UNIVERSITY OF EDUCATION, WINNEBA

GUIDED DISCOVERYAND SELF LEARNING STRATEGIES: BIOLOGY INTERVENTION LESSONS IN A GHANAIAN SENIOR HIGH SCHOOL.

PETER KWASI KRAH

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A THESIS IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PHILOSOPHY, SCIENCE EDUCATION OF THE UNIVERSITY OF EDUCATION, WINNEBA

OCTOBER, 2015

DECLARATION

Student's Declaration

I, **PETER KWASI KRAH**, declare that this Thesis, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work and it has not been submitted, either in part or whole, to any institution anywhere for any academic purposes.

Sign ………………………………… Date……………………………..

Supervisors' Declaration

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

Sign ………………………….... Date……………………………..

Professor Mawuadem Koku Amedeker

(Principal Supervisor)

Sign………………………….. Date………………………………

Dr. J. Nana Annan

(Supervisor)

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DEDICATION

This work is dedicated to my wife Hannah Ameyo and children: Padmond, Georgiet, Sarah, Juliet, Christopher and Michael.

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ABSTRACT

This study used guided discovery and self learning strategies as intervention to improve academic performance of students in biology at Wenchi Senior High School in the Brong Ahafo Region of Ghana. The study investigated whether the guided discovery and self learning approaches can provide opportunity to inculcate science process skills and to identify which science process skills are inculcated during science lessons.The study employed case study design using action research approach. A Form 2 class made up of 48 females and 2 male students were used for the study. The data of study was collected using learning packages and observational checklists. The observational checklist was used to take inventory of science process skills that were exhibited by the students during the lessons. Data collected from the study was analysed both quantitatively and qualitatively. The findings of the study showed that the academic performance of the students improved after being exposed to guided discovery and self learning strategies. This study also revealed that using the approaches in the teaching and learning science has additional advantage of providing opportunities for the inculcation of science process skills. The implications for teaching and learning are that guided discovery and self learning strategies make science classroom more realistic as students are actively involved. Students learn to be responsible for their own learning.

CHAPTER ONE

INTRODUCTION

Overview

This chapter discusses the background to the study, stating clearly what Researcher wants to investigate, highlighting on related literature in the area of study such as benefits derived from effective use of self learning and guided discovery instructional approaches. The next sub-heading discussed under this chapter is the statement of the problem which highlights the rationale for the study. It also deals with purpose of the study, objectives, and research questions the researcher wants to answer at the end of the study. Furthermore, the chapter looks at the significance of the study to the various stakeholders in education, limitations, delimitations or peculiar considerations that defined the scope of the study. The findings from the study would enable the Researcher to develop teaching guide or manual based on self learning and guided discovery strategies for senior high schools. Lastly, it talks about the definitions of terms used in the study.

Background to the Study

One of the challenges in teaching is to create experiences that will involve students and support their own thinking, explanation, evaluation, communication, and application of the scientific models needed to make sense of these experiences, (Afolabi & Akin-bobola, 2009). The need for designing instructions that promote better understanding of scientific concepts is very critical to the development of science education (N.R.C, 2000). The Researcher's interactions with some senior high school science students revealed that students over depend on teachers for information. Most of the students do not participate in science lessons actively and as such cannot comprehend scientific concepts. They are forced to study the lessons for the sake of examinations. In the end, science lessons become boring, meaningless, abstract, hard and problematic. This calls for better instructional methods such as guided discovery and self learning.

Guided discovery (GD) method of teaching involves guiding students to seek information. Teachers serve as facilitators of learning in which students are encouraged to be responsible, autonomous and construct their own understanding of scientific concepts. Guided discovery approaches allow students to become independent thinkers and are ready to accept responsibilities. Akinmoyewa (2003) defines self-learning as an instructional strategy which involves using instructional materials by students to learn either without teacher's intervention or with minimum teacher guidance. Nwagbo (2006) points out that if learners are allowed to discover relationships and solutions to problems and make their own conclusions then, they are better prepared to make wider application of the materials learned.

Guided discovery and self learning has positive impact on students' learning outcomes in that they provide students' with investigative and reflective skills that could be applied in other subject areas, build on student prior knowledge and experience, encourage independence learning, enhance students mental efficiency and help them to overcome obstacles, thereby gaining knowledge by themselves .In addition guided discovery strategy provides for individual differences as well as make the process of learning to be self-sequenced, goal directed, pace self-determined, build initiative, confidence, imagination and creative abilities of students. From the above, the Researcher concluded that guided discovery and self learning equip students with skills that with enable them to be independent, creative and lifelong learners needed to copy with modern trend of education.

Statement of the Problem

Teaching is a constantly evolving practice where research and studies are being performed to find the best practices. For the past twelve (12) years the Researcher has been a biology teacher at the senior high school level and has observed that most students are unable to answer questions in some selected topics in biology correctly. Most of their wrong answers revealed specific misconceptions which need corrections. Anecdotal evidence shows that in Ghana, the teaching of science in the senior high schools generally appears to be through lectures, note-taking ,chalkboard illustrations and other teacher-centred methods. These methods do not actively involve the students in the learning and problem-solving processes as they are predominantly passive. It therefore appears to inhibit development of students' intuition, initiative, imagination and creative abilities. There is need to develop new effective instructional strategy such as guided discovery and self learning strategies which have been found to improve students' academic performance in biology. Guided discovery and self learning help students to attain application and comprehension levels of cognitive development. They are meaningful teaching and learning strategies that engage students in hands-on and minds-on activities that help them to form logical connection between newly presented topics and their existing knowledge. This study was conducted to find out the effect of guided discovery and self learning instructional strategies on students' academic performance in some selected topics in biology at senior high level.

Purpose of the study

This study used guided discovery and self-learning strategies as intervention to improve students' academic performance in some selected topics in biology.

Objectives of the Study

The objectives of the study are to:

1. Determine the effect of guided discovery and self learning strategies on students' academic performance in some selected topics in biology.
2. Find out the progress of students in their academic performance after they have been exposed to guided discovery and self learning instructional strategies.
3. Provide students with the opportunity to demonstrate some process skills in science practical work after exposure to guided discovery and self learning strategies.
4. Determine the effects of guided discovery and self learning strategies on students' attitude toward biology.

Research Questions

The following research questions underpin the study:

1. How does the use of guided discovery and self learning strategies affect students' academic performance in some selected topics in biology?
2. How do students' academic performances progress after they have been exposed to guided discovery and self learning strategies?
3. What science process skills do students who are exposed to guided discovery and self learning strategies demonstrate?
4. What effects do guided discovery and self learning strategies have on students' attitude toward biology?

Significance of the Study

The findings and recommendations of this study may serve as useful guidelines for teachers, students, school administrators, educational researchers and curriculum developers. With regard to the teachers, the outcome of the study may serve as guide for them to in cooperate guided discovery instructional approach which leads to self learning into their teaching processes. The research would help science teachers to realise that their role in teaching and learning science is not to transmit information but to serve as facilitators for learning which includes creating and managing meaningful and impactful learning experiences. To the students, the use of guided discovery approach and self learning would make them to be self independent, discipline, able to take initiatives and plan their own studies. This would enhance students' academic performance in class exercises, tests, assignments and external examinations in biology. The students would also acquire lifelong learning skills needed for solving challenges. The study would help educational curriculum designers to place more emphasis on scientific inquiry skills when developing science curriculum.

Delimitations

Dusick (2011) stated that delimitations are characteristics selected by the researcher to define the boundaries of the study. He further explained that it involves delineating properly the boundaries of the study that is what will be covered and what will not be covered in the study in question. It is a way of trying to bring the problem into sharp focus. Setting delimitations and subsequent justifications help the researcher to maintain objectivity in the study. It also helps other researchers reconstruct a study or advance future research on the topic. Delimitation provides the scope within which researchers conclude their findings and determine a study's reliability or external validity. The delimitations are under the control of the researcher. Delimiting factors include the choice of objectives, the research questions, variables of interest, theoretical perspectives the researcher adopted and the population choose to investigate (Simon & Goes, 2013). In the light of the above, the following are the delimitations of the study:

There are several methods of teaching science but guided discovery and self learning strategies has been selected on the basis of current practices where the need to be independent in order to copy with the influx of technological advancement in this modern age. The study was restricted to Wenchi Senior High School in the Brong Ahafo region of Ghana. This was due to proximity and accessibility of the research subjects and also as a teacher in the school. The study was also restricted to SHS2 students because adequate time is needed to prepare them and monitor their performance with time before they write the final examination. Finally, curriculum content was limited to some selected topics which are activities oriented.

Limitations

Simon and Goes (2013) points out that Limitations are potential weaknesses in research study and are out of the researcher's control. They are the shortcomings, conditions or influences that cannot be controlled by the researcher that place restrictions on the methodology and conclusions. Dusick (2011) points out that any assumption the researcher makes becomes a limitation. Since assumptions are inevitable in empirical studies, the study had some unavoidable limitations. The following limitations can be observed regarding this study:

It was assumed that the population is homogenous in character; hence the sample size was not very large. If this assumption was wrong, then data may not effectively present a large population, and consequently, generalisation of the findings over a large population would inappropriate. Also not all forms guided discovery and self learning strategies were employed in the teaching and learning processes. In this study, there was some minimum guidance provided by the researcher. Another limitation was related to the absenteeism on the part of some of the students. Some students absented themselves from school due to truancy at the time of intervention and this may introduce error and the results of the study would be affected.

Definitions of Terms

Longitudinal Section: a section that is cut along the longer axis (length) of a specimen or organism.

Transverse Section: a section that is cut along the shorter axis (width) of a specimen or organism.

Specimen: is an animal or plant used as an example of its species or type for scientific study or display.

Manipulative materials: are concrete tools or objects that allow students to explore an idea in an active hand – on approach.

Science Process Skills: these are a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behaviour of scientists.

Organisation of the Study

This thesis is organised in five chapters. Chapter one deals with introduction of study. It includes background to the study, statement of the problem, purpose of the study, objectives, research questions, and significance of the study. It also covers limitations, delimitations and definitions of terms used. Chapter two deals with literature review. It looks at concepts guided discovery and self learning. Chapter three discusses the methodology of the study. Chapter four focuses on the analysis of the data and discussion of the findings. Chapter five covers summary of findings, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

Overview

The chapter reviews related literature on the effect of guided discovery instructional strategy which lead to self learning on students' academic performance. Reviewing literature allows the researcher to know the amount of work done in the area concerned (Mahaboobjan, 2010). The topical issues under which literature was reviewed include the concepts of guided discovery and self learning, benefits and problems associated with them. Other areas looked at were role of the teacher, motivation, students' attitudes and process skills acquisition. The chapter further discussed theoretical framework and conceptual model of the study.

The Concept of Guided Discovery (GD)

According to Eggen and Kanchak (2001) guided discovery approach of teaching is a form of problem based instruction which emphasises on students' active involvement in the learning. Guided discovery method is a teaching technique that encourages students to take a more active role in the learning process by answering a series of questions or solving problems designed to introduce a general concept (Mayer, 2003). In this teaching approach, the instructor guides the students' by posing a series of questions whose responses would lead to the understanding of a concept before it is explicitly stated. Students act as detectives as they solve concept-attainment activities in stimulating learning environments. Guided discovery method is based on the notion that learning takes place through classification and schema formation. This teaching method increases retention of material learnt because the students organize the new information and integrate it with information that has already been stored (Gallenstien, 2004).

From the views of these writers, the researcher concluded that GD allows students to take the lead in their own learning experiences. The teacher serves as a facilitator or a resource person whose role is to guide, motivate, stimulate, clarify, explained, and makes it possible for the learners to mutually agree upon goals. The idea is that students are more likely to remember concepts they discover on their own than those forced on them. In a nutshell, the researcher defined guide discovery as an instructional method based on leading questions and problem-forming that guide students to obtain knowledge and discover relations and concepts by getting involved in the classroom interaction where the researcher helps them to be more active and more responsible for their learning.

According to Sekyere (2013) there are two types of guided discovery: inductive and deductive. The inductive method according to Sekyere (2013) leads students to discover what is to be established through questions and answers and experiments. He further explains that the teacher questions students and leads them to make the generalisation and abstraction. However, the deductive method according to Sekyere (2013) makes a statement or fact about something and students are led to prove the validity of the statement through questions and answers, and experiment. This study applies inductive method because it has an advantage over deductive method in that students do not easily forget their findings or discoveries. Guided discovery has some features to follow during lessons. These are discussed below.

Features of Guided Discovery

Westwood (2008) identifies the following as features of guided discovery. These are: students are required to investigate a topic or problem by active means, obtain pertinent information, interpret causes and effects and arrive at conclusions. It is more effective when the process is carefully structured and students have prerequisite knowledge and skills on the topic to be treated. Guided discovery is enhanced by various tools. According to Westwood (200) one of these tools is simulation. In Westwood's view, simulation happens when the teacher provides students with examples and hints that help them to understand certain concepts. Reichert (2005) identifies scaffolds as one of the features of guided discovery. To Reichert (2005) scaffolds mean the necessary support and guidance provided by the teacher to the students as they engage in learning activities in order to reach the discovery in the form of conclusions and principles.

Mayer (2004) points out that, guided discovery can be a very time-consuming method, often taking much longer for information to be acquired than would occur with direct teaching. Jo (2010) explains that the discovery method does not always work. The class size, the ages of the students, or the amount of material that must be covered, may make it inadvisable. But, Jo (2010) is also of the view that when conditions are right, the discovery method can ignite students' enthusiasm for mathematics and science as can no other method, and that it can give them the confidence and the power to independently discover, question, analyse, and conquer, new ideas. He therefore suggests that the materials must be carefully planned in advance and monitored to prevent chaos as students begin to investigate the intended knowledge. The importance of questions in guided discovery is discussed below.

The Importance of Questions in Guided Discovery science Lesson

Dillon (2000) mentions that guided discovery allow teachers to employ good coaching skills as they determine how best to guide the students to understand or apply new learning where the main tools of assessment are questions. So the aim of questions is not to test but to guide the students and direct their attention to the important points in the lesson. Kidman (2001) points out that the teacher asks questions which require the students to think, read, study, ponder and reason. According to Kidman (2001), when the students respond, the teacher expands, develops, enlarges, and illustrates the point. The teacher is accountable to keep the class on track toward specific objectives of the lesson through questions. Walsh and Satters (2005) point out positive effect of students-teacher classroom interaction through questioning. They explained that questioning is the entry into problem formulation in inquiry; promote participatory learning, good communication skills, and confidence building in students' learning process. Thornbury (2004) states that teacher must be clever in the art of asking meaningful questions. This will give students the opportunity to practice problem-solving and will help them to become more capable of solving problems that arise in learning sessions. Thornbury (2004) further explained that the use of low-order and high-order questions is necessary during learning lessons and that high-order questions provide students more opportunities for self-evaluation. In his view one good strategy of engaging students in science lesson is by prompting them to answer questions or ask questions. This would then help the teacher to resolve misconceptions and understanding.

On the score of the above, it is important to sum-up that leading questions are important because they activate and keep students alive all the time, check and give feedback which helps build new knowledge.

The Role of the Teacher in Guided Discovery

Nowadays, people are advocating that teaching and learning process should be student-centered. Despite that, the teacher still plays a great role in the process of interaction whether it is between the teacher and the students, among students, or the students and the classroom environment. Hardy,Jonen, Moller and Stern (2006) argue that students will often have misconceptions (wrong previous concepts students have about something) and do not know they have them. It becomes the teacher's job to draw these out and make them visible to the students. Hardy, et al (2006) further disclosed that without guidance, students will be unable to relate their discovery activity to their misconception and thus give up. In a science lesson, clarifying concepts is very essential for understanding. According to them, if the teacher gives the students no guidance during the activity, they may solve the problem wrongly. There are also students who are completely lost and have no prior knowledge let alone misconceptions about the particular idea that they must discover. Mayer, (2004) claims that to hold students' interest the teacher can allow the students to take part in choosing the purpose of the activity. In fact, to have a class discussion that is carefully facilitated by the teacher regarding, the purpose of self learning and guided discovery activities can yield wonderful results. In Mayer’s view, the key is to provide a context that students can operate within and give them a goal or a purpose for their activity. As long as the purpose holds, according to him, the students’ interest will be driven enough to continue with the discovery process.

