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THE IMPACT OF MULTIMEDIA INSTRUCTION IN BIOLOGY ON SENIOR HIGH SCHOOL STUDENTS' ACHIEVEMENT.

ALLAN AYITTEY

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THE IMPACT OF MULTIMEDIA INSTRUCTION IN BIOLOGY ON SENIOR HIGH SCHOOL STUDENTS' ACHIEVEMENT.

BY

ALLAN AYITTEY

Dissertation submitted to the College of Distance Education University of Cape Coast, in partial fulfilment of the requirements for award of Master of Education Degree in Information Technology.

AUGUST 2015

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DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature:………………………….. Date:………………………………..

Name: Allan Ayittey

Supervisor's Declaration

I hereby declare that the preparation and presentation of the dissertation were supervised in accordance with the guidelines on supervision of dissertation laid down by the University of Cape Coast.

Candidate's Signature:………………………….. Date:………………………………..

Name: Prof. Paul Dela Ahiatrogah

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ABSTRACT

This study investigated the comparative effectiveness of teaching through the use of multimedia and conventional teaching method in biology on senior high school students in relation to students' achievement. The pre-test post-test non-equivalent quasi experimental design was used for this study.

One hundred and ten (110) form three general science students who had biology as one of their major subjects were selected for the study. They were later grouped into control and experimental group.

Students in the experimental group were taught through the use of multimedia whereas those in the control group were taught through the conventional or traditional approach. The study concluded that both methods used in the study were quite effective for teaching photosynthesis in biology however, out of the two methods, the multimedia approach was found more suitable with respect to the marks achieved. The study also concluded that there was no statistically significant difference in the performance of students based on their gender.

These findings suggest that learning outcomes of students in biology can be enhanced with multimedia instruction. It has therefore been recommended that the computer should be used to compliment the teachers' teaching but should not take over the teaching process. A similar study can be done but with more than one variable as this research used only one variable.

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ACKNOWLEDGEMENTS

My deepest appreciation goes to my parents, Mr Jeff Ayittey and Mrs Linda Ayittey. Without them this ambition would never have materialized. I thank you so much for your love, prayers and support. I also thank my siblings for their encouragement. They spurred me on when the going got tough.

I am also very grateful to my supervisor, Professor Paul Dela Ahiatrogah for his patience, tolerance and scrutiny of this thesis. Prof, thank you so much and may God almighty bless you abundantly.

Finally, to my course mates, I say keep the light of quality education burning. Let's change the phase of education in Ghana through computers.

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DEDICATION

To my family.

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CHAPTER ONE

INTRODUCTION

Background to the Study

The Merriam-Webster dictionary defines Science as the study of the natural world based on facts learned through experiments and observation (Merriam-Webster dictionary, 2014). Science is regarded as the bedrock of modern day technology. Countries all over the world especially developing ones like Ghana are making lots of efforts to develop technologically and scientifically. This has become necessary because the world is turning “scientific”. (Quarcoo-Nelson, Buabeng & Osafo, 2012)

In all the history of education, science has held its leading position among all school subjects because it is considered as an indispensable tool in the development of the educated person. Educators give special recognition to biology among the sciences because of its educational values, its close relation to man as a living organism, its peculiar field of experimentation and interrelationships with the other sciences Bibby, 1964 (as cited in Akwaa Yeboah, 2014). As a result of this, biology occupies a relatively pivotal position in the natural sciences and it is one of the requirements to professions such as medicine, pharmacy, agriculture, dentistry and many others. It is for this reason that Bibby, 1964 (as cited in Akwaa Yeboah, 2014) advocated for adequate biology education for every child in the contemporary world dominated by science.

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The importance accorded science, and for that matter biology, in the school curriculum from the basic level to the senior high school level reflects accurately the vital role played by the subject in contemporary society. The importance of the subject is not restricted to the development of the individual alone but for the advancement of the social, economic and political goals of countries all over the world (Gambari, Yaki, Gana & Ughovwa, 2014)

Biology is a natural science that deals with the living world: how the world is structured, how it functions and what these functions are, how it develops, how living things came into existence, and how they react to one another and with their environment (Umar, 2011). It is a pre-requisite subject for many fields of learning that contribute immensely to the technological growth of the nation. This includes medicines, pharmacy, nursing, agriculture, forestry, biotechnology, nanotechnology, and many other areas (Ahmed & Abimbola, 2011).

According to the chief examiners report of the West African Examination Council (W.A.E.C) Ghana, the pure sciences thus Biology, Chemistry, Physics recorded an entry of 59,612 candidates combined representing 49.19% in West African Senior School Certificate Examination (WASSCE, 2006).In some years past, biology as a subject was known to have the highest number of student enrolments in Senior High Schools. A study conducted by Abdullahi, 1982 (as cited in Akwaa Yeboah, 2014) indicated that student enrolments in biology from 1977 to 1989 had always surpassed the combined enrolment in other science subjects. These high enrolment in biology figures indicate that biology is popular among the other sciences. However, this number of candidates sitting for the biology paper in WASSCE does not match the students' achievement in

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the subject. The integration of ICT and other technologies into teaching and learning can help improve the results of students in biology and other subject areas as far as the WASSCE is concerned.

Teaching methods have evolved and changed drastically over the years. Until the beginning of the 20th century, students were taught solely through lectures and textbooks. At this time the only other method of applied education was school museums (Cockerill, Comeau, Lee & Vinayak 2015). Educational trips were organized for students for them to have a first-hand view and feel of whatever they were learning in the classroom. Beginning in 1908, the "Visual Education Movement" in America drove classrooms to adopt visual media devices. During this movement, the first collection of educational films was introduced into the classroom with a motion picture projector. With the emergence of radio broadcasting and recording in the 1920s and 1930s, the new approach to academia was called the "audiovisual instruction movement" which included educational videos with sound (Reiser, 2001). In the 1950s instructional television began to play a large role in classroom education through the creation of public broadcasting stations. In the 1970s, computer-assisted instruction was being developed for use in the classroom and education began focusing instead on "educational technology". By the early 1980s, computers were being used for educational purposes in majority of American schools (Reiser, 2001).

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Ghana, like most developing countries, not wanting to be left behind in the use of technological innovations, has acknowledged the importance of ICT in its development agenda. The Government of Ghana has therefore placed strong emphasis on the role of ICT in contributing to the country's economy and education. The country seeks to promote an improved educational system within which ICT is widely deployed to facilitate the delivery of educational services at all levels of the educational system (Owusu, 2009). The use of ICT as a means of reaching out to the poor in Ghana has been captured in the country's development agenda like the Ghana Poverty Reduction Strategy Paper (GPRS I & II) and the Education Strategic Plan 2003-2015 (Mangesi, 2007). On the basis of the importance of ICT in the nation's socio-economic agenda, the Government of Ghana with the help of the Government of India has established the Kofi Annan Centre of Excellence in Information Technology to help in accomplishing this agenda (Owusu, 2009). The teaching and learning of ICT has therefore been formally enshrined in the educational system. The new education reform has placed emphasis on the teaching and learning of ICT.

