Ammonia

B. Uric acid

C. Urea

D. Amino acid

18. The liver stores excess glucose as

A. Maltose

B. Sucrose

C. Glycogen

D. Galactose

19. The ways by which the body loses heat include the following except

A. Coming into contact with cold environment

B. Metabolic reactions in the body e.g. muscular contractions

C. Profuse sweating

D. Urinating and defecating

20. The part of the brain concerned with thermoregulation is

A. Hypothalamus

B. Cerebellum

C. Medulla Oblongata

D. Cerebrum

INSTRUCTION: **Read each statement carefully and indicate whether it is true or false by underlying your choice of the two options given.**

21. Urea is non – toxic. True/False

22. Removal from the body of waste product of digestion is excretion. True/False

23. The skin of a mammal has three major layers. True/False

24. The absorption of water by the collecting duct of the kidney is influenced by the hormone anti- diuretic hormone (ADH). True/False

25. Oxygenated blood is supplied to the kidney through the renal arteries. True /False

INSTRUCTION: **In the blank space provided in each of the given sentences, write one most befitting word that will make the resulting sentences valid.**

26. Removal of the amino group from amino acid to make ammonia is ……………

27. The conversion of poisonous ammonia into harmless urea is…………………….

28. ………………………… are the main excretory organs in insects.

29. …………………………..is the maintenance of constant osmotic conditions in the body.

30. The three layers of the epidermis of the skin are the cornified layer, the granular layer and the ………………… layer.

APPENDIX D

Marking Scheme for Student's Performance Test in Excretion (SPTE) for the Post-test

1. A	16. C
2. B	17. B
3. D	18. C
4. B	19. B
5. D	20. A
6. C	21. True
7. D	22. False
8. C	23. False
9. C	24. True
10. C	25. True
11. A	26. Deamination
12. C	27. Detoxification
13. C	28. Malpighian tubule
14. D	29. Osmoregulation
15. B	30. Malpighian

APPENDIX E

Discrimination Indices for GKBPT and SPTE

Question No.	Item discrimination index (GKBPT)	Item discrimination index (SPTE)
Q1	0.54	0.32
Q2	0.35	0.50
Q3	0.38	0.69
Q4	0.76	0.63
Q5	0.66	0.63
Q6	0.56	0.69
Q7	0.71	0.38
Q8	0.48	0.56
Q9	0.62	0.56
Q10	0.51	0.69
Q11	0.61	0.38
Q12	0.63	0.44
Q13	0.71	0.50
Q14	0.75	0.50
Q15	0.66	0.63
Q16	0.52	0.75
Q17	0.49	0.50
Q18	0.57	0.31
Q19	0.54	0.13
Q20	0.64	0.56

APPENDIX E Cont'd.

Question No.	Item discrimination index (GKBPT)	Item discrimination index (SPTE)
Q21	0.64	0.63
Q22	0.62	0.25
Q23	0.81	0.50
Q24	0.56	0.38
Q25	0.67	0.38
Q26	0.61	0.25
Q27	0.53	0.13
Q28	0.55	0.60
Q29	0.54	0.31
Q30	0.62	0.38

APPENDIX F

The Difficulty Indices for GKBPT and SPTE

Question No.	Difficulty index (%)(GKBPT)	Difficulty index (%)(SPTE)
Q1	63	46
Q2	57	58
Q3	74	46
Q4	65	56
Q5	69	60
Q6	78	54
Q7	64	68
Q8	65	49
Q9	64	68
Q10	63	63
Q11	56	56
Q12	54	49
Q13	58	49
Q14	48	77
Q15	88	63
Q16	56	53
Q17	54	81
Q18	55	46
Q19	63	56
Q20	65	65

APPENDIX F cont'd.

Question No.	Difficulty index (%)(GKBPT)	Difficulty index (%)(SPTE)
Q21	66	54
Q22	62	74
Q23	54	68
Q24	53	37
Q25	65	42
Q26	64	58
Q27	58	44
Q28	59	58
Q29	68	46
Q30	71	79

APPENDIX G

Introductory Letter issued by the Department of Science Education, University of Education, Winneba

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
P. O. BOX 25, WINNEBA - TEL. NO. 0202041079

March 30, 2016

Dear Sir/Madam

TO WHOM IT MAY CONCERN
INTRODUCTORY LETTER

The bearer of this letter, Mary Obeng with Index Number 8140130002 is a Student offering Master of Philosophy in Science Education in the Department of Science Education at the above University.

She is conducting a research on "*Comparing the Effects of Concept Mapping and Cooperative Instructional Approaches on the Performance of Senior High School Students in Excretion*".

Your school has been selected as part of her sampling area.

I hope you would assist her to do a good thesis write-up.

Thank you.

VICTOR ANTWI, PHD.
Head of Department

31-3-2016