In the light of what is mentioned above, it will be instructive to summarise the role of the teacher in three points: clarifying the wrong concepts for the students, framing well activities and questions which lead students to discovery and giving necessary support and help. The concept self learning which a product is of guided discovery strategy in this study, is looked in the next subheading.

The of Concept of Self Learning (SL)

Self learning is an instructional strategy which involves students using instructional materials to learn by themselves. It is also a method of teaching, where teachers provide opportunities for students to become independent thinkers who are ready to accept responsibilities for their own learning. Self learning may also be called self instruction and it is a technique which involves the use of instructional materials designed for students to learn either without the teacher's intervention or with minimum guidance (Akinmoyewa, 2003). Akinmoyewa (2003) explained that self-instructional strategy is a learner-centered strategy, which involves individual student's use of instructional packages or learning packages especially programmed instructional package that consist of stimuli, provision for responses, feedback or self-assessment packaged to learn. According to Jenkins and Keefe (2001), self-instruction focuses on the needs, talents, learning style, interests and academic background of each learner and also challenges each learner to grow and advance. Self-regulated learning (SRL) helps students to create better learning habits and strengthen their study skills (Wolters, 2011). Ifamuyiwa and Akisola (2008) report of self-instructional learning promote cognitive and affective learning outcomes in different disciplines. Despite the heavy theoretical emphases in recent years in learner-centered types of instruction, the researcher observed that educational practitioners in Ghana have not embraced self-learning as useful institutional strategy for primary and secondary classrooms. Often self-inspection is limited to the delivery of some basic theory of the learning topics. Usually, the teacher structures the basic course content in a number of topics and delivers it as electronic content, composed of text, graphics, sound images or video fragments. Afterwards, the student will either individually or as a member of a team, assimilates the subject of the course.

Self instruction encourages autonomy in learning and the use of self instruction placed the user in far greater control of their learning. The climate becomes more child-centered. This is an important step towards independence and prides the individual work of the student. The using of self instruction is given the opportunity to conduct self paced study with in-built "instant-replay". Furthermore, self instruction packaged can be sequenced in a variety of patterns to build unique courses of study catering for students with different interest and needs. A basic assumption made in the development of any self instructional learning package is that the learning is a process which must be undertaken by the learners (Ifamuyiwa & Akinsola, 2008).The responsibility of learning shifts from the teacher to the students. Self instruction is student centered. This underpinning assumption has important implication for the arrangement of subject matter, types of media to be used and allowances to be made for individual differences. If students "learn to learn" through self instruction they can transfer their skills to most of the other teaching and learning methods.

According to Khanzode (2004), individualised learning is the term used to describe a form of learning in which learning takes place on an individual rather than a group basis. He added that this technique makes learning self-initiated and self directed. It caters for the needs of the individual students. To Khanzode (2004), individual teaching and individual work method are gifts of present century. He explained further that under individual teaching student is the “unit” of teaching. Individual teaching highlights individual differences among students and work on the principle that each student works at their own rate according to their abilities and capabilities. It is only then that the student will become conscious of his or her progress and will gain stimulus to work and think .In this way, they would rely upon their own intelligence abilities. Individual work method enables students to think freely and act for themselves and not subordinate themselves to the majority (Khanzode, 2004). Self instruction is one type of self-paced and individual learning. Others methods such as programmed instruction, Keller’s personalised system of instruction, project, and homework have been discussed below.

Programmed Instruction

Programmed instruction enables majority of students in a class to learn at their own pace and provide opportunity for immediate feedback (Ifamuyiwa & Akinsola, 2008).The authors point out that it is a logically constructed system with objectives, activities and outcomes. According to Anderson and Fretzin (2004) programmed instruction is based on a series of very small steps, called frames. Anderson and Fretzin (2004) further explained that each frame contains some information and a statement with a blank that the student fills in. The student then uncovers the correct answer before going on to the next frame. If the student's answer was correct it is positively reinforced by progress to the next frame .However if wrong answer is chosen the student is referred to another section of the programme to study a remedial frame before being returned to the main. Each frame is introduced either a new idea or repeat material covered earlier. The authors, Anderson and Fretzin (2004) disclosed that because of active student participation, small steps, immediate feedback and reinforcement, programmed learning raises students' cognitive processing ability which makes it very effective. According to Riasat (2005) there are two types of programmed learning: linear and branch. The linear programmed learning according him consists of small frames followed by simple comprehensive typed questions and that the branch type has larger frames. Ifamuyiwa and Akinsola (2008) disclose that, the basic premise is that as with the learners are in control of the instruction, it affords them the opportunity to have some time to think things through, structure the task of learning and to decide on the meaningfulness of what is learned. They further stated that the materials so programmed are presented in a well-arranged and organised form that lead the students from a body of unknown principles to the known, from simple to complex concepts within the same content area.

Keller's Personalised System of Instruction

Keller's plan is another technique developed for individualised instruction. According to Riasat (2005), Keller's plan is also known as personalised system of instruction (PSI) and that it emphasises individual pace and learning. According to Riasat, it is composed of small self-paced modularised units of instructions where study guides direct learners through the modules. According to Liu (2003), there are five components of the PSI. These are self-pacing, unit perfection, motivation, communication and proctor's feedback. The first feature of PSI, according to Liu which is self-pacing, allows a learner to move at his/her own pace through a course at a self-determined speed. Liu further intimates that the unit-perfection requirement means that before the learner can move to the next unit of instruction, he/she must complete perfectly the assessment given on the previous unit. Motivation for a PSI course, in the author's view, is provided by a positive reward structure. Learners, who have attained a certain level of mastery, as indicated by the number of completed units, are rewarded through special lectures and demonstrations. Communication, in classic PSI systems, according to him relies primarily on written communication between learner and teacher. However, the proctor-learner relationship, in his view, relies on both written and verbal communication, which provides valuable feedback for learners.

A PSI class is highly structured according to Liu (2003), and that all information is packaged into small, individual units. According to Liu the learner is given a unit, reads the information, proceeds through the exercises, and then reports to a proctor for the unit assessment. If the score is unsatisfactory, the learner is asked to re-examine the material and return for another assessment. After completion of a certain number of units, the learner's reward is permission to attend a lecture, demonstration, or field trip, which is instructor-led. According to Eyre (2007), PSI produces superior learner achievement, less variation in achievement, and higher learner ratings in numerous college courses.

The Project Method

Olatoye and Adekoya (2010) describe project-based learning (PBL) as an instructional method in which students learn important skills by doing the work in the task by themselves. Olatoye and Adekoya (2010) further explained that students apply core academic skills and creativity to solve authentic problems in real world situations. The authors further disclosed that Project-based learning is based on the constructivist learning theory, which states that learning is deeper and more meaningful when students are involved in constructing their own knowledge. Students are given the opportunity to select a topic that interests them within the required content framework and then they are responsible for creating their project plan. Rather than a lecturer, typically, the teacher's role is that of an academic advisor, mentor, facilitator, task master and evaluator. Olatoye and Adekoya (2010) intimates that the project-centered approach learning was extensively applied and found effective in science, legal and medical education as well as engineering. The authors said substantial body of literature supports the view that PBL substantially improves long-term retention, deeper understanding and ability to extrapolate scientific knowledge to subsequent learning experience and situations. According to Rwodizi and Mukundu (2013), pupils taught using the inquiry or project method developed better science process skills than those taught the traditional way.

Homework Method

Cooper (2007) defined homework as tasks assigned by school teachers that are meant to be carried out during non-instructional time. According to Erinosho (2009), homework is example of an active learning strategy that provides opportunities for new interactions and application of knowledge in new situations. Erinosho's (2009) points out that given home work provides opportunity for students to review and practise learned skills on their own. This reinforces learning, builds confidence and promotes retention. If properly utilised and well coordinated with instructional objectives, it can provide insight into students' progress and difficulties. Erinosho (2009) further discloses that home work helps students to work independently to imbibe necessary study habit and learn how to manage time. School achievements and homework are closely related to each other. If teachers properly utilised them, they have a great impact on the achievement of students. Bembenutty (2011) finds out that a positive relationship exists between homework activities and self-efficacy, responsibility for learning, and delay of gratification. According to the author, homework assignments enhance development of self-regulation processes and self-efficacy beliefs, as well as goal setting, time management, managing the environment, and maintaining attention. These are skills that will serve students well not only as they proceed through their schooling but also as working adults.

There is considerable debate over the effectiveness of homework among researchers, administrators, teachers, parents, and students. Cooper, Robinson and Patall (2006), conducted a meta-analysis on homework-related research and found out that there is a positive relationship between the amount of homework students do and their academic achievement. Redding (2000) points out that when homework is properly utilised by teachers, it produces an effect on learning three times as large as the effect of socioeconomic status. Cooper (2007) outlined three benefits of homework. These are long-term academic benefits, such as better study habits and skills; non-academic benefits, such as greater self-direction, greater self-discipline, better time management, and more independent problem solving; and greater parental involvement and participation in schooling.

Benefits of Self Learning and Guided Discovery

Akerson, Hanson and Cullen (2007) point out some benefits of self learning and guided discovery. They are students are actively involved in the process of learning and the topics are usually intrinsically motivating, the activities used in discovery contexts are often more meaningful than the typical classroom exercises and textbook study, students acquire investigative and reflective skills that can be generalised and applied in other subject areas, new skills and strategies are learned in dealing with activities, builds on student prior knowledge and experience and independence in learning is encouraged. Students are also more likely to remember concepts and information if they discover them on their own. According to them, the benefits derived from self learning and guided discovery are both for the teacher and the students because they are the human beings in the classroom who interact in doing the tasks. Motivation and science process acquisition are integral part of guided discovery and self learning. These are highlighted in the next three sub-headings below:

Students' Motivation

Pintrich and Schunk (2002) define motivation as the process whereby goal-directed activity is instigated and sustained .They also explained that motivation leads to cognitive engagement. Adkisson and McCoy (2006) stated that self learning and guided discovery are generally regarded as motivating methods, enjoyed by students. Adkisson and McCoy (2006) also think that learning is usually most efficient and rapid when students are motivated. Motivation according to them is concerned with a drive, incentive or energy to do something. According to them, guided discovery which leads to self learning lessons engaged students in activities which are essential in motivating and helping them to establish their own personal connection to the intended learning objectives. They further intimate that the methods make learning useful, enjoyable and meaningful as students are motivated which lead to attainment of learning outcomes.

Science Process Skills for Students

Science process skills according to Bilgin (2006) are very important for meaningful learning because learning continues throughout life, and individuals need to find, interpret, and judge evidence under different conditions they encounter. Therefore, Bilgin (2006) thinks that it is essential for students to be provided with science process skills at education institutions. Saat (2004) proposes that science process skills consist of basic and integrated skills, and that the basic science process skills (BSPS) provide the intellectual groundwork in scientific inquiry such as ability to order and describe natural objects and events. Some examples of BSPS according to him are observing, classifying, measuring and predicting. Saat (2004) continues that BSPS are the prerequisites to the integrated process skills, and that the integrated science process skills (ISPS) are terminal skills for solving problems or doing science experiments. Some examples of ISPS according to the author are identifying and defining variables, collecting and transforming data, constructing tables and graphs of data, manipulating material, describing relationships between variables, interpreting data, formulation hypothesis, designing and investigations, drawing conclusions and generalising. Colley (2006) says that the basic skills are integrated together when scientists design and carry out experiments in everyday life and that all the basic skills are important individually as well as when they are integrated together. According to Colley(2006), science process skills form the foundation for scientific method and that there are several instructional approaches that science educators and teachers use to help students acquire process skills, for example activity-based, problem-based and project based instruction. These strategies in his view are very similar in terms of their emphasis on student-directed rather than teacher-directed learning, active learning rather than passive learning, and integration of content and process rather than separation of content and process. Taraban (2007) also reports that an active learning and teaching strategy has advantage in learning and teaching science rather than a traditional strategy both in science content and acquisition of process skills. He says active teaching and learning strategies include hands-on, minds-on activities which help students to acquire process skills.

Students' Attitudes to science

Aiken (1998) cited in Mogari (2003) defines attitude as a composite trait that consists of the following personality factors: motivation, enjoyment, value and fearlessness of science and mathematics. He intimates that, attitudes are reinforced by beliefs (the cognitive component) which attracted strong feelings (the emotional components) that finally let to a particular form of behaviour (the action tendency components). In this study, attitude refers to students' motivation (encouragement), interest (enjoyment), participation and their interpersonal relationship with science teachers in studying science. Ellington (2003) explains that attitude can be seen as positive or negative. According to him positive attitude toward science reflects a positive emotional disposition in relation to the subject and in a similar way, a negative attitude towards science relates to a negative emotional disposition. These emotional dispositions according to him have an impact on an individual's behaviour, as one is likely to achieve better in a subject that one enjoys, has confidence in or find useful. Ellington (2003) further points out that positive attitude towards science are desirable since it influences one's willingness to learn and also the benefits one can derive from science instruction. Hannula (2002) points out that, attitudes can change in a short period, and sometimes dramatically. Hannula (2002) discloses that many students especially the younger ones and less established student's attitude toward a particular subject is proportional to their recent success in class. Again, according to him, a good day can sway the attitude to the positive side and on the other hand, a bad day can swing the attitude toward the negative side. Similar results were obtained by Udousoro (2002) after using computer and text assisted programmed instruction and Popoola (2002) after exposing students to a self learning device.

From the above explanations, it could be deduced that attitudes have direct correlation with the learning and performance of student in science (Biology) at the SHS level. It is therefore necessary for all players in education (parents, teachers, etc) to encourage students to develop positive attitude toward the learning of science. It is worthy of agreeing that creating enabling environment is a key factor to development of positive attitudes to help students achieve better results in the study of Biology. The society needs to have a positive frame of mind about science which will help children to develop a very good attitude even before starting school.

Constructivist Theory

This theory holds that learning always builds upon knowledge that a student already has; this prior knowledge is called a schema. Constructivists point out that learning is more effective when a student is actively engaged in the learning process rather than attempting to receive knowledge passively. A wide variety of methods claim to be based on constructivist learning theory. Most of these methods rely on some form of guided discovery where the teacher avoids most direct instruction and attempts to lead the student through questions and activities to discover, discuss, appreciate and verbalise the new knowledge (Trochim, 2006). Constructivism is a theory that suggests that learners construct knowledge out of their experiences which is associated with pedagogical approaches that promote learning by doing or active learning (Afolabi & Akinbobola, 2009). Constructivist learning theory is based on the fact that learners actively construct knowledge and that knowledge cannot be passively transmitted from the mind of an expert into that of a novice (Moll, 2002). Moll (2002) further explained that constructivist teachers do not take the role of the "sage on the stage"; instead, they act as "guide on the side" providing students with opportunities to test the adequacy of their current understandings. According to him, students use inquiry methods and a variety of resources to investigate a topic by themselves and find solutions to questions.

Theoretical Framework

According to Khan (2010), theoretical framework of a study is the structure that holds and supports the theory of a research work. The author further disclosed that it serves as the lens that a researcher uses to examine a particular aspect of his or her subject field. A good theoretical framework assures the reader that the type of investigation researchers propose is not based on their personal instincts or guesses but rather informed by established theories and empirical facts obtained from credible studies (Trochin, 2006). The theoretical perspective that guided this study is constructivist theory. The cognitive developmental theories of John Dewey, Jean Piaget, Lev Vygotsky, and Jerome Bruner provide the theoretical basis for application of constructivist theory in the classroom (Kearsley 2001). The cognitive developmental view is largely based on the theories of Piaget and Vygotsky (Bjorklund, 2000). The work of Piaget and his contemporaries are based on the premises that when individual react to the environment, socio-cognitive conflicts occur that bring cognitive instability. This then stimulates perspective thinking ability and hence cognitive development (Bjorklund, 2000). Lev Vygotsky emphasised the impact of cultural and social influences on cognitive development, particularly the interaction of children with other people in cognitive development (Kearsley 2001). Vygotsky described the difference between what children can do unaided and what they can achieve with a little help from peers, teachers and parents as the zone of proximal development (Mcleod, 2010). Dewey believed that children were naturally motivated to actively learn and that education only serve to make more learning possible (Berding, 2000). Kearsely (2001) reported that "Bruner's constructivist theory is based upon the study of cognitive. A major theme in this theory is that learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge.