The further development of computers and the internet in the 1990s has introduced a virtually endless capacity for the acquisition of information and presentation of material, and has proven to be one of the most influential tools for education. Online resources have provided easier access for students to material that had previously been difficult and time-consuming to obtain. Tools, such as slide shows created using Microsoft PowerPoint, and textbook CD-ROMs, are continually being developed with the hope of creating more effective and interesting ways to convey information and enabling students to better

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understand classroom material. These new forms of material presentation are known today collectively as multimedia, and have truly shaped the modern education system (Velleman & Moore, 1996).

Multimedia technology today uses various forms of communication or promotional media such as videos, computers, and still images, and is now widespread throughout the modern world. This insurgence of multimedia into the world of information technology has resulted in a significant decrease of information being presented in plain text, replacing it instead with combinations of computer-produced digital media, such as graphic images, photographs, videos, animations, and audio (Reiser, 2001). Since multimedia technology allows information to be demonstrated in so many different ways, it enables teaching styles that can be directed toward a broadened range of learning preferences (Pippert & Moore, 1999). Multimedia technologies can help educators present their material in both clear and creative ways to students, allowing students to better understand the concepts and materials presented. Numerous studies, such as those conducted by Pryor and Bitter (2008), Bockholt, West & Bllenbacher (2003), McDaniel, Lister, Hanna, & Roy (2007), and Ziv (1988), affirm that the addition of multimedia to education results in a more thorough comprehension of material when compared to the traditional text and lecture formats. For that reason, incorporating multimedia as a teaching practice has been an important step forward in the world of education.

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The use of multimedia for the purpose of enhancing learning is beneficial because it allows for an easier and broader variety of teaching styles with which information can be obtained; it promotes interactive learning and, as a result, encourages greater enthusiasm toward education in both students and teachers (Cockerill et al, 2015). In laboratory science, the use of video technology is particularly useful, as it enables the visualization of procedures, and allows for deeper comprehension than that obtained just through textual presentation. In a study by Moreno and Oregano-Layne (2008), students were introduced to various teaching principles verbally, which were then reinforced by one of four methods: the principle accompanied by a text example; the principle accompanied by a video example; the principle accompanied by a visual example from the teacher; or the principle not accompanied by any example. Each student was then given a conceptual test, an application test, and an opinion-based survey. Students who were provided with video or in-person visualization showed enhanced interest, as well as a stronger grasp of the material. Contrarily, students who were not given further explanation, and those who were given explanation via text did not show a difference in enthusiasm or comprehension of the material compared to the control group.

The fast pace of advancements in technology have also brought dynamic changes in classroom interactions all over the world. With the integration of multimedia technology, old and conventional teacher centered or subject centered methods are rapidly being replaced by student centered instructional designs and practices that can cater for new emerging needs of learners thus providing facilitative classroom environment for effective learning. Instruction

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through multimedia is finding a prominent place in the classrooms world over. Multimedia, as defined by Neo and Neo (2001), is the combination of various digital media types, such as text, images, sound, and video, into an integrated multisensory interactive application or presentation to convey a message or information to an audience.

Conventional methods of classroom teaching are found to be generally monotonous, abstruse and less participative thus are often unable to arouse curiosity and interest of learners especially in Science subjects like Biology. Mayer (2001) suggested that students learn at a higher level from well-designed multimedia presentations than from traditional verbal or text only presentations. Imparting instruction through Multimedia presentations offer remarkable opportunities in the acquisition of biological concepts as it allows the educator to present more information, examples, illustrations, and problems for students to solve than the conventional instructional method. It also facilitates a user to seek information and construct knowledge in a variety of ways, and it frequently relies on problem solving as a basis for understanding–using images and video of real world experiences to help illustrate abstract principles and concepts.

Multimedia is becoming an important tool for faculty in the biological sciences as it has the potential of providing novel learning environments and pedagogical applications to foster student interest, involve students in the research process, advance critical thinking/problem-solving skills, and developed conceptual understanding of biological topics (Bockholt, West & Bollenbacher, 2003); provides meaningful connections between text and graphics that potentially

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allow for deeper understanding and better mental models than from text alone. (Mayer,2003); can incorporate 3-D visualization of many biological and biochemical structures as well as more interactive animations of the processes, which can substantially enhance the understanding of learners of biological concepts (Stith, 2004). Well-designed multimedia helps learners build more accurate and effective mental models than they do from text alone (Shank 2005). Research findings of many recent studies have indicated that the use of Multimedia in class room teaching improved learning, retention of material presented and students performed better than the ones taught through conventional method in many subjects including English (Sharma, 2013), Biology (Satyaprakasha & Sudhanshu, 2014 & Udayakumar 2013), Science (Krishnakumar 2013; Owolabi & Oginni, 2014) and Physics (Erdemir 2011). Research studies conducted to investigate the effect of gender differences on acquisition of Biological concepts have shown mixed results: in life science, girls perform better than boys (TIMSS, 1994-1995); girls perform significantly better than boys on a test of errors in biological labelling (Soyibo, 1999); both boys and girls are found to be equal with respect to achievement and attitude toward Biology (Sungur & Tekkaya, 2003). Though there are ample research studies to acknowledge the effectiveness of instructing various subjects through multimedia presentation, its effectiveness in the acquisition of Biological concepts especially in relation to gender needs further examination. Also, the studies about the interaction between teaching strategies and gender are found to be inconclusive which persuaded the researcher to take up this study.

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Statement of the Problem

Since the introduction of the Senior Secondary School (SSS) programme in 1991 (which is now Senior High School) as part of Ghana's educational reforms in 1987, the Chief Examiners' Reports from the West African Examination Council (WAEC) have consistently indicated poor performance of SHS students in Science (WAEC, 1994; 1995; 1996; 2002; 2003; 2004; 2005). Most students fail or get low quality grades in biology more than in the other science subjects such as physics and chemistry.

The Chief Examiners' Reports show that more students fail in biology because "the weakness as we pointed out year out don't seem to be addressed by the schools" (WAEC, 2004 and 2006).

It also indicated that students did not perform very well in biology because they do not perform creditably in the practical paper. Some weaknesses identified by the Chief Examiners over the years for biology are as follows:

i. Candidates' answers show that they had not been taken through adequate practical lessons.

ii. Few candidates failed to adhere to the rubrics regarding biology drawings.

iii. Scientific terms were wrongly spelt by many candidates.

iv. Reports on experiments were poorly presented.

v. Inability to relate structure of organisms to their functions.