The Researcher then grounded the theoretical framework into four concepts: the teacher' role, the learner's role, primary source and manipulative materials and self learning as shown in Figure 1 below.

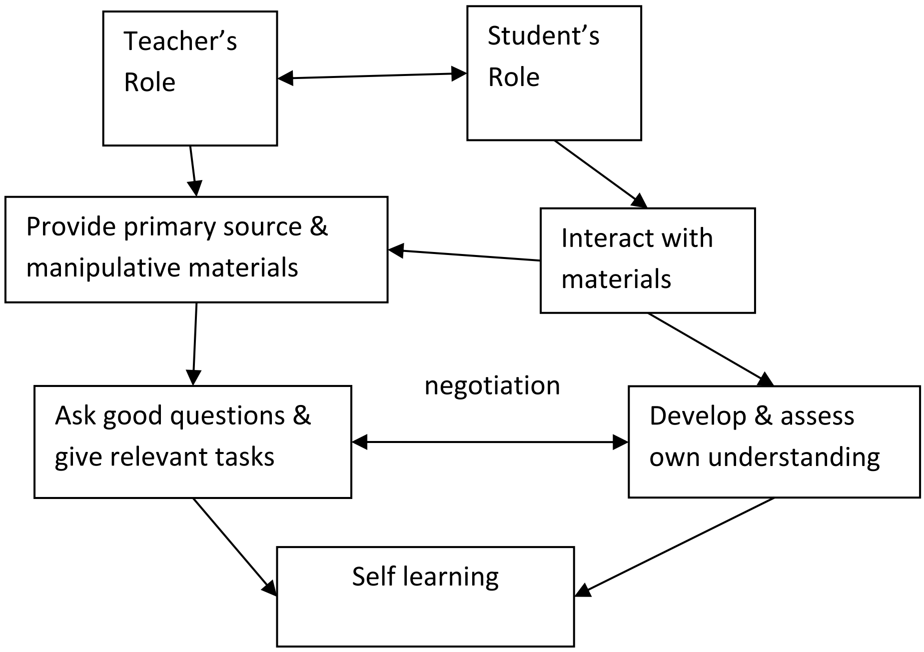


Figure 1: Conceptual model of the study

In this model, the teacher and the learner interact to bring about meaningful learning. The teacher acts as a facilitator who provides instructional guides and manipulative materials. Manipulative materials are concrete objects that allow learners to explore an idea in an active hand-on approach. The learner follows the instructional guides which are the primary source materials and interacts with the manipulative materials and carries out activities. In the process, the teacher asks facilitating questions which stimulate and help the learner to think and which are relevant to the assignment or task given. However, students who find the task difficult to do may negotiate with the teacher for change. The learner develops and assesses his or her own understanding and this leads to self learning

CHAPTER THREE

METHODOLOGY

Overview

This chapter deals with the research methodology employed in the study. It discusses types of research designs and supports the bid for the choice of action research design. It further explained how the population and sample were selected and then gave reasons for the choice of a particular sampling technique. Other areas covered include instruments used for data collection and validity of the research instruments and how the data collected were analysed to determine the effectiveness of the teaching approaches used.

Research Design

According to Gay and Airasian (2000), a research design is used as the overall plan for obtaining answers to the research questions being investigated. Research design deals with specific data analysis techniques or methods that the researcher used (Fraenkel & Wallen, 2000). Amedahe (2002) asserts that research design is a plan or blue-print that specifies how data relating to a given problem should be collected and analysed. Amedahe (2002) further explained that for every research study, the choice of a particular research design must be appropriate to the subject under investigation, and that the various designs in research have specific advantages and disadvantages. According to Amedahe (2000) some examples of research designs are survey, case study, quasi-experimental and action research or experimental.

Survey

Çepni (2010) explains that where a scientific study involves collecting information from a large number of cases, possibly using questionnaire is usually describe as survey. According to Creswell (2008) surveys are good for asking people about their perceptions, opinions and ideas, though they are less reliable for finding out how people actually behave. Cepni identifies survey as being either cross-sectional (data collected at one time) or longitudinal (data collected over a period of time), and that issues on generalisation are usually important in presenting survey results. The author further disclosed that survey design methods enable a researcher to collect data from a large sample within a short period of time, and that because the survey method studies are carried out in order to determine current situations, they prepare the required background for case studies.

Case Study

This involves collecting data, generally from only one or a small number of cases. It usually provides rich detail about those cases of a predominantly qualitative nature. The case study approach is appropriate for individual researchers as it gives the opportunity for one aspect of a problem to be studied to some required depth within a limited time scale (Seidu, 2007). A case study generally aims to provide insight to a particular situation and often stresses the experiences and the interpretations of those involved. It may generate new understanding, explanations or hypothesis. Cepni (2010) explained that the greatest strength of this study is that it allows the researcher to concentrate on a specific instance or situation and to identify, the various interactive processes at work. These processes may remain hidden in a large scale survey but may be crucial to the success or failure of the study. However it does not usually claims representativeness and should be care not to over-generalise.

Quasi-experimental

Quasi-experimental research design involves selecting groups, upon which a variable is tested, without any random pre-selection processes (Shuttleworth, 2008). Quasi-experimental research designs include, but are not limited to: the one-group post test only design; the one-group pre-test post test design; the removed-treatment design; the case-control design; the non-equivalent control groups design; the interrupted time-series design and the regression discontinuity design (Shadish, Cook & Campbell, 2002). According to Shadish, Cook and Campbell (2002), quasi-experiments are exceptionally useful in instances, such as, evaluating the impact of public policy changes, educational interventions or large scale health interventions, where it is not feasible or desirable to conduct an experiment or randomised control trial.

Action Research

Action research involves systematic observations and data collection which can be used by practitioner-researcher in reflection, decision making and development of more effective classroom strategies (Parson & Brown, 2002).The linking terms, action and research, highlight the essential features of this method: trying out ideas in practice as a means of increasing knowledge about or improving curriculum, teaching and learning process (Seidu, 2007). Mills (2000) is of the view that the purpose for choosing action research is to effect positive educational change. By this, Mills (2000) implies that an action research is resorted to in order to solve an immediate problem in a given situation to bring about a positive change. Labaree (2011) asserts that the essentials of action research design follow a characteristic cycle where initially an exploratory stance is adopted. This in his view helps the researcher to learn and understand the problem under consideration so that some form of intervention strategy could be developed. The intervention according to Labaree (2011) is carried out during which pertinent observations are made in various forms to collate and examine data to improve the intervention strategy. The approach enables researchers and their participants to learn from each other through a cycle of planning, action, observation and reflection (Steepless, 2014). According to Steepless (2014), the cyclical nature fosters deeper understanding of a given situation starting with conceptualising and moving through several interventions and evaluation. Figure 2 shows the cyclical nature of the action research model described by Steepless (2014).

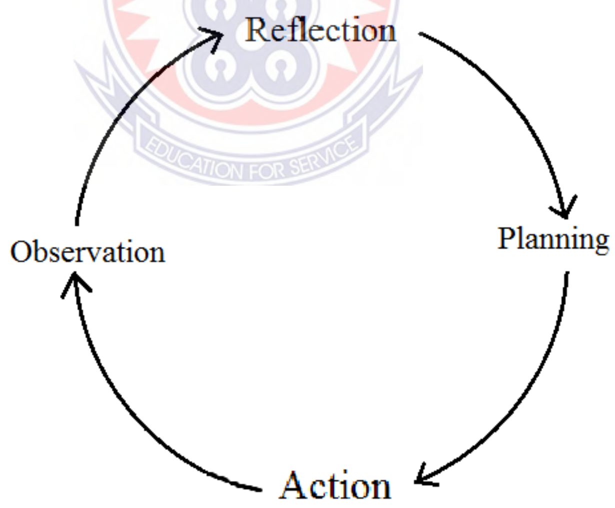


Figure 2 Action Research Model

They include reflecting on one's practice and identifying a problem or concern, planning a strategy or intervention that may solve the problem, acting or carrying out the plan, and finally, observing the result or collecting the data. This cycle is continually repeated seeking improvement until the problem is solved, Steepless

(2014). Ferrance (2000) proposed that action research refers to a disciplined inquiry done by a teacher with the intention that the research will inform and change his/ her practices in future. To him it is an interactive process rather than a one-off exercise of transmitting information by the teacher and that it is mostly chosen when circumstances require flexibility, the involvement of the participants in the research, or change must take place quickly or holistically.

In this study, case study design using action research approach was adopted and this design sought to find an immediate solution to students' inability to answer questions in some selected topics in biology correctly. Again, an action research method allowed for minimum disruption of the normal routine of the school and was more manageable since the researcher did the study during the assigned biology periods.

The study was in three major phases: pre-intervention, implementation of intervention, and post-intervention activities. In this study, the Researcher developed Students' Instructional learning package. This is teaching and learning guide prepared by the Researcher for the students on guided discovery and self learning. The package contained students' study guides and self assessment worksheet. The steps involved in the package were: presentation of the topic, distribution of study guides and manipulative materials to students, interaction with the manipulative materials and formulation of responses to the questions by students, monitoring of the learning by the teacher, discussion of ideas with whole class by students, conclusion and evaluation. Students who find the task difficult to do may negotiate with teacher for change of task. This learning package was used during the intervention stage.

Population

A population, according to Punch (2006) is the target group of people about whom a researcher wants to develop knowledge. Similarly, Creswell (2008) is of the view that population is a group of individuals or objects who have the same characteristics. Creswell (2008) further explained that a population defines the limits within which research findings are applicable and that a population could be large or small and a researcher needs to decide what group to use for the study. There are two different types of population in research: target population and accessible population (Castillo 2009). The target population according to Castillo (2009) is also known as the theoretical population and refers to the group of individuals to which researchers are interested in generalising the conclusions. However, the accessible population which according to him is the population which the researchers can readily access, work with, and apply their conclusions.

In this study, the target population comprised all science students at Wenchi Senior High School in the Wenchi Municipality of Brong-Ahafo Region. However the accessible population was second year biology students in Wenchi Senior High School. The choice of SHS form two biology students was made because they had been exposed to prerequisite concepts in the first year and had attained some level of maturity and confidence needed for guided discovery and self learning. They will also be more receptive to the teaching strategies as they are not under pressure of preparing for external examination.

Sample

A sample is a smaller group which is drawn from a larger population and studied (Robson, 2002; Punch, 2006). The concept of sample arises from the inability of the researchers to test all the individuals in a given population. The sample must be a fair representative of the population from which it was drawn and it must have good size to warrant statistical analysis (Castillo, 2009). Trochim (2002) points out that there are two main types of sample: probability and non-probability samples. According to the author, probability sample is the type where every member of the population has equal opportunity to be selected into the sample. Some of the probability samples are simple random, systematic and stratified sample.

Simple random sample is the type where each member of the population under study has equal chance of being selected into the sample. Simple random sample gives the opportunity to have homogeneous representation of the population (Amoani, 2005). Systematic sample is the type in which the selected subject from the population list is systematic rather than the random fashion (Cohen, Manion & Morrison, 2008). This type is more convenient when dealing with a very large population and a large sample is needed. Stratified sample is the type where certain subgroups or strata are selected in the same proportion as they exist in the population. Fraenkel and Wallen (2000) explained that stratified sample involves dividing the population into homogeneous groups, each group containing sample with similar characteristics. This sample type ensures that different strata in the population are represented. It also increases the precision of the sample and it is convenient for practical purposes.

Non-probability sample is a deliberately selected sample to represent the wider population; it seeks only to present a particular group, a particular named section of a wider population, such as a class of students, a group of students who are taking a particular examination, and a group of teachers. There are several types of non-probability sample: convenience sample, quota sample, snowball sample and purposive sample (Cohen, Manion & Morrison, 2008). According to Patton (2002), purposive sample is the type in which the researcher handpicked the people to be included in the sample on the basis of their judgment of their typicality or possession of the particular characteristics being sought.

In this study, purposive sampling was used to select sample for the study. The sample for study was second year home economic biology students. The sample size was 50 students and of out these 48 of them were girls and the remaining 2 were boys. The Researcher used purposive sample because among the accessible population these students' over depended on teachers for information and their responses to oral questions and classroom exercises revealed some misconceptions. Again the class was a female dominated type; the Researcher saw it as an opportunity to demystify the study of science among girls.

Sampling Technique

Sampling, according to Amoani (2005), is the procedure whereby elements or people are chosen from a population to represent the characteristics of that population. Kumekpor (2002) also explains sampling as the use of definite procedure in the selection of a part for the express purpose of obtaining from its description or estimates certain properties and characteristics of the whole.

There are two types of sampling techniques that are use in educational research which are probability sampling and non-probability sampling (Cohen, Manion & Morrison, 2008). According to Cohen, Manion and Morrison (2008), in probability sampling randomness is the essential and it is a key element in the process. On the other hand, non-probability sampling is based on the judgment of the researcher. The authors disclose that there are several types of sampling techniques and some of them are simple random and stratified (probability), convenience and purposive (non probability) samplings. According to them, in simple random sampling all the units of the target population have an equal chance of being selected and that this technique is appropriate when a population of study is similar in characteristics of interest. Stratified sampling involves dividing the population into a number of homogeneous groups or strata. Each group contains subjects with similar characteristics and a sample is then drawn from each group or stratum. Stratified sampling technique is employed when there is a need to represent all the groups of the target population in the sample. Amedahe (2002) points out that convenience sampling is a form of non probability sampling which involves choosing the nearest or available individuals to serve as respondents. This type sampling is employed in qualitative research and in other studies where representativeness is not an issue. Purposive sampling is also a form of non probability sampling in which decisions concerning the individuals to be included in the sample are taken by the researcher, based on a variety of criteria which may include specialized knowledge of the research issue, or capacity and willingness to participate in the research (Bernard, 2002). This technique is used when the researcher wants a sample of experts as in the case of a need assessment using the key informant approach.

In this study, purposive sampling was used to select the sample for the study because the Researcher had taught home economics classes consistently for the past five years and has observed that the students' over depended on teachers for information. Also, the students' responses to questions revealed some misconceptions and some of them also exhibit negative attitudes like laziness, lack of interest and truancy during biology lessons.

Research Instrument

Research instruments are tools used to collect data to answer the research questions. Zohrabi (2013) points out that there are various procedures of data collection. According to him some of them are questionnaire, interview, classroom observation and test. These instruments are discussed below.

Questionnaire

Questionnaire is the most frequently used instrument or tool in educational research for obtaining the data beyond the physical reach of the researcher which for example may be sent or mailed to people who are thousands of miles away.

According to Jack and Norman (2003), a questionnaire is a written document that has a set of questions given to respondents or used by an interviewer to ask questions and record answers. The authors pointed out that there are two forms of questionnaire: closed-ended and open-ended form. The closed-ended form is also known as restricted or structured calls for short, check-mark and require the respondent to provide "yes" / "no" responses or rank alternatives provided based on how one feels about the issue. The respondent's choices are limited to the set of opinions. However, the open-ended questionnaire which is also termed as unrestricted or unstructured calls for a free response in the respondent's own words. The respondent frames and supplies the answers to the questions raised in the questionnaire. Questionnaires are used when researchers want to obtain information on a large number of issues. They are usually employed in survey researches.

Interview

Amedahe (2002) discloses that an interview involves posing questions to respondents for answers in a face-to-face situation or by phone. According to Amedahe (2002), there are many types of interviews, each of which differs from the others in structure, purpose, role of the interviewer, number of respondents involved each interview, and form and frequency of administration. These types however fall under two main categories: structured and unstructured. The structured interviews follow specific questions to be asked and the orders of the questions are pre-determined and set by the researcher .They are based on a strict procedure and a highly structured interview guide. However, the unstructured interviews have no strict procedure to follow. There are no restrictions in the wording of the question or the order of the question. Interviewers develop questions as they go along and probe respondents' answer with follow-up inquires. Merriam (2001) discloses that interview is the best technique to use when conducting intensive case studies of a few selected individuals. Interview is useful when the informant cannot be directly observed.

Observation

Annum (2015) point out that observation involves watching people, events, situations, or phenomena and obtaining first hand information relating to particular aspects of such people, events situation or phenomena. It deals with perceiving data through the senses: sight, hearing, taste, touch and smell. According to Annum (2015), there are several type observations. Some of them are participant and non participant observation. According to him, in participant observation the observers actually become members of the group they are supposed to be studying. They observe from inside the group and, ideally, their identity as a researcher is not known. However, in the non-participant observation, observers study their subjects from outside without becoming a part of the environment of the observed. Annum (2015) explained that observation is one of the important methods for obtaining comprehensive data in qualitative research especially when a composite of both oral and visual data become vital to the research. Ary and Razavied (2002) point out that observation is employed when children are to be studied while busy in different activities such as games, dramatics or social services.

In this study, two instruments were used to collect data. These are learning package and observational checklist. They were developed by the Researcher and used as treatment on the students during the intervention stage.

Learning Package

The learning package contained instructional objectives, primary source materials which are the study guides, manipulative materials and self assessment worksheet. The learning package was tagged Instructional Package for Guided Discovery and self learning (IPGDSL). The IPGDSL had been compared with the standard of Akinbobola (2009) and Yusuf and Afolabi (2010). Samples of IPGDSL at Appendices A – F.

Each student was given IPGDSL to learn on their own. The students' follows the instructional guides which are the primary source materials, interacts with the manipulative materials and carries out activities independently. The Researcher asked facilitating questions which stimulate and help the learner to think and which are relevant to the assignment or task given. However, students who find the task difficult to do may negotiate with the teacher for change. At the end of lesson, the students answered self assessment questions in the worksheet as evaluation. In addition, the students were given home work.

Observational Checklist on science process skills

An observational checklist was developed and used by the Researcher to take inventory of science process skills that are exhibited by the students during the lessons. Some of the process skills were also checked after marking students' classroom exercises. The checklist contained lesson topics and the science process skills to be observed. Sample is found at the Appendix G.

Observational Checklist on student attitude

An observational checklist was used to gather information about students' attitudes to science. The form was used to evaluate students' attendance and participation aspects of attitude in the classroom. It was designed in such a way that it contains some attributes of attitude (attendance and participation) to be observed and brief remarks or notes. The Researcher wrote observational note after each lesson in order avoid Hawthorn effect. Hawthorn effect is a form of reactivity whereby subject improve or modify an aspect of their behaviour which is being experimentally measured, in response to the fact that they know that they are being studied (McCarney, Warner, Iliffe, Van Haselen, Griffin & Fisher, 2007).Sample at Appendix H.

Validity of the Instrument

Creswell (2008) states that validity means the individual's scores from an instrument make sense, are meaningful, and enable a researcher to draw good conclusions from the sample being studied, and that validity seeks to determine whether the instrument actually measures what it is intended to measure. Cohen, Manion and Morrison (2008) also explained that validation of research instrument must show that it fairly and comprehensively covers the domain or the items that it purported to cover. In this study the learning package was validated by my supervisors.

Data Collection Procedure

In this study data was collected with the aid of the research instruments. The data collection procedure was divided into three phases: pre-intervention, intervention and the post intervention phase.

Pre-intervention phase

This stage of the study lasted for two weeks. The Researcher informed the headmaster about the research work he wanted to carry out in the school in order to solicit his cooperation and assistance. He then liaised with the headmaster to supply all the students with recommended biology textbooks (Excellent biology and Anointing mega etc). A Termly scheme of work or forecast was prepared and each student was given a copy to follow.

Intervention phase

This phase had to do with the implementation of the learning package. The stage lasted for eight weeks. The students performed activities at this stage and provided feedbacks. The Researcher monitored students' activities and intervened when necessary. In this study five lessons were reported and analysed.

Implementation of the Instructional Package for Guided Discovery and self learning (IPGDLD)

This involved six steps. The steps are explained as follows:

Introduction

The Researcher introduced the lesson by reviewing the students' relevance previous knowledge through question and answer technique. This stage is very essential to arouse the students' attention and help in bridging the gap in learning by activating students' prior knowledge and in taking in the new material.

Practice of the IPGDSL

The Researcher distributed study guides, manipulative materials and self assessment task worksheets to the students. The students' follows the instructional guides, interacted with the manipulative materials, carried out activities independently and recorded their findings. However, students who find the task difficult to do may negotiate with the teacher for change.

*Monitoring and intervening***.**

While the students were working on the given task, the Researcher moved round and observed each individual task work. At random, the Researcher asked facilitating questions which stimulate the students to think and which are relevant to the assignment or task given. The Researcher intervened in each individual if he/she asked for a clarification to be made while working on the task. He intervened when the need aroused.

Assessment

The Researcher evaluated the individual student using students' checklist and the worksheet task. To evaluate individual understanding, the Researcher made a checklist to keep track of individual points. The expression of students' opinion, asking of questions and contributions during lessons were assessed. For instance, each time an individual ask a significant question on the package, the Researcher awarded one bonus point. Any insignificant question received no bonus point. Each student answered the self assessment questions on the worksheet. Students were not permitted to help one another during the evaluation exercises.

Scores

Each worksheet exercise taken was marked and scored. These scores were accumulated for each student.

Individual recognition

The Researcher figured out excellent, good and average students and awarded them. Individual scores were announced and students who have improved over the previous exercise were also awarded. This was done to recognise individual accomplishment and to encourage the students to learn hard.

Observational checklist

This was developed and used by the Researcher to take inventory of the science process skills that are exhibited during the lessons. Some of the process skills were checked after marking the students' classroom exercises. The checklist contained lesson topics and the science process skills to be observed. The Researcher ticked (√) if the process skill is observed and crosses (×) if the process skill is not observed. The results were collated and analysed.

Data analysis procedure

Data analysis is the process of simplifying data in order to make it comprehensive (Jack & Norman, 2003). According to Bogdan and Bilklen (2003) data analysis refers to the process of systematically searching and arranging the interview transcripts, field notes, and other materials that are accumulated to produce findings. Data analysis is the process of converting raw data collected into usable information.

In this study qualitative data analysis methods were employed. Reports were presented on the lessons and analysed based on the progress of the students from lesson to lesson. The activities carried out, the interactions, the level of participation in the lessons and the progression of the lessons were all grounded in the report. The observations made during the lessons and findings from the five lessons were analysed qualitatively. Discussions of the findings were made based on the research questions. On the basis of analysing the findings, conclusions and recommendations were made.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

Overview

This chapter deals with the findings of the five lessons. Each lesson report was based on the teaching and learning activities that went on in the classroom. A number of Tables and Figures have been constructed for easy presentation and analysis of data. The chapter ends with discussion of the findings according to the research questions.

Report on Lesson 1

Topic: Internal structures of dicotyledonous and monocotyledonous stem.

Objectives: After studying this package students should be able to:

1. Cut transverse sections of dicotyledonous and monocotyledonous stems.
2. Mount and observe the internal structures of the cut stems under the microscope.
3. Draw the transverse section of the cut stems and label them.
4. Identify internal structural differences between dicotyledonous and monocotyledonous stems.

Relevant Previous Knowledge: The Researcher introduced the lesson by asking the Students to mention some organelles found in a eukaryotic cell.

Students' response: mitochondrion, chloroplast, lysosome, Golgi body, vacuole endoplasmic reticulum, ribosome and centriole.

Activity 1: Cutting transverse sections of dicotyledonous and monocotyledonous stems.

The students were provided with instructional guides and manipulative materials. The Researcher instructed the students to hold the bean seedling firmly between their forefingers and the thumbs in their left hands. Students were asked to hold the razor blade firmly between the tips of the thumbs and their forefingers in their right hands. They were guided to cut thin transverse sections as fast as possible by smoothly running the blade over the bean seedling repeatedly. The students were instructed to lower the cut sections of the stem into petri-dish containing water.

Findings 1: The student cut thin transverse sections of bean seedling stem into petri-dishes containing water. The skills acquired were manipulating, cutting, holding, mounting, observing and communicating skills were demonstrated by the students. The activity was carried out through guided discovery approach.

Activity 2: Discovery of internal structures of sections under the compound microscope.

The students were instructed to remove the thinnest section of the cut stem from the petri-dish with a fine brush or a feather and place it on a slide. They covered it with cover slip with the help of a needle and mounted it on the microscope. The students were asked to connect the microscope to a power source and switch it on. They were instructed to turn revolving nosepiece until the low power lens is in line with the cut section of the stem to be viewed. This is achieved when a click sound is heard. The students were then asked to look into the microscope, turning the coarse adjustment to move the objective lens away from the slide until a sharp image of the cut section of the stem is seen through the eyepiece lens.

Findings 2: The students observed the cut transverse sections of the stem under the microscope and recorded their findings as epidermis, cortex, phloem, cambium, xylem and pith. The skills acquired were manipulating, cutting, mounting, measuring, comparing, observing and communicating skills were demonstrated by the students. The activity was performed through guided discovery approach.

Activity 3: Drawing and labelling the transverse section of the cut stem

Students were asked to draw and label transverse section of dicotyledonous stem as seen under the microscope. The students made individual drawings and labelled the internal structures as shown in Figure 1 below.

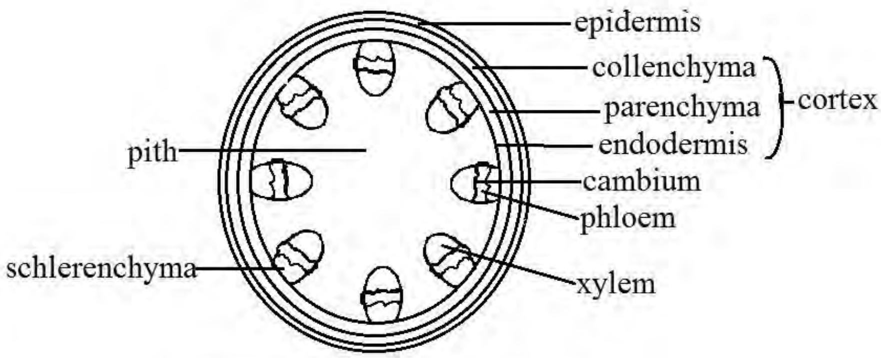


Figure 3 diagram of T/S of a dicot stem

The students were asked to examine prepared permanent slide of transverse section of dicotyledonous stem under the microscope. They were asked to point the differences between prepared slide and their slides.

The students repeated the same experiment but this time using transverse section of monocotyledonous stems (Appendix A). They made individual drawings and labelled the internal structures as shown in Figure 2 below.

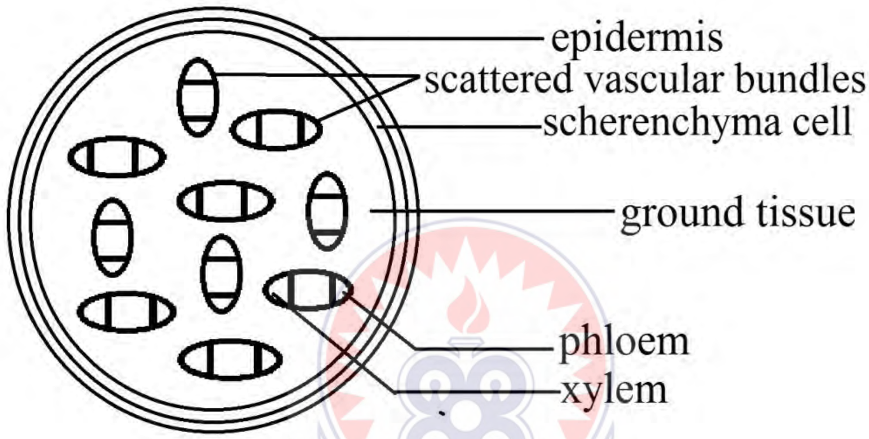


Figure 4: Diagram of T/S of a monocot stem

Finding 3: The students' found out that the structures observed under their temporary slide were the same structures observed under prepared slide provided by the Researcher. Majority of the students were unable to draw neat and clear diagrams. The outlines of their diagrams were woolly and wavy, provided guidelines with arrow heads which are not accepted in biological drawings. The skills acquired were manipulating, observing, comparing, communicating, drawing and labelling skills. The activity was carried out through self learning.

Activity 4: Identifying the differences between dicotyledonous and monocotyledonous stems

The students were asked to write down the internal structures found in the dicotyledonous stem and that of the monocotyledonous stem. They were then asked to compare and contrast the internal structures of the stems in a tabular form.

Finding 4: Internal structural differences between dicotyledonous and monocotyledonous stem

Dicotyledonous Stem	**Monocotyledonous Stem**
Vascular bundles are arranged in rings	vascular bundles are scattered
Presence of cambium	Absence of cambium
Cortex present	Absence of Cortex
endodermis and pith are present	endodermis and pith are absent

The skills acquired were observing, communicating, comparing and contrasting. The activity was carried through self learning approach.

Evaluation questions and students responses

1. Draw and label the transverse section of a dicotyledonous stem.

   Expected students' response: Students drew and labelled the parts as epidermis, cortex, vascular bundle (Phloem, cambium and xylem) and pith. In addition student provided title of the diagram drawn.

2. Describe the structure and function of the labelled parts in question (1) above.

   Expected students' response: Epidermis is a tissue of a single layer of closely fitting cells, which form a continuous layer around the stem. The outer walls are impregnated with waxy waterproof material called cuticle. Functionally, it protects the shoot against water loss, mechanical damage and the entry of harmful bacteria and fungi.

Cortex comprises the collenchymas, parenchyma and endodermis. The collenchyma is three or four cells thick with cell walls thickened at the corner. It strengthens the stem. Parenchyma consists of a large thin-walled cell with intercellular air spaces between them. It is responsible for gaseous exchange within the stem. The endodermis or starch sheath forms the innermost layer of the cortex. It is a single layer of tightly packed rectangular cells. It stores starch grains and allows passage of solutions from the vascular bundles to the cortex.

Vascular bundle consists of three main tissues namely xylem, cambium and phloem. The phloem is located towards the outside of the bundle and the xylem towards the centered. The cambium separates the xylem and phloem. The xylem consists of four cell types, namely tracheids, vessel elements, xylem parenchyma and xylem fibres. It transports water and mineral ions from the root system to the leaves, strengthens and supports the stem. The phloem is composed of five cell types namely sieve tube, companion cells, phloem parenchyma and fibres. It transports synthesised organic food from the leaves to storage organs and other parts of the plant. The cambium is present between the phloem and the xylem. It divides to produce new xylem and phloem cells and this brings about secondary growth in plants.

The pith or medulla occupies the central part of the stem. It consists of thin-walled parenchyma cells with intercellular air spaces and medullary rays. The pith stores water and starch, allows gaseous exchange and the medullary transport substances from the xylem and phloem to the inner and outer parts of the xylem.

Summary of Findings from lesson 1

Majority of the students were able to cut, mount, and observe internal structures of transverse section of dicotyledonous and monocotyledonous stems under the microscope. The following skills were acquired by the students in the lesson:

1. Manipulating skill which was acquired when the students turned the revolving nosepiece and the coarse adjustment knob to move the objective lens away from the slide until a sharp image of the cut thin stem (specimen) was seen through the eyepiece lens. This skill was also displayed during the cutting of the thin sections of bean and maize seedling stem.
2. Holding skill was demonstrated when the students held the bean seedling and the razor blade firmly between their forefingers and the thumbs in their left and right hands respectively.
3. Cutting skill was demonstrated when students as fast as possible smoothly ran the razor blade over the bean seedling repeatedly.
4. Observing skill was acquired when students looked into the microscope with both eyes and identified the internal structures of the cut thin stem (specimen).
5. Mounting skill was displayed when students placed the slide containing the cut thin stem on the stage and held it in place with stage clips.
6. Communicating skill was acquired when the tabulated four external differences between dicotyledonous and monocotyledonous stem. It was also displayed when they followed the Researchers' instructions and performed the tasked.
7. Comparing and contrasting skills were demonstrated when the students pointed out the similarities and differences between internal structures of dicotyledonous and monocotyledonous stem.