Poor teaching methods adopted by teachers have been identified as one of the major factors contributing to poor performance of students in biology (Ahmed

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& Abimbola, 2011; Kareem, 2003; Umar, 2011). The conventional teaching method is classroom-based and consists of lectures and direct instructions conducted by the teacher. This teacher-centered method emphasizes learning through the teacher's guidance at all times. Students are expected to listen to the teachers and learn from them as they teach. The teacher often talks at the students instead of encouraging them to interact, ask questions, or make them understand the lesson thoroughly. Most classes involve rote learning, where students depend on memorization without having a complete and deeper understanding of the subject. Just passing the tests, consisting of descriptions, matching, and other forms of indicators, is all that matters to complete the curriculum (Adegoke, 2011; Umar, 2011). The persistent use of this method makes students passive rather than active learners. It does not promote insightful learning and long–term retention of some abstract concepts in biology (Ahmed, 2008; Ahmed & Abimbola, 2011; Kareem, 2003; Umar, 2011).

The picture today is that, biology education is failing. The results of the Senior Secondary School Certificate Examination (SSSCE) of biology students in Ghana as shown in Figure 1 are highly disturbing, considering the fact that the students would become future scientists.

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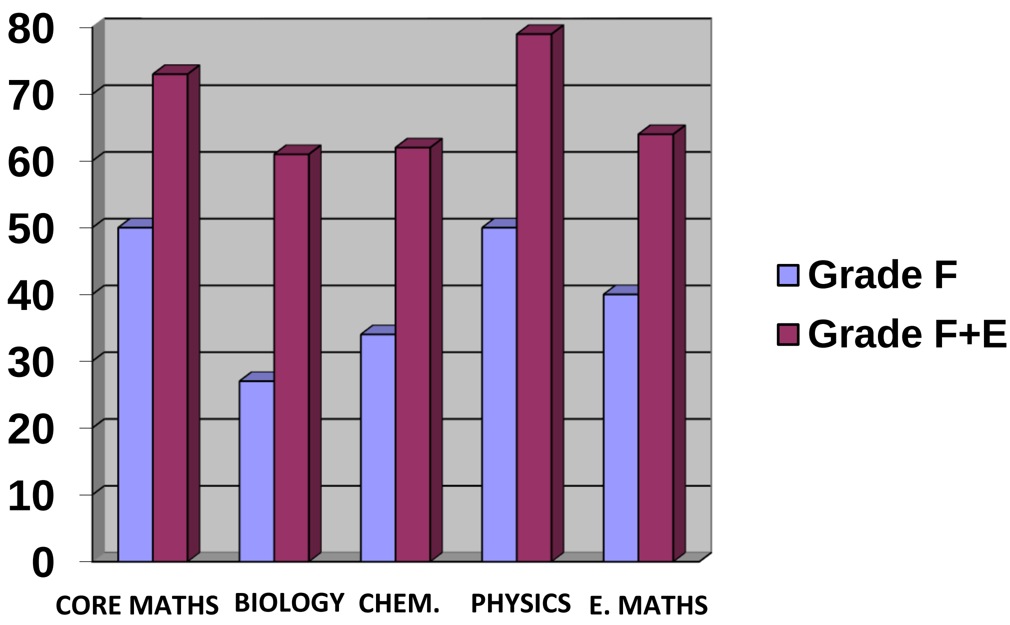

Figure 1. A bar graph comparing the performance of students in Biology against Core mathematics, Chemistry, Physics, and Elective mathematics.

Source: West African Examination Council 2002 Annual Report.

Tamakloe, Atta, and Amedahe (2005) observed that it is not all those who teach students that are considered in the traditional sense as teachers. In their opinion, the teacher is the one who understands what his or her students need to learn and their capabilities of learning. Thus, the teacher must be able to judge just how much intervention students will require in their learning activities. The biology teacher is therefore supposed to be one who would facilitate the learning process of learners. He/she ought to be a professional who will make use of any available resources to enhance teaching and learning.

From research evidence, educators see the pressing need to reconsider the techniques and methods of instruction at Senior Secondary School level. To

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address these challenges, there is the need for an instructional system that is supported by technology for meaningful learning. In this 21st century, a motivating and captivating approach should be encouraged to help students better learn, understand, and retain biology concepts and promote their future involvement. (Gambari et al, 2014). One of the promising approaches, according to Adegoke (2011); Kuti (2006); Mayer, Dow, and Mayer (2003); Moreno and Mayer (2000), involves multimedia presentations supported in visual and verbal formats supplemented with pictures, animations, texts, and narrations.

From the foregoing, it is well recognized that multimedia remains the key towards improving learning outcomes. However, the extent to which this has been achieved has not yet been addressed in biology education. Therefore, this study aims to investigate how Secondary School students' achievement and retention in Biology could be improved through video-based multimedia instruction.

Purpose of the Study

The main purpose of this study is to investigate whether multimedia instruction could improve Secondary School students' achievement in biology.

Specifically, the study examined the effects of the combination of the following:

i. Video based instruction on photosynthesis,

ii. Power point presentation on photosynthesis , and

iii. Animation on photosynthesis with on-screen text packages and those exposed to conventional teaching method.

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Research Questions

1. What are the differences in achievement scores between students taught using multimedia approach and those taught using the traditional approach in selected schools in Cape Coast metropolis?
2. What are the differences in achievement scores between male and female students taught using multimedia approach and those taught using the traditional approach in selected schools in Cape Coast metropolis?

Research Hypotheses

To achieve the objectives of the study and authenticate the findings, the following null hypotheses were tested via statistical decision theory with SPSS.

H_{01}: There is no statistically significant difference between the academic achievement scores of students taught photosynthesis using multimedia approach and those taught using the traditional approach.

H_{02}: There is no statistically significant difference between the academic achievement scores of male and female students taught using multimedia approach and those taught using the traditional approach.

Significance of the Study

The findings of this study will be an important source of information to the teachers in the selected schools and other teachers who teach biology. The study will bring to bear the teaching and learning activities that could ensure

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maximum student participation in the teaching and learning of biology. The study could give a useful information to the Ministry of Education and other educational authorities to undertake interventions to promote the use of video-based and multimedia instruction to deliver lessons in biology. This study would also serve as a source of information for further research work on the topic. Additionally, the findings would augment the pool of data required by other educational researchers in their bid to design interventions to solve educational problems in the sciences in general and biology in particular.

The findings of this study will also help teachers, educational authorities and policy makers see the need to integrate Information Communication Technology tools and other forms of technology into classroom lessons so as to improve teaching and learning in schools.

Delimitations of the Study

Only form three students were used for the study. The study was additionally delimited to an aspect of biology, focusing on Photosynthesis in the SHS elective biology syllabus.

Limitations of the Study

The subjects of the groups, that is, experimental and control were not assigned randomly. Again, only two schools from Cape Coast metropolis were used. Therefore the use of the outcome of this study should be with circumspection.

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Definition of Terms

SSCE – Secondary School Certificate Examination.