8. Drawing skill was displayed when students represented the transverse section of the bean and maize seedling stem on their sketch pads and
9. Labelling skill was demonstrated when students used ruled guidelines to indicate the structures on their drawn diagrams and labelled them horizontally.

Report on lesson 2

Topics: Transport in flowering plants

Objectives: After studying this package, students should be able to:

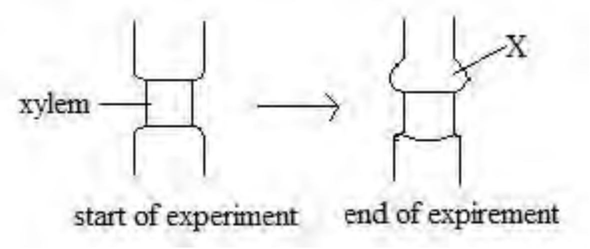
1. Demonstrate that phloem tissue is responsible for translocation of manufactured food substances of photosynthesis.
2. Demonstrate that xylem tissue is responsible for transportation of water and minerals salts in plants.

Relevant Previous Knowledge: Students were asked to mention some internal structures that are found in the transverse section of a stem.

Students' response: epidermis, cortex, vascular bundles (phloem, cambium and xylem) and pith.

Activity 1: Discovering phloem as responsible for translocation

The students were grouped into ten with maximum of five (5) members in each group. The groups were instructed to cut and removed a ring of bark and associated phloem from trees using sharp knife or cutlass. They were asked to observe above and below the ring after some few hours (Appendix B). The students were also asked to describe a control experiment for the set up.



*Finding 1***:** The students observed that bark above the ring became swollen indicating an increased in sugar content. However below the ring the sugar concentration remains the same or decreased indicating that there is no movement of food substances down the stem. They concluded that because the phloem tissue was removed that brought about the accumulation food substances above the ring hence phloem tissue is responsible for the translocation of manufactured organic compounds such as sugars and amino acids. The skills acquired were manipulating, cutting, observing, comparing, communicating and inference. The activity was carried through guided discovery approach.

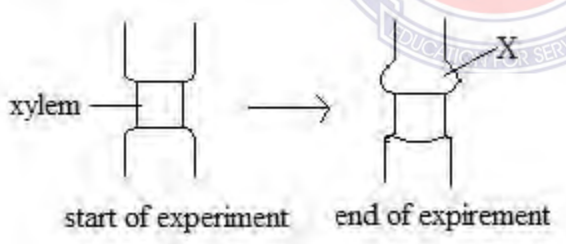
Activity 2: Discovering xylem as responsible for transportation of water and mineral salts.

The students were instructed to carefully uproot a small water leaf or balsam plant and placed it in a beaker stained with dye (red ink).They were asked to make sure that the roots are completely immersed in the solution. The set-up was then left for 24 hours and the plants removed from the solution. They were then asked to cut thin transverse sections of the stem as fast as possible by smoothly running the blade over the bean seedling repeatedly. They mounted the thinnest cut section of the stem on a slide and carefully examined it by turning the coarse adjustment to move the objective lens away from the slide until a sharp image of the cut section of the stem is seen through the eyepiece lens under the microscope. Students were asked to write down their observation and conclusion (Appendix C).

Findings 2: The students observed that xylem vessels became stained or red indicating that the coloured water moved from the root through the xylem vessels to all parts of the plant. This indicates that xylem conduct water and mineral salts upwards. The skills acquired were manipulating, cutting, mounting, observing, communicating and inference. The activity was carried through guided discovery approach.

Evaluation questions and students responses

In an experiment in which a ring of bark and certain tissue was removed from a woody stem, the region marked X above the ring became swollen with food substances. Study the diagram below carefully and answer the following questions.



1. Give a suitable title to the experiment

   Expected student response: Experiment to show that phloem tissue is responsible for translocation of manufactured food substances of photosynthesis or stem ringing experiment.

2. Which of the following statements best explain that accumulation of food materials at region X?

A) Xylem transports food downwards

B) Xylem transports water and minerals salts upwards

C) A tissue outside the xylem transport food downwards

D) A tissue outside the xylem transport food upwards

Expected student response: C). A tissue outside the xylem transport food downwards

3. Briefly describe a control experiment for the set-up.

Expected students' response: Ringing a twig on the same plant, but leaving some of the phloem tissue, no swelling and accumulation of sugars or soluble compounds occur.

4. Name the processes by which water and mineral salts are absorbed by the root hairs.

Expected students' response: water is absorbed by osmosis and mineral salts are absorbed by diffusion and active transport.

5. Briefly explain how the processes mentioned in (a) above occurs.

Expected students, response: vacuoles in the root hairs of plants normally contained a higher concentration of solute than the surrounding soil solution. Water potential gradient therefore exists between the root hairs and the soil water. Water therefore enters the root hairs by osmosis.

Mineral elements whose concentrations are greater in the soil solution than the root hair are absorbed by diffusion whereas those found in greater concentrations in cell sap than those in the surrounding solution are absorbed through active transport. This involves the use of energy in the form of ATP to move mineral ions into the root hair cells against a concentration gradient.

Summary of findings from lesson 2

The following skills were demonstrated by the students in this lesson:

1. Manipulating and cutting skills were demonstrated when the student cut and removed a ring of bark and associated phloem from trees using sharp knife or cutlass.
2. Observing skill was demonstrated when students looked above and below the ring after some few hours and identified that the bark above ring was swollen. The skill was also displayed when students identified that the xylem vessels became stained or red in colour.
3. Comparing skill was displayed when students observed that the bark above ring was swollen but below the ring the bark remained the same.
4. Communicating skill was displayed when the students explained that below the ring the sugar concentration remains the same or decreased indicating that there is no movement of food substances down the stem.
5. Inference skill was displayed when the students drawn conclusion that because the phloem tissue was removed that brought the accumulation of food substances above the ring. This skill was also demonstrated when the students drawn conclusion that the coloured water moved from the beaker into the xylem vessels to all parts of the plant.

Report on lesson 3

Topic: Experiment to show that carbon dioxide is necessary for photosynthesis.

Objective: After studying this package, students should be able to:

1. Perform an experiment to show that carbon dioxide is necessary for photosynthesis.

2. **Relevant Previous Knowledge:** Students were asked to mention the conditions necessary for photosynthesis to occur.

Students' response: water, carbon dioxide, light and chlorophyll.

Activity 1: Destarching two potted plants

The students were instructed to destarch the leaves of two potted plants by putting them in dark for 48 hours (in a cupboard). They were then asked to detach a leaf from each of plants, boil the leaves in water, then ethanol and soften them in cold water. The students placed the leaves on white tiles and added few drops of iodine solution on them.

Finding 1*:* The students observed that is no colour change after destarch exercise indicating that the plant has used up the starch reserve. The skills acquired were manipulating, holding, siphoning, observing, communicating, comparing and inference. This activity was carried through self learning approach.

Activity 2: exposing the potted plants to sunlight

The students were asked to enclose one potted plant in a transparent polythene bag containing sodium hydroxide and labelled it A. They were also instructed to enclose another potted plant in another transparent polythene bag containing sodium hydrogen carbonate and labelled it as B. The students were asked to tie both ends of the bags tightly with elastic band and exposed the set-ups to sunlight for 3-4 hours as shown Figure 3. After some time, the students were instructed to remove leaves from potted plant A and B and test for starch.

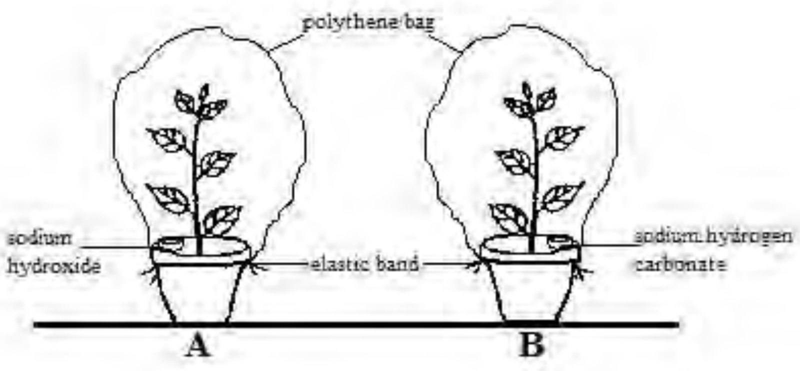


Fig. 5 Potted plants exposed to sunlight

Activity 3: testing for starch in the leaves

The students were instructed to prepare water bath using Bunsen burner and heat the water to the boiling point. They were to detach a leaf from each of the potted plants. With aid of a pair of tongs they held the leaves in boiling for about 10 seconds, placed each leaf in a test tube containing ethanol and boiled them in hot water. They removed the leaves from the ethanol with forceps and washed them in cold water. The students were instructed to place the leaves in a petri dish and using a dropping pipette; they covered each leaf with iodine solution and allowed for 3 minutes. They then washed away the iodine solution with tap water. Students were asked to point out which of the plants served as control experiment (Appendix D).

Finding 2*:* The students observed that after the starch test, leaf from A did not turn blue-black or no change colour indicating starch is absent. This because the sodium hydroxide has absorbed carbon dioxide from bag A hence carbon dioxide which is one factor necessary for photosynthesis is absent so the process does not occur. However leaf from potted plant B turned blue-black indicating starch is present. This because the sodium hydrogen carbonate has produced carbon dioxide in bag B hence potted plant B served as control experiment because it contained all the factors (carbon dioxide, water and sunlight) necessary for photosynthesis. The skills acquired were manipulating, holding siphoning, observing, communicating, comparing and inference. This activity was carried through self learning approach.

Evaluation questions and students responses

1. Why was the set-up kept in dark for two days?

   Expected students' response: To remove food reserves from the leaves of the potted plants or to allow the plant to use its reserve of starch and not allow its replacement by photosynthesis

2. During the starch test, the leaves were boiled in hot water. Briefly explain the reason for this treatment.

   Expected students' response: Starch is within the cells, the cells are surrounded by cell membrane, tough cellulose cell wall and again some leaves also have a protective waxy cuticle. The hot water treatment softens the protective structures, disrupts or kills the cells, stops all chemical reactions and allows alcohol and iodine solutions to penetrate more easily.

3. Distinguish between test and control experiment.

   Expected students' response: A test experiment is an experiment set up to show the effects produced in the absence or variation of a particular factor. However a control experiment is an experiment placed under normal condition or all the necessary factors are present.

4. Briefly describe a control experiment for the set-up.

Expected students' response: Potted plant B served as control experiment because it contained all the factors (carbon dioxide, water and sunlight) necessary for photosynthesis.

5. State one precaution to be taken to ensure the success of this experiment.

   Expected students' response: Both ends of the transparent polythene bags should be tightly tied to make the set-up air tight.

Summary of Findings from lesson 3

The students focused and concentrated on the learning package and the manipulative materials. The following skills were demonstrated by the students in this lesson:

1. Manipulating skill was acquired when students regulated the tap of the Bunsen burner on and off during the preparation of the water bath.
2. Tying skill was demonstrated when the students tied both ends of the bags tightly with elastic bands to make the set up air tight.
3. Holding skill was acquired when the students with the aid of a pair tongs held the leaves in the boiling water and the test tube containing ethanol and the leaves also in the hot water to dissolve the chlorophyll in the leaves. Manipulating skill was also demonstrated in this activity.
4. Siphoning skill was displayed when the students used the dropping pipette to sip iodine solution from the bottle containing it and covered the leaves with the solution.
5. Observing skill was acquired when the students identified that there was no change in leaf and leaf A became blue black after the iodine treatment.

6. Comparing skill was demonstrated after the iodine treatment when the students observed that in leaf A there was no colour change but leaf B there was colour change (blue black coloration).
7. Communicating skill was acquired when the students explained that the set up was kept in dark cupboard for two days in order to remove food reserves from the leaves before the start of the experiment.
8. Inference skill was acquired when the students drawn conclusion that because of the blue black coloration observed, starch is present in leaf B but starch is absent in leaf A because there was on colour change.

Report on lesson 4

Topic: Floral formula

Objectives: After studying this package, students should be able to:

1. Determine and write floral formulae of some flowers.
2. Cut and draw longitudinal sections of half flowers and state their placentation.

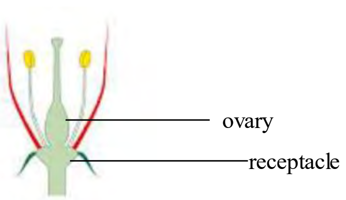
Relevant Previous Knowledge: students were asked to mention the whorls of a flower.

Students' response: calyx (consisting of a number of sepals), corolla (consisting of a number of petals), androecium (comprises a number of stamens) and gynoecium (consisting of one or more carpels or pistils).

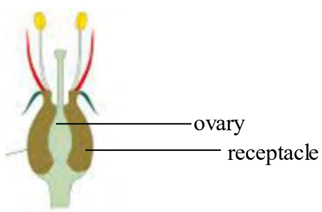
Activity 1: Examining and writing floral formulae

Individually, each student was given *Crotalaria retusa* flower to examine. They were instructed to remove the sepals, the petals and the stamens one after the other carefully. They were asked to count members of each whorl, identify whether the sepals, petals and the stamens are free or fused, measure the length of stamens, and observe the position of ovary either superior or inferior (Appendix E).

Finding 1*:* calyx = 5 fused sepals, corolla = 5 free petals with 2 of the same size and shape, other 2 also of the same size and shape and 1 of different shape, androecium = 9 free stamens of the same size and shape and one different, and the gynoecium = superior ovary. The students explained the meaning of the concept floral formula as a concise way of describing the structure of a flower using letters, numbers and symbols. They discovered that in writing the floral diagram, K stands for calyx, C stands for corolla, P for perianth, A for androecium and G for gynoecium. They also found out that the figure following each letter gives the number of parts of the whorls, and that the symbol ⚥ means bisexual or hermaphrodite flower, % mean the flower is zygomorphic (symmetry is bilateral) and ⊕ means actinomorphic flower (symmetry is radial). The students also discovered the position of the gynoecium is indicated by drawing a line above or below it and that ($\bar{G}$) means inferior ovary and ($\underline{G}$) means superior ovary (ovary on top of the receptacle is superior and ovary inside receptacle inferior ovary).



superior ovary



inferior ovary

The students were able to write the floral formula of *Crotalaria retusa* as:

% ⚥ K (5) C 2+2+1 A (9+1) $\underline{G}1$

The skills acquired were manipulating, measuring, observing, communicating, comparing and inference. The activity was carried through guided discovery approach.

Activity 2: cutting longitudinal sections of flowers

The students were guided to cut longitudinal section through Crotalaria retusa flower using sharp blade. They were asked to observe the internal structure of the ovary using hand lens, draw (12cm long) and label the longitudinal section of half of the flower.

Finding 2: Students made individual drawings and labelled the following parts: ovule, ovary, style, stigma, filament, anther, petal sepal, pedicel and thalamus as shown in Figure 3. They observed the ovules within the ovary and identified placentation as marginal because the ovules are arranged along one edge of a monocarpous ovary.

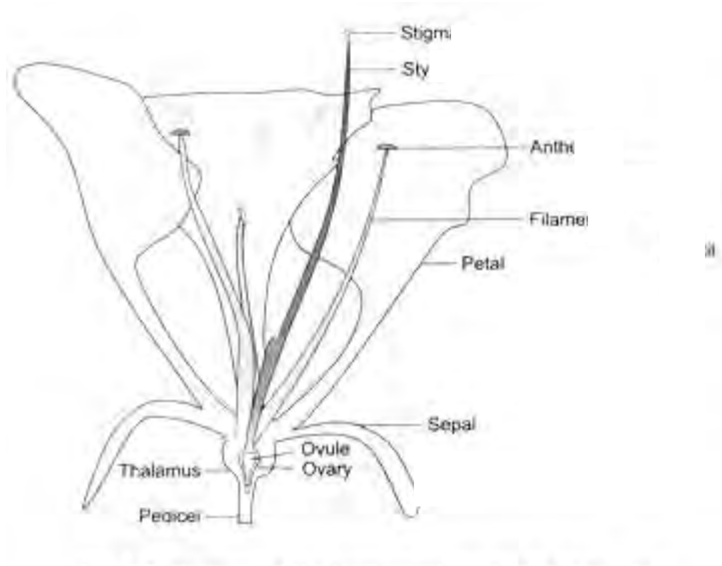


Fig. 6 Labelled drawing of longitudinal section of a flower

The skills acquired were manipulating, cutting, measuring, observing, communicating, comparing, drawing and labelling. The activity was carried through guided discovery approach.

Evaluation questions and students responses

1. Write the floral formulae for *Caesalpinia pulcherrima* and Hibiscus flower.

   Students' responses:

   Floral formula of *Caesalpinia pulcherrima:*

   % ⚥ K 4+1 C 4+1 A 5+5 $\underline{G}$1

   Floral formula of Hibiscus flower

   ⊕ ⚥ K 5 C (5) A∞ $\underline{G}$5

2. Explain the meaning of the symbols %, ± and♀ in floral formula.

   Students' response: % mean the flower is zygomorphic (symmetry is bilateral). The flower can be divided into two equal parts along only plane.

⊕ Means actinomorphic flower (symmetry is radial). The flower can be divided into two equal parts along several planes.

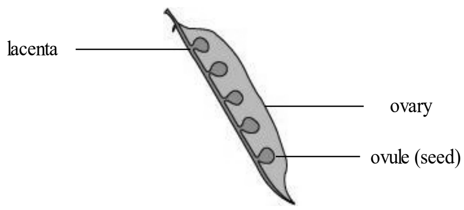
⚥ Means bisexual or hermaphrodite flower. Both male (androecium) and female (gynoecium) parts are present in the flower.

3. Distinguish between ovary and ovule.

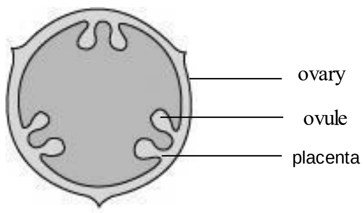
   Expected students' response: the ovary is part of part of the female reproductive organ in flowering plants. It contains the ovules and develops into the fruit. The ovule on the other hand, is located within the ovary. It contains the gamete cell and develops into seed after fertilization.

4. Explain the term placentation and give three types of placentation in flowering plants.

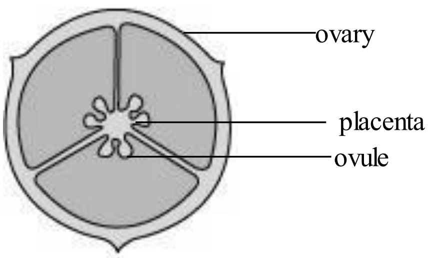
   Student response: placentation is the arrangement of the ovules within the ovary. Three types of placentation are marginal (ovules are arranged along one edge of a monocarpous ovary. Example crotalaria and beans), parietal (ovules are arranged in several lines on the ovary wall, example pawpaw.) and axile (ovules are on the central column, example tomato, lemon).



marginal placentation



parietal placentation



Axile placentation

Summary of findings from lesson 4

The lesson recorded a great improvement in the student performance. The students wrote the floral formulae of *Crotalaria retusa* as: % ⚥ K (5) C 2+2+1 A (9+1) $\underline{G}$1 *Caesalpinia pulcherrima* as: % ⚥ K 4+1 C 4+1 A 5+5 $\underline{G}$1 and Hibiscus flower as: ⊕ ⚥ K 5 C (5) A∞ $\underline{G}$5.

Students made individual drawings and labelled the following parts: ovule, ovary, style, stigma, filament, anther, petal sepal, pedicel and thalamus. They observed ovules are within the ovary and identified placentation as marginal. The following skills were acquired by the students in this lesson:

1. Manipulating skill was displayed when the students removed the sepals, petals and the stamens one after the other and counted each whorl separately.
2. Measuring skills was acquired when the students measured the length of the stamens to find out whether they are the same or not.
3. Observing skill was acquired when the students found out that some of the sepals and petals were free while others were fused and also identified that the ovary of the Crotalaria retusa was superior. The skill was also demonstrated when the students examined the longitudinal section of the half flower of the *Crotalaria retusa* identified that the ovules are found within the ovary using hand lens.
4. Communicating skill was demonstrated when students explained floral formula as a concise way of describing the structure of a flower using letters, numbers and symbols. This skill was also displayed when the students wrote the floral formula of *Crotalaria retusa* as: % ⚥ K (5) C 2+2+1 A (9+1) $\underline{G}$1

5. Comparing skill was displayed when the students identified that the shape and size of the sepals, petals and stamens were not the same.
6. Manipulating and cutting skills were acquired when the students cut longitudinal section through *Crotalaria retusa* flower using razor blade.
7. Measuring skills was displayed when the students drew the longitudinal section of half flower of *Crotalaria retusa* within the given length (12cm long). The skill was also acquired when the students measured the length of their drawn diagrams and that of the length of the *Crotalaria retusa* flower in order to find the magnification.
8. Drawing skill was displayed when students represented the longitudinal section of the half flower of the *Crotalaria retusa* on their sketch pads.
9. Labelling skill was demonstrated when students used ruled guidelines to indicate the parts of their half flower drawn diagrams and labelled the parts horizontally.

Report on lesson 5

Topic: Organs of vegetative propagation

Objectives: After studying this package, students should be able to:

1. Examine, draw and label the external features of bulb of onion, rhizome of ginger and corm of cocoyam.
2. Cut and draw the longitudinal section of an onion bulb.

Relevant Previous Knowledge: Students were asked to explain term the term vegetative propagation and give some examples.

Students' response: vegetative propagation as a type asexual reproduction where special organs are used to produce new individuals without using seeds. It occurs when new plants grow from modified parts. Offspring produced in this way are identical to the parent plant. Vegetative parts of plants that are used for propagation include: bulb, corm, rhizome, sucker, tuber and runners (Appendix A5)

Activity 1: Examining the external features of bulb of onion, rhizome of ginger and corm of cocoyam.

In groups, students were instructed to examine and compare the external features of bulb of onion, rhizome of ginger and corm of cocoyam. The students were instructed compare and contrast the external features in a tabular form. They were asked to make individual drawings and label the diagrams drawn.

Findings 1**:** students' made individual drawings and labelled the following parts: scale leaves, lateral buds, nodes, internodes and adventitious roots. They pointed out that these external features are common to all the organs (bulb, rhizome and corm). The skills acquired were manipulating, observing, communicating, comparing, drawing and labelling. The activity was carried through self learning approach.

Activity 2: **Cutting and drawing the longitudinal section of an onion bulb.**

Students were instructed to cut the longitudinal section of the onion bulb using knife. They were asked to observe the internal structure using hand lens and make individual drawings (Appendix F).

Findings 2: The students cut and made individual drawings. They observed and identified internal parts as fleshy leaves, flower and axillary buds and short vertical stem as shown in Figure 5. The skills acquired were manipulating, cutting, measuring, observing, communicating, comparing, drawing and labelling.

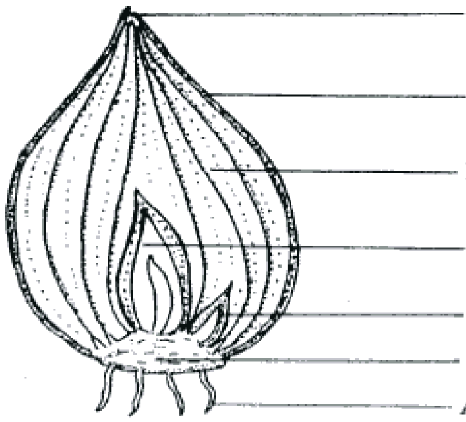


Fig. 7: Longitudinal section of an onion bulb (Alliun Cepa)

Evaluation questions and students responses

Study specimen A, B and C carefully and answer the questions that follow (A – rhizome of ginger, B – corm of cocoyam and C – bulb of onion)

1. Describe observable features of specimen A.

   Expected students' response: specimen A or rhizome of ginger is a horizontal underground stem with terminal and lateral buds. The terminal buds form the aerial shoot and the lateral buds develop into lateral branches. It has brown scale leaves, nodes, internodes and adventitious roots. The adventitious roots grow from the nodes.

2. List four external features that are common to specimen A and B.

   Expected students' response: (rhizome and corm)

Both have scale leaves, terminal and lateral buds, nodes and internodes and adventitious roots.

3. Using a sharp knife, cut specimen C (onion bulb) into two halves longitudinally, observe features which are visible in the section but not in the whole specimen. Draw and label one half of the specimen (onion bulb) to show its internal features.

   Expected students' response: students drawn and labelled the internal features as fleshy leaves, axillary buds and short, vertical stem. They mentioned the external features as brown scale leaves, terminal bud and adventitious roots.

Summary of findings from lesson 5

The following skills were acquired by the students in this lesson:

1. Manipulating and cutting skills were acquired when the students cut longitudinal sections through onion bulb using razor blade.
2. Measuring skills was displayed when the students drew the longitudinal section of the onion bulb within the given length (12cm long). The skill was also acquired when the students measured the length of their drawn diagrams and that of the length of the onion bulb and found the magnification.
3. Observing skill was acquired when the students examined the longitudinal section onion bulb identified it internal features as axillary buds, fleshy leaves and short, vertical stem using hand lens.
4. Comparing skill was acquired when the identified that scale leaves, lateral buds, nodes, internodes and adventitious roots as external features common to all the specimens (rhizome, corm and onion bulb).
5. Communicating skill was acquired when the tabulated four external differences between rhizome of ginger and onion bulb. The skill was also

demonstrated when the students explained that the terminal buds form the aerial shoot and the lateral buds develop into lateral branches.

6. Drawing skill was displayed when students represented the longitudinal section of the onion bulb on their sketch pads.
7. Labelling skill was demonstrated when students used ruled guidelines to indicate the parts of the onion bulb drawn.

The students were highly motivated and eager to learn as they asked meaningful questions and finished worksheet exercises before the schedule time. In general, the students attitude towards the lesson was very impressive (both attendance and participation were very good).

Table 1: Science process skills demonstrated by students during the lessons.

N	Science Process Skill (SPS)	Lesson					Total
		1	2	3	4	5	
1	Observation (Ob)	√	√	√	√	√	5
2	manipulation (MA)	√	√	√	√	√	5
3	Comparison (CA)	√	√	√	√	√	5
4	experimentation (Ex)	√	√	√	√	√	5
5	communication (Cm)	√	√	√	√	√	5
6	drawing (DR)	√	X	X	√	√	3
7	measuring	√	X	X	√	√	3
8	Interpreting Data (ID)	X	√	√	X	X	2
9	Forming Hypothesis (FH)	X	X	X	X	X	3
10	Making Inference (MI)	X	√	√	X	X	2
11	Making Prediction (MP)	X	X	X	X	X	0
	total	7	7	7	7	7	

√ science process skill observed, X = science process skill not observed

Table 1 contained science process skills (SPS) that were demonstrated by the students in five biology lessons. A tick (√) means science process skill is observed and a cross (X) means science process skill not observed. From table 1, it is observed, that in lesson 1,7science process skills (observation, Manipulation, comparison, contrasting, drawing, comparing and communication) were observed. In lessons 2, 3 4and 5, 7 science process skills were observed in each lesson. The process skills: observation, Manipulation, comparison, contrasting and communication were observed in all the lessons, drawing was observed in lesson 1, 4 and 5, measuring was observed in lessons 4 and 5, interpreting occurred in lessons 2 and 3. Making inference was observed in lessons 2 and 3, forming hypothesis and making prediction did not occurred at all. These science process skills demonstrated by the students were presented diagrammatically in the pyramid in figure 6 below.

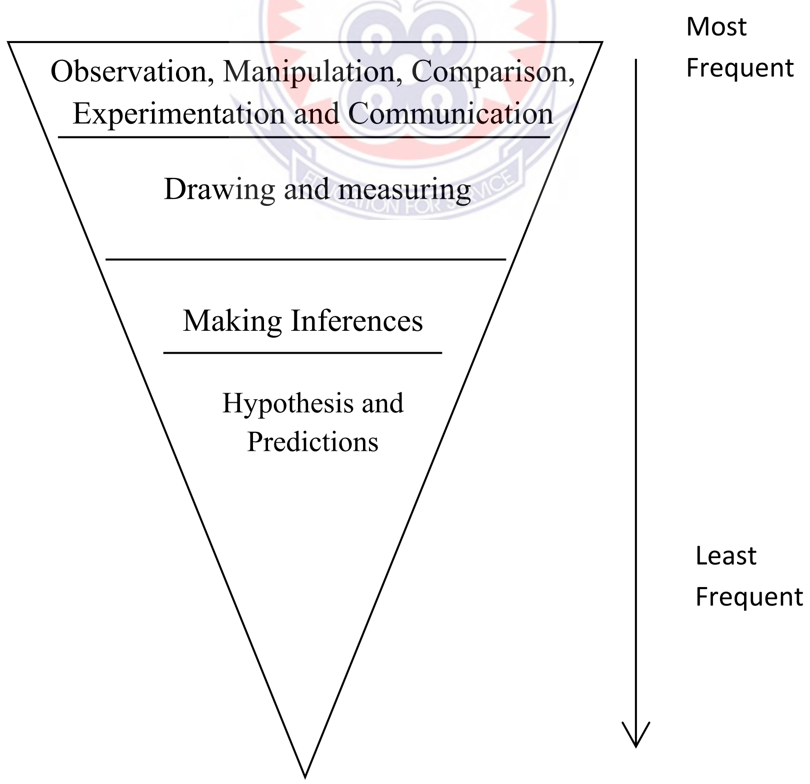


Figure 8: Science Process Skills demonstrated in order of occurrence in the lessons

Discussion

Research question 1: *How does the use of guided discovery and self learning instructional strategies affect students' academic performance in some selected topics in biology?*

From the observation made before the guided discovery and self learning approaches were introduced, it was evident that most of the students were unable to answer questions in some selected topics in biology correctly. Most of their wrong answers revealed specific misconceptions which need corrections. They also had poor practical skills and do not participate actively in biology lessons.

In answering this question, the information gathered was based on conceptual understanding of biological concepts and execution of practical skills. The Classroom interactions that occurred within the five lessons were analysed.

In lesson 1, manipulating, holding, cutting, mounting, observing, comparing, communicating, drawing and labelling skills were acquired by the students. Majority of the students were able to cut the thin sections of the bean and maize seedlings by smoothly running the razor blade over the seedlings repeatedly. Almost all the students mounted slide on the stage, held it in place with stage clips and observed the internal structures of the cut thin stem under the microscope using both eyes. In the process, they turned the coarse adjustment knob to move the objective lens away from the slide for sharp image to be observed. In doing so, manipulating skill was acquired. The students were able to compare and contrast the internal structures of dicotyledonous and monocotyledonous stem in tabular form hence they have acquired communicating skill. Only few students were able to make individual drawings and labelled the following parts: epidermis, cortex (collenchyma, parenchyma, and endodermis), vascular bundles (xylem, cambium and phloem) and pith. Majority of the students were not able to draw neat and clear diagrams. The outlines of their diagrams were woolly and wavy, provided guidelines with arrowheads which are not acceptable in biological drawing. Also most of them did not represent cut surface with double line to show the thickness of the section.