WASSCE –West African Senior School Certificate Examination

SSS – Senior Secondary School

SHS – Senior High School

WAEC – West African Examination Council

Organization of the Study

The study is organized into five (5) different chapters. The first chapter talks about the background to the study, the statement of the problem, the research questions. The chapter also deals with the significance of the study, the delimitation and limitation encountered in the study. The second chapter deals with the review of the related literature. The third chapter talks about the research methodology that was used in the study. The fourth chapter dealt with the presentation and analysis of the data that were collected. It also discussed the data that have been analyzed. The last chapter talks about the summary of findings, the conclusions that were drawn and the recommendations thereof.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter discusses the literature relevant to the study. The major objective of the study is to explore the effect of Multimedia Instruction on Students' Achievement and Retention in Biology. The purpose is to provide the basis for drawing generalization in the research study.

The chapter reviews relevant literature that provides support for the study under the following subheadings: conceptual framework of the study, theoretical framework of the study, the use of multimedia in the teaching and learning process, the use of multimedia in the teaching of biology, what actually is multimedia, advantages/strengths of multimedia usage in education, disadvantages/limitation of multimedia usage in education and studies conducted by other people showing the importance of multimedia integration in education.

Conceptual Framework of the Study.

The figure below depicts the conceptual framework model adopted for the study. This was adopted from the work of Yu-Hsin, Ju-Tzu & Deng-Jyi (2012). He conducted a study on the effect of multimedia computer assisted instruction and learning style on learning achievement.

When students are exposed to confusing or complex concepts, they are thrown into a state of disequilibrium. Multimedia instructional packages however, seems to enable students to develop cognitive structures or mental models or

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reorganize their already existing ones to better understand confusing and complex concepts in biology and other subjects.(Yeboah, 2010) Some researchers (Von Glasersfeld, 1993; Gardner, 1993; Pintrich, Marx & Boyle, 1993) have noted that, the constructivists' position that students should have access to multiple viewpoints and representations of information is partially satisfied by well-constructed simulations and other multimedia packages.

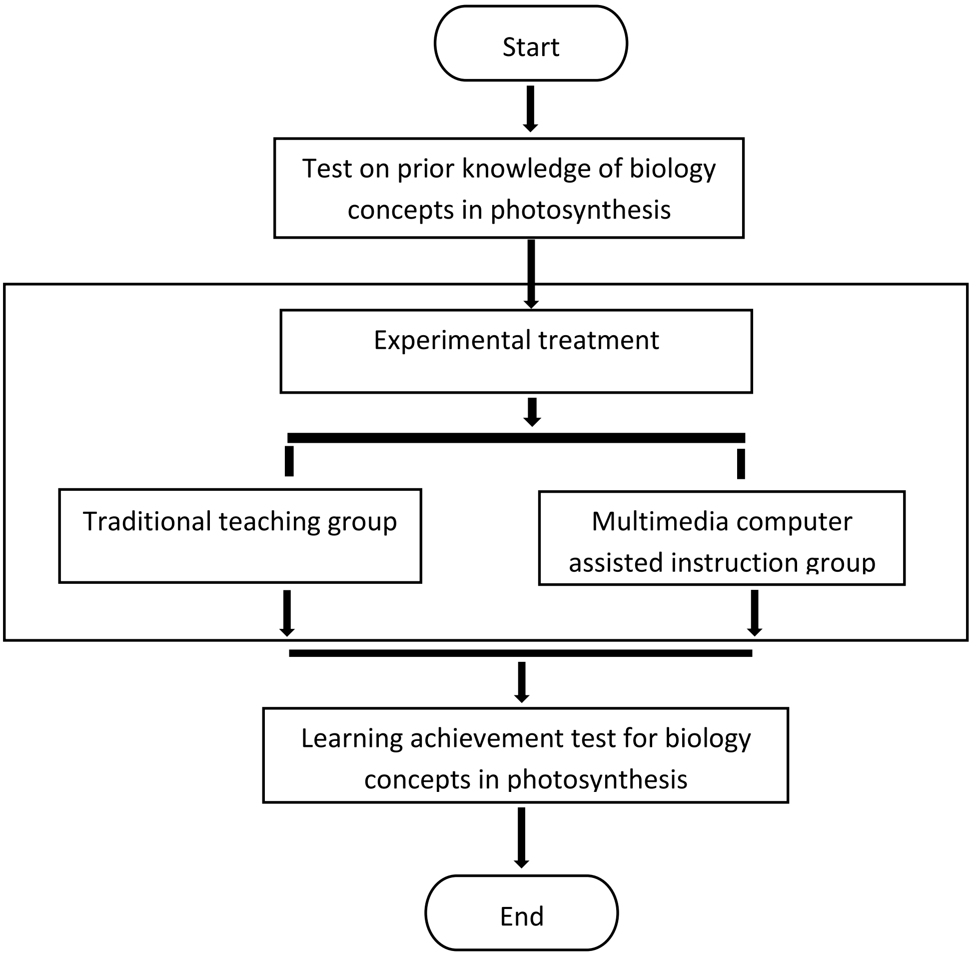

Figure 2: Conceptual Model of the Study

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Ramasundarm, Grunwald, Mangeot, Comerford and Bliss (2005) and Cholmsky (2003) have also observed that, simulations have the potential to make learning of confusing and complex or difficult concepts more interactive, authentic, and meaningful. Computer simulations and multimedia instructional packages therefore, seem to give students experiences that facilitate conceptual development leading to increased understanding of difficult concepts.

Theoretical Framework of the Study

The theoretical framework that underpinned the study was hinged on the cognitive theory of multimedia learning which was popularized by the work of Richard E. Mayer and other cognitive researchers who argue that multimedia supports the way that the human brain learns. They assert that people learn more deeply from words and pictures than from words alone, which is referred to as the multimedia principle (Mayer, 2005). Multimedia researchers generally define multimedia as the combination of text and pictures; and suggest that multimedia learning occurs when we build mental representations from these words and pictures (Mayer, 2005). The words can be spoken or written, and the pictures can be any form of graphical imagery including illustrations, photos, animations, or videos. Multimedia instructional design attempts to use cognitive research to combine words and pictures in ways that maximize learning effectiveness.

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The theoretical foundation for the cognitive theory of multimedia learning (CTML) draws from several cognitive theories including Baddeley's model of working memory, Paivio's dual coding theory, and Sweller's Theory of Cognitive Load. As a cognitive theory of learning, it falls under the larger framework of cognitive science and the information-processing model of cognition. The information processing model suggests several information stores (memory) that are governed by processes that convert stimuli to information (Moore, Burton & Myers, 2004). Cognitive science studies the nature of the brain and how it learns by drawing from research in a number of areas including psychology, neuroscience, artificial intelligence, computer science, linguistics, philosophy, and biology. The term *cognitive* refers to perceiving and knowing. Cognitive scientists seek to understand mental processes such as perceiving, thinking, remembering, understanding language, and learning (Stillings, Weisler, Chase, Feinstein, Garfield, & Rissland, 1995). As such, cognitive science can provide powerful insight into human nature, and, more importantly, the potential of humans to develop more efficient methods using instructional technology (Sorden, 2005).