In lesson 2, almost all the students were able to carry out simple experiments to show that phloem is responsible for translocation of sugars downwards and xylem is responsible for transportation of water and mineral salts upwards. In this lesson, manipulating, cutting, mounting, observing, comparing, communicating and inference skills were acquired by the students. It was noticed that there was improvement in the students manipulating, cutting, observing and comparing. With the manipulating and the cutting skills almost all the students were able to cut and remove a ring of bark and it associated phloem from trees using sharp cutlass. In sectioning the balsam plant, all the students were able to cut very thin sections with ease this time. With the observing and the comparing skills all the students observed that the bark above the ring was swollen and the bark below the ring remained the same size. They also observed that the xylem vessels became stained or red in colour. Almost all the students inferred that because the phloem tissue was removed that brought about the accumulation of food substances (swollen) above the ring. They also inferred that the coloured water moved from the beaker into the xylem vessels and this indicates that xylem is responsible for water transport up the stem.

In lesson 3, manipulating, tying, holding, siphoning, observing, comparing, communicating and inference skills were acquired by the students. Tying, holding and siphoning are examples of manipulating skills. The students were able to tie both ends of the bags tightly with elastic bands to make the set up air tight and they explained that this precaution was done to ensure the success of the experiment. Almost all the students with the aid of a pair of tongs were able to hold the leaves in the boiling water and the test tube containing ethanol and the leaves also in the hot water. The students explained that the hot water treatment softens the protective structures, disrupts or kills the cells, stops all chemical reactions and allows alcohol and iodine solutions to penetrate through the leaves more easily. They discovered that ethanol treatment dissolves the chlorophyll in the leaves because the colour of ethanol became green after the activity. The students observing and comparing skills have improved drastically. All the students were able to identify that there was no colour change in leaf A but leaf B turned blue black after the starch test. The students explained that the set up was kept in dark cupboard for two days in order to remove food reserves from the leaves before the start of the experiment. The students' inference skills have improved over that of lesson 2. All the students inferred that the blue black colour observed indicates the starch is present in leaf B and the no colour change in leaf A indicates that starch is absent.

In lessons 4, manipulating, cutting, observing, comparing, measuring, communicating, drawing and labelling. With the manipulating and comparing skills, all the students were able to remove the sepals, petals and stamens one after other and counted each whorl separately. They compared the shape, size and length of the sepals, petals and the stamens whether they are the same or not, free or fused and the position of the ovary either superior or inferior. With cutting skill, almost all the students were able cut longitudinal section through *Crotalaria retusa* flower using razor blade. The students observed the longitudinal section of the half flower of the *Crotalaria retusa* and identified the ovules within the ovary and the placentation as marginal using hand lens. With the communication skill, all the student were able to use letters, numbers and symbols to write the floral formula of *Crotalaria retusa* as:

% ⚥ K (5) C 2+2+1 A (9+1) $\underline{G}$1

The students measured the length of their drawn diagrams and that of the length of the *Crotalaria retusa* flower and calculated magnification of the diagrams drawn. The students' drawings this time have improved as they avoided woolly and wavy outlines and guidelines without arrow heads. They represented cut surface with double line to show the thickness of the section, used ruled guidelines and labelled parts horizontally. The students drew the longitudinal section of half flower of the *Crotalaria retusa* and labelled the following parts: ovule, ovary, style, stigma, anther, petal, sepal and pedicel.

In lesson 5, comparing, manipulating, cutting, observing, measuring, communicating, drawing and labelling skills were acquired by the students. With comparing skill, all the students identified that scale leaves, lateral buds, nodes, internodes and adventitious roots as external features common to all the specimens (rhizome, corm and onion bulb). With the manipulating and cutting skills all the students were able to cut longitudinal sections through onion bulb using razor blade. The students observed the longitudinal section of the onion bulb and identified the short stem and axillary bud as internal structures using hand lens. The students measured the length of their drawn diagrams and that of the length of the onion bulb and calculated the magnification of the diagrams drawn. The students' drawings this time have improved drastically as they avoided woolly and wavy outlines and guidelines without arrow heads. They represented cut surface with double line to show the thickness of the section, used ruled guidelines and labelled parts horizontally. The students drew the longitudinal section of the onion bulb and labelled the following parts: fleshy leaves, axillary bud, and short, vertical stem.

Based on the quality responses provided by the students during the lessons, it is clear that the guided discovery and self learning strategies have improved the students understanding of concepts and acquisition of practical skills. This finding of the study supported the study conducted by Gallenstein (2004) who concluded that guided discovery and self learning approaches encourage independence, make learning more memorable, and increased students' academic achievement. This is also consistent with the findings of Mayer (2003) who asserted that guided discovery strategy encourages learners to search actively for how to apply rules and make sure that the learners come into contact with the rules to be learned. The finding is also in consonance with the results of Ugwanyi (2008) who noted that guided discovery and self learning instructions are more effective than the commonly used expository methods.

Research question 2: How do students' academic performances progress after they have been exposed to guided discovery and self learning strategies?

This research question was answered by the academic performance of the students in responding to questions asked and acquisition of skills during the five lessons. It was noticed that students' responses and acquisition of skills progressively improved from lesson 1 to 5. In lesson 1, majority of the students were not able to draw neat and clear diagrams of dicotyledonous and monocotyledonous stem. Also few of the students could not cut thin sections of dicotyledonous stem well and observing specimens under the microscope was a problem to some of the students but as time went on and the approaches were improved and intensified, the students' responses and acquisition of skills increased progressively lesson by lesson. In lesson 2 students were able to cut very thin sections of balsam stem observed that the xylem tissue was stained red. The students cutting and observing skills in lesson 2 have improved compared with their performance in lesson 1. Also in lessons 4 and 5 almost all the students were able to cut, draw and label the longitudinal sections of half flower and half onion bulb. Also an improvement in performance over lessons 1and 2. In the course of the lessons, responses, reasoning abilities, use of terminologies and explanation of phenomena increase progressively from lessons 1 to 5. Almost all of the students showed better knowledge in the concepts transverse and longitudinal sections, precaution and inference. This progressive increased in concepts and skills acquisition by the students indicates that guided discovery and self learning instructional package is effective for teaching and learning biology. This result is consistent with the findings of Sutherland and Wehby (2001) who asserted that students who are actively engaged and are provided with frequent opportunity to respond to academic tasks demonstrate improved academic skills and performance.

Research question 3: what science process skills do students who are exposed to guided discovery and self learning strategies demonstrate?

This research question was answered with reference to Table 1. The data was collected based on students interactions with the manipulative materials, oral and written responses to questions. Acquisition of science process skills was demonstrated by the students in all the five lessons. The science process skills differ in the intensity of acquisition and dependent on the activities that were carried out during the lessons. Ten science process skills were assessed (observing, comparing, communicating, predicting and drawing) are basic skills while (manipulating, experimenting, interpreting, hypothesising and inferencing) are integrated process skills. *Observation skill* involves using the various senses to identify features of specimen or objects. Students' demonstrated this skill as they observed transverse sections of dicotyledonous and monocotyledonous stems under the microscope, both external and internal features of flowers and organs of vegetative propagation. This skill occurred in all the lessons. *Manipulative and experimental skills* also occurred in all the lessons. This is because all the lesson topics taught have several experimental activities. The finding showed that almost all the students acquired these skills because they followed the procedures in study or instructional guide directly and systematically and interacted with the manipulative materials. *Communication skill* involves action requiring the students to talk, listen and explain ideas. Students were given opportunities to demonstrate this skill through their responses to questions, tabulating and drawing. This skill occurred throughout all lessons. *Drawing skill* was demonstrated by students as they drew and labelled transverse sections of dicotyledonous monocotyledonous stems, longitudinal sections of half flowers and onion bulb. This occurred in lessons 1, 4 and 5. *Measuring and using numbers skill* was required when the students measured the length of their drawings and that of the half *Crotalaria retusa* flower and the onion bulb and calculated the magnification of their drawings. From the observation, almost all the students were able to measure the length of the given specimens and calculate the magnification. This skill occurred in lessons 4 and 5. *Inference skill* was also demonstrated as students drawn conclusions from the experiments performed to show that carbon dioxide is necessary for photosynthesis to occur and the stem ringing experiment. This skill occurred in lessons 2 and 3. *Forming hypothesis and making prediction skills* were not inculcated into the lesson as such students did not demonstrate these skills.

This evident that guided discovery and self learning strategies created more opportunities for inculcation and acquisition of science process skills by the students. It was noted that there was a drastic improvement in students' observational, drawing, communication, experimental, comparing and inference skills from lesson to lesson. This finding is in line with AbdRayl, Rasul, Mansor, Othman and Lyndon (2013) concluded that teachers should always give guidance to students in experiment or lesson in order for them to acquire or demonstrate science process skills.

Research question 4: What effects do guided discovery and self learning strategies have on students' attitude toward biology?

In answering this question, information gathered with the aid of students' observational checklist was used (Appendix D). Before the introduction of the guided discovery and self learning strategies, the students' attendance to class and involvement in biology lessons was unsatisfactory. However during and after the intervention the Researcher observed the students are now regular in class, participate actively in lessons, always jot down points and able to work within the allotted time. In lesson 4, the students were very excited when they discovered the ovules and their arrangement within the ovary. This motivated them to examine placentations of more flowers and even over stayed in the laboratory after closing. This is clear indication that guided discovery strategy has positive effects on students' attitudes toward biology.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Overview

In this chapter the summaries of the findings of the study have been documented. There were seven major findings that emerged out of the intervention lessons. In concluding the work it is stated that the guided discovery and self learning strategies have the potential of enhancing students' academic performance. In this study it was observed that though only five lessons were given, there was quite an appreciable gain in students' learning and answers to questions as the guided discovery and self-learning strategies were used. This is an indication that if there was enough time to extend the teaching and learning approach used, the students would have made substantial gains in learning.

Summary of findings

There were seven main findings in this study which spanned five biology lessons on some selected topics. The following were the major findings that emerged from the study:

1. Almost all the students were able to cut, manipulate the microscope and observe the transverse sections of dicotyledonous and monocotyledonous stem under it using both eyes.
2. Majority of the students were able to cut, observe, draw and label given specimens such as longitudinal section of *Crotalaria retusa* and onion bulb. They used double line to show the thickness of the cut sections, avoided wavy and woolly outlines and provided appropriate titles to the diagrams drawn.

3. Students were able to perform experiments to show that phloem is responsible for translocation of sugars downwards and xylem is responsible for transportation of water and mineral salts upwards.
4. They were able to carry out starch test and made inference based on their observations that the blue black colouration indicates the presence of starch in the leaf and no colour change indicates the absence of starch in the leaf. The students stated the appropriate precaution to be taken to ensure the success of the experiment as the set up should air tight.
5. Almost all the students were able to manipulate the given flowers and write down the floral formulae of *Crotalaria retusa*, *Caesalpinia pulcherrima* and Hibiscus flower.
6. The students acquired the following science process skills: manipulating, observing, comparing, contrasting, communicating, measuring, drawing and inference.
7. The students' attendance to class and involvement in lessons have improved

Conclusion

On the basis of the results obtained in the study, it is concluded that guided discovery and self learning is capable of improving students' academic performance in some selected topics in biology. Moreover, the strategies make classroom more realistic as students are more actively involved and make them responsible for their own learning. Carefully planned lessons encourage, motivate, reduce disruptive behaviour, promote positive effects on mutual concern and care among students. Also from this study, it can be inferred that guided discovery and self-learning strategies fosters the development of practical skills such as manipulating, observing, comparing, communicating, measuring, drawing and inference which is intended to stimulate healthy intellectual climate for students to interact effectively with each other with minimal friction. However, without proper planning and guidance, the opportunity to inculcate the acquisition of science process skills might not occur. If teachers take the attitude that the students will get it eventually in a science class, the goal of science teaching might not be achieved. Science teaching should be planned and done along side with the aim of inculcating science process skills in the students and to ensure their acquisition.

Recommendations

In the light of the results, the following recommendations are made for science teachers and school administrators:

1. Planning of lessons enables teachers to acquire teaching equipment so teachers may take cue from the way the lessons were planned in this work.
2. Teachers may empower and motivate students to be responsible for their own learning by creating opportunities that will actively involve them in the learning process. This may help them discover knowledge, concepts and relations in the texts.
3. Science teachers may allow students to explain their findings. This is because while some had found the answer, others will be more creative. After all the students have given their answers, the teacher can explain the correct way, which is the way that the syllabus stipulates.
4. Guided discovery and self learning approaches could be implemented for different types of students. Science teachers may consider students' individual

differences and make the class a suitable environment for all students to participate in the classroom activities.

5. Students with special needs might need different strategies to keep them on track. In this research, there were students who preferred to work alone.
6. School administrators may facilitate teachers' missions by providing them with worksheets needed for their lessons and the available internet services to enable them search for methodology issues.

Suggestions for Further Research

The findings of this study showed that guided discovery and self learning activities can improve students' practical skills; it is therefore suggest that students should be given more practical activities to do to reinforce the theory lessons. Teachers should always give exercises on drawing of specimens to students to improve their biological skills as evident in this study. The same drawing can be given to the students twice and the result compared to find out whether there is improvement or not.

This study examined improvement of school academic performance in biology at the SHS level in Wenchi Municipality in the Brong Ahafo region in Ghana, further studies can be conducted to investigate the effectiveness of guided discovery and self learning in other disciplines, in urban, in rural, in suburban schools, and for high, average, and low achievers.

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APPENDIX A

Guided Discovery and Self Learning Instructional Package on dicotyledonous and monocotyledonous stems (sectioning).

Name of student:

Class: 2 HE

Number of students: forty five

Date: 14/02/15

Duration: 80 mins

Lesson number: one

Topic: Examining the internal structures of Dicotyledonous and Monocotyledonous stems.

Instructional objective: After studying this package student should be to:

1. Cut transverse sections of dicotyledonous and monocotyledonous stems and observe the internal structures under the microscope.
2. Draw and label the internal structures of dicotyledonous and monocotyledonous stems.
3. Compare and contrast the internal structures of dicotyledonous and monocotyledonous stems.

Manipulative materials: razor blade, stem of young bean seedling, stem of young maize seedling, iodine solution, petri dish, water, microscope, slide, cover slip, and prepared slides of dicotyledonous and monocotyledonous stems.

Instructional guide

1. Using a sharp razor blade carefully cut several very thin, transverse sections of stems of a young bean seedling.

2. Select the thinnest section and place it in a watch glass containing iodine solution for about three minutes
3. .Mount the section under a microscope and observe the internal structures.
4. Obtain a prepared slide of transverse section of a dicotyledonous stem and examine it under the microscope. What differences can you observe between your section and the prepared slide?
5. Repeat the experiment but this time using T.S of a monocot stem.
6. Make a large label drawing of the T.S of:
   a. the stem of dicotyledonous plant
   b. the stem of monocotyledonous plant
7. Compare and contrast the internal structures of the dicotyledonous and monocotyledonous stems. Tabulate your answer in the space provided below.

Students' Self Assessment Worksheet

The diagram below shows the transverse section of a stem. Study the diagram carefully and answer the following questions.

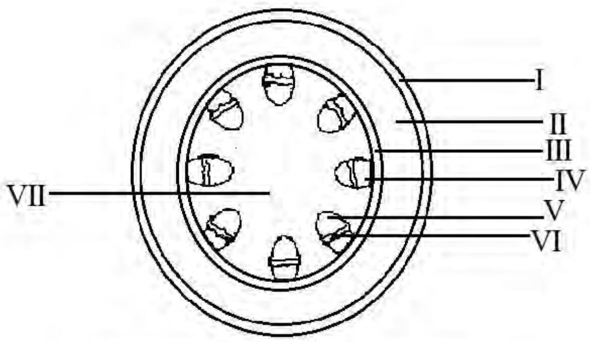

diagram of T/S of a dicot stem

a. What type of stem is it?...

b. Name the labelled parts

I. ....

II. ....

III. ....

IV. ....

V. ....

VI. ....

VII. ....

c. Briefly describe the structure and state one function of each of the parts labelled

I. ....
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II. ....
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III. ....
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IV. ....
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V. ....

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VI. ....

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VII. ....

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d. Tabulate five internal differences between dicotyledonous and monocotyledonous stems.

APPENDIX B

Guided Discovery and Self Learning Instructional Package on phloem translocation

Name of student:

Class: 2 HE

Number of students: forty five

Date: 24/02/15

Duration: 80 mins

Lesson number: two

Topic: Experiment to show that phloem is responsible for translocation of manufactured food substances of photosynthesis.

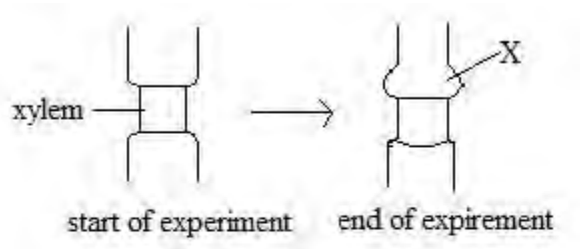
Instructional objective: After studying this package student should be to:

1. Demonstrate that phloem tissue is responsible for translocation of organic food substances of photosynthesis.

Manipulative materials: potted plant, knife or cutlass

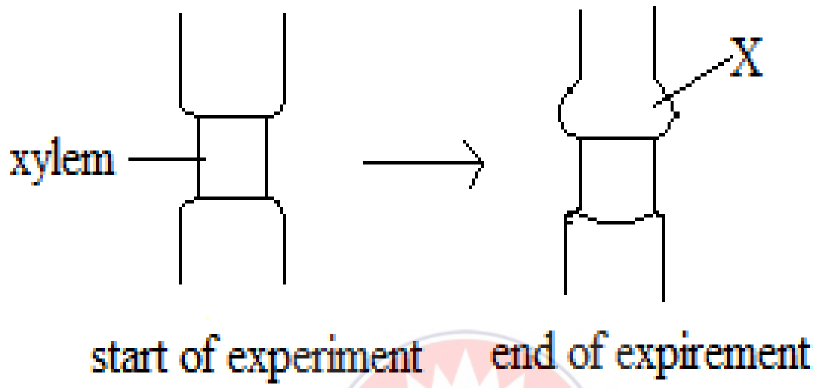
Instructional guide

1. Remove a ring of a bark and associated phloem a tree.
2. Leave it for some few hours or weeks.



Students' Self Assessment Worksheet

In an experiment in which a ring of bark and a certain tissue were removed from a woody stem, the region marked X above the ring became swollen with food substances. Study the diagram below carefully and answer the following questions.



a. Give a suitable title to the experiment.

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b. Which of the following statements **best** explains the accumulation of food materials at region X? Circle the correct answer.

   a) Xylem transport food downwards

   b) Xylem transports water and mineral salts upwards

   c) A tissue outside the xylem transports food downwards

   d) A tissue outside the xylem transports food upwards

c. Name the tissue that was removed in the experiment.

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d. Briefly describe a control experiment for the set-up.

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APPENDIX C

Guided Discovery and Self Learning Instructional Package on xylem transport.

Name of student:

Class: 2 HE

Number of students: forty five

Date: 5/03/15

Duration: 80 mins

Lesson number: five

Topic: Experiment to show that xylem is responsible for transportation of water and mineral salts.

Instructional objective: After studying this package student should be to:

1. Demonstrate that xylem tissue is responsible for transportation of water and minerals salts in plants.

Manipulative materials: balsam plant, beaker, water dye such as eosin or red ink, razor blade, microscope and microscope slide.

Instructional guide

1. Carefully uproot a small plant such as a water leaf or balsam.
2. Place the plant in a beaker of stained with dye such as eosin or red ink. Make sure that the roots are completely immersed in the solution.
3. Leave the set-up for 24 hours.
4. Remove the plant from the solution, and using a razor blade carefully cut thin transverse section of the stem.
5. Mount the cut section on a slide and carefully examine it under the microscope.

Students' Self Assessment Worksheet

a. The process by which water is absorbed by the root hairs is called.

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b. Briefly explain how the processes mentioned in (a) above occurs.

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c. Name two processes that are involved in absorption of water and mineral salts.

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d. Briefly explain how each process mentioned in (c) above occurs.

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APPENDIX D

Guided Discovery and Self Learning on carbon dioxide

Name of student:

Class: 2 HE

Number of students: forty five

Date: 12/02/15

Duration: 80 mins

Lesson number: three

Topic: Experiment to show that carbon dioxide is necessary for photosynthesis

Instructional objective: After studying this package student should be to:

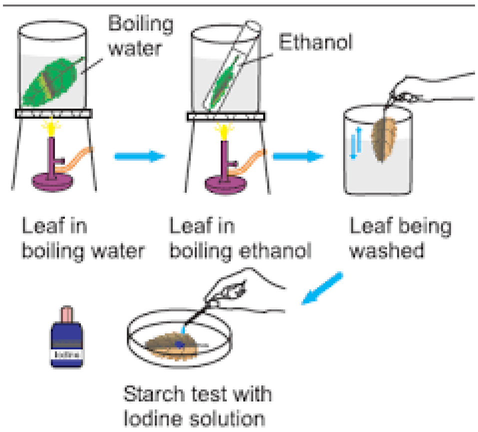
1. Carry out an experiment to demonstrate that carbon dioxide is necessary for photosynthesis to occur.

Manipulative materials: two potted plants kept in dark for 48 hours, sodium hydroxide solution, Sodium hydrogen carbonate solution, two transparent polythene bags, two elastic bands and starch test materials.

Instructional guide

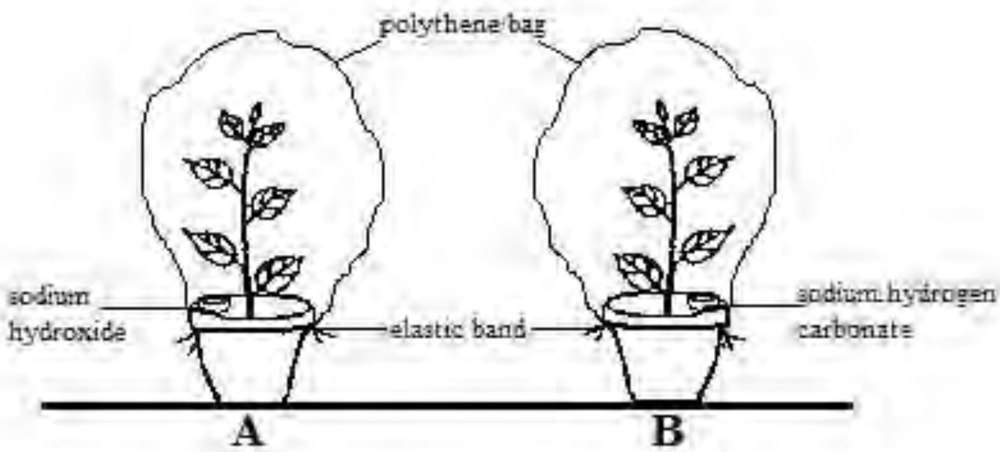
1. Destarch the leaves of two potted plants by putting them in dark for 48 hours.
2. Cover each plant with a transparent polythene bag.
3. Place a container of Sodium hydroxide inside one bag and label it A.
4. In the other bag, place a container containing Sodium hydrogen carbonate and label it B.
5. Tie each set-up tightly with elastic band.
6. Put the set-ups in sunlight for four hours.
7. Remove a leaf each plant and test for starch.

Testing for starch in a leaf



Students' Self Assessment Worksheet

In an experiment to investigate the effect of an environmental factor in photosynthesis, two potted plants were placed under transparent polythene bags. The base of each transparent polythene bag was tied tightly with elastic band and the plants were exposed to sunlight light for 48 hours. Study the diagrams below carefully and answer the questions that follow.



a. Suggest a title for the experiment.

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b. Why was the set-up kept in dark for two days?

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c. What is the function of Sodium hydroxide solution in A.?

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d. What is the function of Sodium hydrogen carbonate in set-up B.?

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e. Which of the set-ups (A or B) serves as the control experiment?

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f. Explain your answer in (e) above.

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g. What observations could be made if leaves from A and B are tested for starch?

Plant A

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Plant B

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h. What would be the conclusion for the experiment?

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i. State one precaution to be taken to ensure the success of this experiment.

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APPENDIX E

Guided Discovery and Self Learning on floral formula

Name of student:

Class: 2 HE

Number of students: forty five

Date: 19/03/15

Duration: 80 mins

Lesson number: four

Topic: Floral formula

Instructional objectives: After studying this package, students should be to:

1. Determine and write floral formulae of some flowers.
2. Cut, draw and label longitudinal section of ovaries of some flowers and state their placentation.

Manipulative materials: flowers of different plants: flamboyant (Delonix), pride of barbadoe (Caesalpinia), rattle box (Crotalaria) hibiscus, razor blade and hand lens

Instructional guide

1. Collect and examine a flower of Crotalaria retusa.
2. Determine the symmetry of the flower.
3. Remove the sepals' one after other. How many are they?, Are they free or fused?
4. Remove the petals' one after other. How many are they? Are they the same type?
5. Remove the stamens one after the other and count them.
6. Examine the position of the ovary.

7. Using the above information, write the floral formula of the Crotalaria retusa.
8. Using the razor blade cut a longitudinal section through the flower and observed it ovary using hand lens. What is the placentation?
9. Draw and label the longitudinal section (10- 12cm) long of the ovary.
10. Repeat the above exercise for pride of barbadoe (Caesalpinia), flamboyant (Delonix), hibiscus flower.

Students' Self Assessment Worksheet

1. Write the floral formulae for the following flowers:

   a. Caesalpinia pulcherrima.

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   b. Hibiscus flower.

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   c. Flamboyant (Delonix).

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2. Explain the meaning of the symbols %, ⊕ and ⚥ n floral formula.

   a. % .

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b. ⊕ ....

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c. ⚥

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3. Distinguish between ovary and ovule.

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4. Explain the term placentation and give three types of placentation in flowering plants...

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APPENDIX F

Guided Discovery and Self Learning on vegetative propagation organs

Name of student:

Class: 2 HE

Number of students: forty five

Date: 26/03/15

Duration: 80 mins

Lesson number: five

Topic: Organs of vegetative propagation

Instructional objectives: After studying this package, students should be able to:

1. Examine, draw and label the external features of bulb of onion, rhizome of ginger and corm of cocoyam.
2. Cut, draw and label the longitudinal section of an onion bulb.

Manipulative materials: bulb of onion, rhizome of ginger, corm of cocoyam, knife and drawing instruments.

Instructional guide

1. Carefully examine bulb of onion, rhizome of ginger and corm of cocoyam.
2. Draw and label and label the external features of each the specimen (onion, ginger and cocoyam). Which features are common to all the specimens?
3. Using a sharp knife cut a longitudinal section through an onion bulb and observe each half carefully using hand lens. Which features are visible in the section but not in the whole onion?
4. Draw and label the longitudinal section of the onion bulb.

Students' Self Assessment Worksheet

Study specimen A, B and C carefully and answer the questions that follow (A – rhizome of ginger, B – corm of cocoyam and C – bulb of onion)

4. Describe observable features of specimen A

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5. List four external features that are common to specimen A and B.

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6. Using a sharp knife, cut specimen C into two halves longitudinally, observe features which are visible in the section but not in the whole specimen (onion). Draw and label one half of the specimen (onion bulb) to show its internal features.

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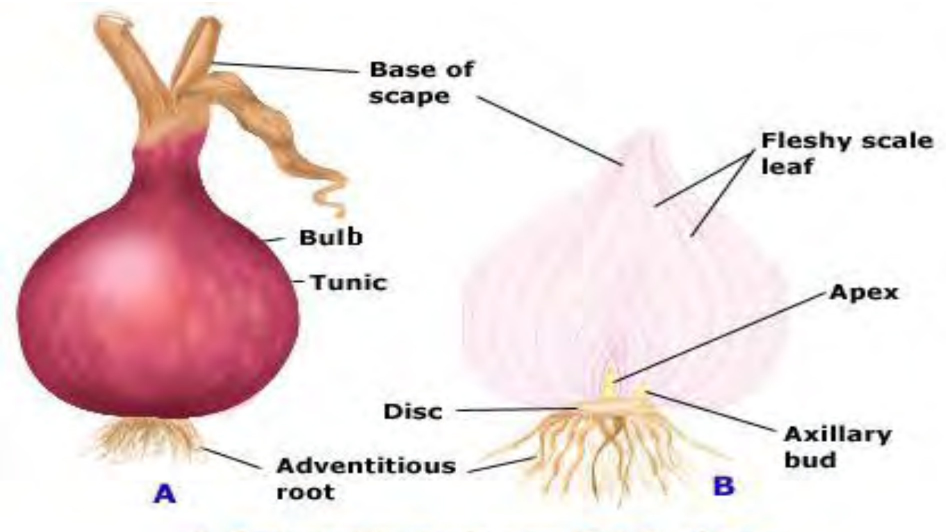
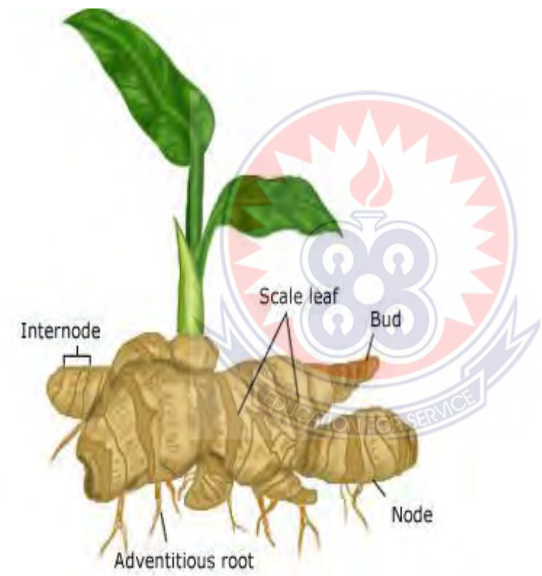


A. Tunicated bulb of onion B. L.S. of bulb



Rhizome of ginger

Corm of cocoyam

APPENDIX G

Science process skills demonstrated by students during the lessons.

N	Science Process Skill (SPS)	Lesson 1	2	3	4	5	Total
1	Observation (Ob)	√	√	√	√	√	5
2	manipulation (MA)	√	√	√	√	√	5
3	Comparison (CA)	√	√	√	√	√	5
4	experimentation (Ex)	√	√	√	√	√	5
5	communication (Cm)	√	√	√	√	√	5
6	drawing (DR)	√	X	X	√	√	3
7	measuring	√	X	X	√	√	3
8	Interpreting Data (ID)	X	√	√	X	X	2
9	Forming Hypothesis (FH)	X	X	X	X	X	0
10	Making Inference (MI)	X	√	√	X	X	2
10	Making Prediction (MP)	X	X	X	X	X	0
	total	7	7	7	7	7	

√ Science process skill observed, X = science process skill not observed

APPENDIX H

Observational Checklist on Students' Attitude

Class: 2HE

Number of Students: Fifty   Date:

Duration: 80mins   lesson number: 1-5

Students' Attitude	Notes
Regular in Class	In lesson 1, 3 students out of 50 were absent. However, in the subsequent lessons (2, 3, 4 and 5) all the students were present in all the lessons.
Sleeping in Class	None of the students slept during the lessons They stayed focus and attentive in all the lessons.
Working independently	Majority of the students were able to work independently in all the lessons.
Asking and responding to questions	Majority of the students asked meaningful questions and participated actively in all the lessons.
Working with materials for acquisition of skills	Few of the students had difficulty in manipulating the microscope. However, almost all the students were able to interact with the manipulative materials in the subsequent lessons (2, 3, 4, and 5).
Working within the allotted time	In lessons 1 and 2, majority of the students were able were not able to work within the stipulated time. However, in lessons 3, 4 and 5 almost all the students were able to finish before the schedule time.
Jotting down points during lessons	In lessons 1, majority of the students did not jot down points during the lessons. However, as the lessons progress and teaching strategies improved and intensified, almost all the students jotted down the saline points during the lessons (2, 3, 4, and 5).