The cognitive theory of multimedia learning (CTML) centers on the idea that learners attempt to build meaningful connections between words and pictures and that they learn more deeply than they could have with words or pictures alone (Mayer, 2009). According to CTML, one of the principal aims of multimedia instruction is to encourage the learner to build a coherent mental representation from the presented material. The learner's job is to make sense of the presented material as an active participant, ultimately constructing new knowledge.

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According to Moreno and Mayer (2000) and Mayer (2003), CTML is based on three assumptions: *the dual-channel assumption*, the *limited capacity assumption*, and the active processing assumption. The dual-channel assumption is that working memory has auditory and visual channels based on Baddeley's (1986) theory of working memory and Paivio's (1986) Clark and Paivio (1991) dual coding theory. Second, the limited capacity assumption is based on cognitive load theory (Sweller, 1994) and states that each subsystem of working memory has a limited capacity. The third assumption is the active processing assumption which suggests that people construct knowledge in meaningful ways when they pay attention to the relevant material, organize it into a coherent mental structure, and integrate it with their prior knowledge (Mayer, 1999).

What Is Multimedia?

Multimedia is a term frequently heard and discussed among educational technologists today. Unless clearly defined, the term can alternately mean a judicious mix of various mass media such as print, audio and video or it may mean the development of computer-based hardware and software packages produced on a mass scale and yet allow individualized use and learning. In essence, multimedia merges multiple levels of learning into an educational tool that allows for diversity in curricula presentation. Multimedia is the exciting combination of computer hardware and software that allows you to integrate

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video, animation, audio, graphics, and test resources to develop effective presentations on an affordable desktop computer (Fenrich, 1997).

Multimedia is characterized by the presence of text, pictures, sound, animation and video; some or all of which are organized into some coherent program (Phillips, 1997). Today's multimedia is a carefully woven combination of text, graphic art, sound, animation, and video elements. When you allow an end user, i.e. the viewer of a multimedia project, to control 'what' and 'when' and 'how' of the elements that are delivered and presented, it becomes interactive multimedia. As such, multimedia can be defined as an integration of multiple media elements (audio, video, graphics, text, animation etc.) into one synergetic and symbiotic whole that results in more benefits for the end user than any one of the media element can provide individually. Besides being a powerful tool for making presentations, multimedia offers unique advantages in the field of education. Multimedia enables teachers to provide a way by which learners can experience their subject in a vicarious manner. The key to providing this experience is having simultaneous graphic, video and audio, rather than in a sequential manner. The appeal of multimedia learning is best illustrated by the popularity of the video games currently available in the market. These are multimedia programmes combining text, audio, video, and animated graphics in an easy-to-use fashion.

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With multimedia, the process of learning can become more goal oriented, more participatory, and flexible in time and space, unaffected by distances and tailored to individual learning styles, and increase collaboration between teachers and students. Multimedia enables learning to become fun and friendly, without fear of inadequacies or failure.

It is possible to say that the introduction of multimedia into the classroom has a profound impact on styles of teaching and learning (Slack, 1999). Students are seen to be more motivated when using multimedia, which one teacher described as 'using the multimedia "hook". According to Slack (1999), teachers have stated that multimedia enables students to work at a different pace, and some packages can be tailored to student needs. Teachers have also suggested that they regard students as learning co-operatively when multimedia is used. The teacher becomes a facilitator, problem setter and guide as opposed to taking a central role.

The Use of Multimedia in the Teaching and Learning Process

The concept of multimedia came into existence in early 1990s. Multimedia also refers to computer media. Multimedia is the integration of multiple forms of media. This includes text, graphics, audio, video, etc. For example, a presentation involving audio and video clips would be considered a 'multimedia presentation.' Educational software that involves animations, sound, and text is called 'multimedia software '. As the information is presented in various formats, multimedia enhances user experience and makes it easier and faster to

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grasp. The old days of an educational institution having an isolated audio-visual department are long gone! The growth in use of multimedia within the education sector has accelerated in recent years, and looks set for continued expansion in the future.

Teachers primarily require access to learning resources, which can support concept development by learners in a variety of ways to meet individual learning needs. The development of multimedia technologies for learning offers new ways in which learning can take place in schools as well as at home. Teachers have access to multimedia learning resources, which support constructive concept development, allows the teacher to focus more on being a facilitator in learning while working with individual students. Due to advances in computers and electronic media, the potential for quality education has been elevated with the appearance of innovative instructional methods employing multimedia equipment and resources. Multimedia approach to teaching and learning has become standard forms of education. The classroom has become digital and called as smart class. Smart class is a comprehensive solution designed to assist teachers in private schools in meeting day to day classroom challenges and enhancing student's academic performance with simple, practical & meaningful use of technology. It also enables teachers to instantly assess and evaluate the learning achieved by their students in class. Smart class is powered by a vast repository of digital instructional materials exactly mapped to meet with the specific objectives laid out by different state learning standards. The content repository consists of thousands of highly animated, lesson specific, 2D and 3D multimedia modules built with an Instructor-led design that allows

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the teacher to effectively transact the lesson in a typical classroom of diverse set of learners. Educational videos from Eureka and Discovery channel are available for teachers to use in the classroom. The modules are embedded in a template that allow the teachers to teach a chosen lesson in class, frame by frame, with engaging and instructionally sound animated set of visuals while retaining complete control on the pace of delivery. The Smart Class Multimedia System helps in establishing an easy yet effective control and communications system for teachers in the computer lab and ensures that teachers have uninterrupted quality time with students while dealing with learning concepts. This solution will enrich teaching methods with modern technology and introduce the children to a wealth of information and interactive learning techniques to improve the overall education experience.

There are many researches conducted in Ghana as well as aboard, in the area of multimedia. Acha (2009), Jadal (2011), Kumar (2011) and others have conducted research by using multimedia in the teaching of English and found positive results. Ellaisamy, (2007) also conducted a study by using the multimedia approach to teach Science and found that teaching through multimedia is effective. Many experiments have been done in various subject areas till date to find the effectiveness of multimedia in teaching. Most of the results show positive outcomes, with students being enthusiastic about new methods of learning. Most of the experiments suggest that multimedia approach to teaching is more effective than traditional approach to teaching. Taking the findings of such experiments into account, many schools have also started using the multimedia approach to teaching in their classrooms.

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As multimedia teaching technologies become more widely advocated and employed in education, researchers strive to understand the influence of such technologies on student learning. Advances in technology enable pedagogical enhancements that some believe can revolutionize traditional methods of teaching and learning. When viewed collectively, these studies reported that advanced technologies, especially multimedia instruction, which often involves introducing or enhancing the visual aspects of the presentation of course contents, created an active learning environment, improved students' performance, fostered positive attitudes toward learning complex concepts, increased communication and could be adapted to all learning styles and levels of instruction. Researchers suggest that, compared to classes with a traditional teacher-leading approach, those using multimedia are better liked by students and yield slight but statistically significant improvements in student learning as measured by both student self-report and objective outcome testing. Such encouraging findings have precipitated the adoption of these technologies on a widespread basis. Therefore, there is a need to further educators' understanding of the effect of multimedia technologies on students' learning quality.

The combined outcomes of the majority of studies across disciplines indicated that multimedia-based delivery systems offered ways to optimize the advantages and minimize the disadvantages of traditional methods of teaching and learning. These are expected to be true in biology. Biology laboratories are designed to help students understand the basic concepts and their applications by experiments, collecting specimens, using specimens to know the parts and functions, and drawing and writing a laboratory report. Many factors such as

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the time limit for setting up, the unavailability of specimens in the traditional laboratories. However, the disadvantages elicited by these factors can be addressed with the use of multimedia-based delivery systems.

The Use of Multimedia in the Teaching of Biology.

Biology occupies a unique position in the school curriculum. Biology is central to many science related courses such as medicine, pharmacy, agriculture, nursing, biochemistry, genetics and so on. It is obvious that no student intending to study these disciplines can do without Biology. These factors, among others, have drawn attention of researchers and curriculum planners towards Biology as a subject in the school curriculum (Kareem, 2003). In spite of the importance and popularity of Biology among students, performance at secondary school level had been poor (Ahmed, 2008). The desire to know the causes of the poor performance in Biology has been the focus of researchers for some time now. It has been observed that poor performance in the sciences is caused by the poor quality of science teachers, overcrowded classrooms, and lack of suitable and adequate science equipment, among others (Yusuf & Afolabi, 2010).

Students perform poorly in Biology because the Biology classes are usually too large and heterogeneous in terms of ability level. In addition, the laboratories are ill equipped and the Biology syllabus is over loaded (Ahmed, 2008; Ajayi, 1998). As multimedia teaching technologies become more widely advocated and employed in education, researchers strive to understand the influence of such technologies on student learning. Advances in technology enable

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pedagogical enhancements that some believe can revolutionize traditional methods of teaching and learning (Gatlin-Watts, Arn, Kordsmeier, 1999; Persin, 2002). Studies of multimedia-based instruction report a variety of outcomes. When viewed collectively, these studies reported that advanced technologies, especially multimedia instruction, which often involves introducing or enhancing the visual aspects of the presentation of course contents, created an active learning environment, improved students' performance, fostered positive attitudes toward learning complex concepts, increased communication, and could be adapted to all learning styles and levels of instruction (Harris, 2002). Researchers suggest that, compared to classes with a traditional teacher-leading approach, those using multimedia are better liked by students and yield slight but statistically significant improvements in student learning as measured by both student self-report and objective outcome testing (Dimitrov, McGee, and Howard, 2002; Feeg, Bashatah, and Langley,. 2005; McKethan and Everhart; Moreno and Valdez; Sneddon, Settle, and Triggs, 2001; Worthington, Welsh, Archer, Mindes, and Forsyth, 1996). Such encouraging findings have precipitated the adoption of these technologies on a widespread basis.

Despite many studies suggesting that multimedia instruction benefits students, there are also some that found no significant differences between multimedia classes and traditional classes (Everhart, Harshaw, Everhart, Kernodle, and Stubblefield, 2002; Homer, Susskind, Alpert, Owusu, Schneider, Rappaport & Ruben, 2000; Lee, Gillan, and Harrison, 1996; Stoloff, 1995). Therefore, there is a need to further educators' understanding of the effect of multimedia technologies on students' learning quality. Thus to ascertain the effectiveness of

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Multimedia it would be reasonable to compare it with classroom instruction. A number of studies (cited in Najjar, 1998) have been conducted in the area to ascertain the effectiveness of multimedia instruction. Analysis has been done by (Fletcher, 1990; Khalili and Shashaani, 1994; Kulik, Bangert, and Williams, 1983; Kulik, Kulik, and Bangert-Drowns, 1985; Kulik, Kulik, and Cohen, 1980;) by examining over 200 studies. The information included sciences, foreign languages and electronics. The control group normally learnt the information via classroom or lecture combined with hands-on experiments. The comparison group learnt information via interactive videodiscs or computer based instruction. The achievement of learning was measured via tests taken at the end of the lessons. Over this wide range of students, meta-analysis found that learning was higher when computer-based education was used. Learning also appeared to take less time when multimedia instruction was used.

Advantages / Strengths of Multimedia Usage in Education.

Multimedia is very helpful and fruitful in education due to its characteristics of interactivity, flexibility, and the integration of different media that can support learning, take into account individual differences among learners and increase their motivation. The provision of interaction is the biggest advantage of the digital media in comparison with other media. It refers to the process of providing information and response. Interactivity allows control over the presented content to a certain extent: learners can change parameters, observe their results or respond to choice options. They can also control the speed of applications and the amount of repetition to meet their individual needs.

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Furthermore, the ability to provide feedback tailored to the needs of students distinguishes the interactive multimedia from any other media without a human presence.

However, many aspects need to be taken into account when using multimedia in education. Even though multimedia is offered worldwide, access to learning materials and computing equipment differs from country to country.

The use of multimedia by students needs to be supported by very skilled teachers. They must guide students through the learning process and provide them with appropriate and effective learning strategies. Like the use of textbooks, the use of educational multimedia fosters teaching strategies, where the teacher's role is not just that of information provider but one of a guide, supporter and facilitator. Multimedia offers a variety of media usually combined in a meaningful manner. This gives an opportunity to use the computer for the presentation of ideas in different ways, including by means of: Images, including scanned photographs, drawings, maps and slides; Sounds, e.g. recordings of voice, noise and music; Video, including complex procedures and 'talking heads'; Animation and simulations; Discussions among learners (social networks, online discussions, blogs, etc.).

Often, presentations supported by attractive images or animations are visually more appealing than static texts, and they can support the appearance of emotions to complement the information presented. Multimedia can appeal to many types of learning preferences – some students profit more from learning by reading, some by hearing and some by watching, etc. In addition, the use of multimedia allows for different ways of working – students can decide on their

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own how to explore the materials as well as how to use interactive and collaborative tools.

Moreover, students can adjust their own learning processes according to their abilities and preferences. They can work according to their interests, repeat material as much as they want reducing embarrassment concerning their learning outcomes. The use of multimedia can thus be tailored to the students' differences in interests, social and cultural backgrounds, learning preferences and rates, etc. Individual learning can promote active, self-directed learning. In addition, multimedia applications can be used to facilitate group work. Small groups of students can work through multimedia applications together – in order to learn from each other as well as to improve their dialogue skills. The interactive opportunities of multimedia lead to high flexibility, which can be very helpful for students with special needs:

Dyslectic students can use synthetic speech in order to become familiar with the content of digital texts. Autistic children show an increase of phonologic awareness and word reading by using multimedia (Heimann et al. 1995 as cited in Andresen and van den Brink, 2013).Students with severe speech and physical impairments gain from learning with multimedia, because the computer is flexible enough to meet individual needs they can repeat as often they want, can hear it loud, etc. (Steelman, 1993 as cited in Andresen and van den Brink, 2013). For deaf students, the visual presentation of content improves their motivation to learn (Voltena et al., 1995 as cited in Andresen and van den Brink, 2013).The computer can noticeably improve student access to information. Such delivery platforms as the World Wide Web provide 24-hour access to information.

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Moreover, it is relatively easy to update web-based educational materials, i.e. to change design, content, instruction methods, etc.

Disadvantages / Limitations of Multimedia Usage in Education.

Self-regulated learning: Some learners are not able to handle the freedom provided by hypertext-based multimedia.

Distraction: Often, confused presentations of the material can cause distraction due to conflicting messages. Non-linear structured multimedia allows the user to follow the supplied links, which can distract from the topic to be learned. The massive amount of information provided by multimedia applications may distract our attention during learning. The human short-term memory is limited; usually it can hold around 7 pieces of information. When several media presented at the same time, the learner can only concentrate on some of them and ignore others. This could result in ignoring important information.

Human beings cannot use all channels available simultaneously, and this can prevent us from realizing the full potential of multimedia.

Low interactivity: Even though the interactivity between the learner and multimedia applications is increasing, it is still considered restricted compared to the elaborated human-human interactivity.

No selective feedback: Feedback is generally very limited within computer-assisted learning packages. Generally, computers can't substitute for person-to-person teaching, only enhance it. Often, the feedback provided is limited to right/wrong, and it does not support in learning strategies or further content

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explanations. Multimedia applications cannot identify individual needs or problems of the learner, so they cannot respond like people.

Simulations are often not enough: It may be important for students to have true hands-on experience. For example, for studying insects in biology it is necessary to go out in nature, to see insects living in their natural environments.

Lack of skills – pupils and teachers: Students, particularly mature-age students, may not be ICT literate. Also teachers may lack some personal skills, which are needed to teach effectively with multimedia.

Difficult to do: Creating audio, video and graphical materials can be more challenging than creating ordinary texts.

Time consuming: Using multimedia can be time consuming. Especially the production of multimedia takes much time.

Access: Not all students have appropriate access to proper hardware and the Internet. This may limit the scope of teaching.

Social in/exclusion: Not all members of a society can be involved in the use of multimedia technology due to lack of access to the Internet or lack of hardware to make full use of the educational material on the web.

Equipment problems: Hardware and software needs to be configured in a way that their usage is as simple as straight forwarded as possible.

Bandwidth issue: Limited bandwidth means slow performance for sound, graphics and video, interrupting streaming and causing long waits for download that can affect the ease of learning.

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Multimedia is portable: Paper-based notes can be read everywhere, on the bus, at the beach, etc., but web-based materials or multimedia materials require specific hardware devices.

Computer screens aren't paper: The content on screens may not be as easy to read as the content on paper. If there are large chunks of information that need to be read from top to bottom, it is probably best to view such a document on paper. Books and journal articles may still be better to read on paper. End users often prefer to use technology to search for information, but when it comes to reading, they tend to read from print-outs.

In summary, multimedia products can be used to represent and process various types of knowledge. They can be used as means of representation and communication of knowledge. The use of these products can foster students' construction of their own knowledge. They can construct knowledge and develop skills related to various subjects by accessing or producing digital representations of knowledge. In particular, they can develop literacy and other core competencies. For example, they can develop motivation for learning activities, communication abilities, social competencies as well as learning competencies, values and ethics.

Studies Conducted By Other People Showing the Importance of Multimedia Integration in Education.

The science education community emphasizes the implementation of inquiry-based instruction in both primary and secondary schools. Reform-driven publications in science education emphasize the importance of inquiry both as an instructional method and as a learning framework (AAAS, 1989, 1993, 1998;

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National Research Council, 1996). Teaching science via inquiry involves engaging students in the kinds of processes used by scientists. These processes include asking questions, making hypotheses, designing investigations, grappling with data, drawing inferences, redesigning investigations, and building and revising theories (Kubasko, Tretter & Andre, 2007).

Stuckey-Mickell & Stuckey-Danner (2007) conducted a study to investigate student perceptions of Virtual Biology labs used in two online introductory Biology courses. Students completed an online survey, containing Likert type and open-ended items, about perceptions of the CDROM based Virtual Biology laboratories and face-to-face (F2F) laboratories they completed during the courses. Findings indicated that though most students (86.9%) perceived the F2F laboratories as more effective than the virtual laboratories across several criteria, many of them (60.8% on one criterion) perceived the virtual laboratories as effective as well. The authors discuss how student identified issues related to interactivity and feedback could be influenced by the design of the learning experience, virtual laboratory tool, and/or the use of synchronous collaboration tools. Additionally, the authors include suggestions for future research on the use of virtual Biology laboratories in the online setting. Hennessy, Deaney & Ruthven (2006) discussed ways teachers make use of computer-based technologies to support the learning of science, and suggested that technology supports stepwise knowledge building and application. Such applications have implications for both curriculum-related science activities and emerging computer-based learning technologies. Technology helps students construct links between theories and phenomena by extending the human capacity.

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Chi-Yan and Treagust (2004) suggested that Biology educators are increasingly using technology to supplement their teaching. A variety of computer technologies has been used over the past two decades to enhance student learning of many of the biological sciences in colleges and universities. Computer technology and educational software has provided new learning opportunities that can change the look and feel of traditional science classrooms. This does not necessarily imply that learning in traditional education is ineffective. However, traditional methods sometimes fail to reflect skills and interests of students who have grown up in the digital age. Technology can enhance learning environments and increase opportunities for authentic hands-on experiences (Zumbach, Schmitt, Reimann & Starkloff, 2006). Computer technologies support the development and implementation of teaching and learning strategies that support many important science skills (Maor & Fraser, 1996).

Angadi & Ganihar, (2015) mentioned that technology and multimedia facilitates the knowledge-construction process for students by allowing learners to construct links among their prior knowledge and the new concepts. This assertion supports research suggesting that science education should include both constructivist methodologies and technology integration as a natural part of its ideology. Computerized magnification systems and video-based virtual experiences have been studied in the attempt to improve areas such as the ease of viewing, interactivity, and improvement of group learning activities within the context of science education. Susanne (2002) has studied cancer cell Biology and has experienced that a student-centered instructional module

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exploring the use of multimedia to enrich interactive, constructivist learning of science. Multimedia has the potential of providing bioscience education novel learning environments and pedagogy applications to foster student interest, involve students in the research process, advance critical thinking/problem-solving skills, and develop conceptual understanding of biological topics.

Klein and Koroghlanian (2004) have investigated the effects of audio, animation, and spatial ability in a multimedia computer program for high school Biology. The study examined the effects of instructional mode (text vs. audio), illustration mode (static illustration vs. animation) and spatial ability (low vs. high) on practice and post-test achievement, attitude and time. Results indicated that spatial ability was significantly related to practice achievement and attitude. Participants with high spatial ability performed better on the practice items than those with low spatial ability. Participants with low spatial ability responded more positively than those with high spatial ability to attitude items concerning concentration, interest and amount of invested mental effort. Findings also revealed that participants who received animation spent significantly more time on the program than those who received static illustrations. Implications for the design of multimedia are discussed.

Sivin-Kachala and Bialo (2000) reviewed 311 research studies on the effectiveness of technology on student achievement. Their findings revealed positive and consistent patterns when students were engaged in technology-rich environments, including significant gains and achievement in all subject areas, increased achievement in preschool through high school for both regular and

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special needs students, and improve attitude toward learning and increased self-esteem. Paris (2004) stated that e-Learning can improve school results. Furthermore, a simple multimedia presentation helped the students to better understand a subject without the help of a teacher particularly for shy and weak students.

Sangodoyin (2010) studied computer animation and the academic achievement of Nigerian senior secondary school students in Biology. This study investigated the effects of computer animation on the academic achievement of Nigerian senior secondary school students in Biology. The moderating effects of mental ability and gender were also investigated. The pre-test and post-test, control group, quasi-experimental design with a 2x2x2 factorial matrix was adopted for the study. One hundred and eighty-nine senior secondary school Year II Biology students from two randomly selected Federal Government Colleges in two states in South-western Nigeria were the participants. Findings showed that there was a significant main effect of treatment on students' achievement in Biology. The computer animation was effective in improving students' achievement therefore, computer animation is recommended as a means of teaching Biology to students in Nigerian secondary schools.

According to Ali and Elfessi (2004), the significant role of technology in teaching and learning is limited as an instructional delivery medium and not a key determinant of learning. It can only support the classroom learning.

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Thus, there is empirical evidence to suggest both the positive and negative effects of multimedia. The key issue is to analyse these findings and find out the precise reasons and the situations in which multimedia is useful and in which it is not. While Multimedia seems to be improving the learning rate, it is not a universal fact. In the next section contains discussion on the main conditions in which multimedia would be useful. Today's teachers are concerned with how to use technology to enhance and enrich their learning environment. According to Cline (2007), the role of technology in the classroom is not to replace traditional educational methods, it does act as an enhancement for teaching students to think critically, communicate creatively and solve problems in analytical way. Students can learn "from" computers – where technology is used essentially as tutors and serves to increase students basic skills and knowledge; and can learn "with" computers- where technology is used as a tool that can be applied to a variety of goals in the learning process and can serve as a resource to help develop higher order thinking, creativity and research skills.

Summary

According to Fenrich (2005), the media a teacher selects does not determine whether learning will occur. The media simply carries the teacher's message to the learner. For learning to occur, the message must be received and understood by the student. This is independent of the media. However, the media one uses can influence the amount of learning that can occur. If teachers combine the media's strengths with instructional methods that take advantage of these

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strengths, this can positively influence learning. Complete multimedia packages can, but should not necessarily, include all of the different media.

Learning from materials made with more than one medium is usually more effective than material comprised of only one medium. This is partly due to the fact that different parts of the brain process different information. For example, some parts of the brain process text while other parts process visuals. When multimedia packages activate more regions of the brain, there are increases in learning and retention of information

In many Situations, you can and should use more than one medium to teach the skill. Determine the media that will complement the intended instructional strategy. Video materials often include an audio component.
Using too many media at one time can impede learning. Although multi-sensory learning experiences tend to be effective, learners can only process a limited amount of information at one time.

Media mix decisions should be based on what is being taught, how it is being taught, how it will be tested, and the previously specified target audience characteristics. Different media may be needed for different groups of learning outcomes. For example, video may be appropriate for the attitude component but video may not provide the corrective feedback necessary for the intellectual skills component. Do not select media simply to dazzle or for convenience.

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The integration of ICT and multimedia in schools can change the existing learning principles tremendously. The school's organisation may become innovative in the sense that it adopts reflexive, pragmatic and experiential approaches which place the individual student closer to the center of the learning processes. Using multimedia often means there are more student-centered work and flexible schedules. The teacher's role is often changing from being an authority or the source of knowledge to being a facilitator or a conductor of the learning process. Students have to find their own individual access to the fast changing world and, therefore, they need a huge pool of appropriate individualised strategies, which enable them to be active and critical learners. The ability to share knowledge collaboratively with others in a world where most products are the result of teamwork having the appropriate strategies and knowing why and how to apply them, will be one of the most important qualifications in lifelong learning.

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CHAPTER THREE

METHODOLOGY

The study is aimed at investigating the effect of multimedia instruction on secondary school students' achievement in biology. This chapter is concerned with the various aspects of the research methodology adopted by the researcher. It includes a detailed description of the research design, population and sampling techniques, research instruments, procedure for data collection and analysis.

Research Design

Quasi – experimental design was used in this study. The quasi-experimental design involves a non-equivalent comparison-group. This is said to be among the most commonly used quasi-experimental designs. Structurally, the design is quite similar to the experimental design except that random assignments were not employed.

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The pre-test post-test control group design using symbols and conventions from Campbell and Stanley (1963) can be represented as:

Groups	Pre-test	Treatment	Post-test
Experimental Group	RO_1	(MULTIMEDIA INSTRUCTION)	O_2
Control Group	RO_3	Xo	O_4

Figure 3: Pre-test Post-test control group design.

Using Campbell and Stanley's terminology, *X* represents the exposure of a group to an experimental variable or event, the effects of which are to be measured. *O* refers to the process of observation or measurement. *R* indicates random assignment to separate treatment groups.

This design is one of the most effective in minimizing the threats to experimental validity, especially because both groups took the same pre-test. Again using Campbell and Stanley's terminology, the effect of the experimental intervention is: $(O_2 - RO_1) - (O_4 - RO_3)$. If the result is negative then the causal effect was negative. One problem that has been identified with this particular experimental design is the interaction effect of testing.

Campbell and Stanley (1963) postulated a number of factors which affect the internal and external validity of experimental designs. Relevant to internal validity, there are eight different factors. These include: history, maturation testing, instrumentation, statistical regression, differential selection,

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experimental mortality and selection – maturation interaction. If these factors are not controlled in the design, they may produce adverse effects which confound the effects of the independent variables. As a way of controlling these factors, two groups will be used in the study instead of only one group, which would have suffered from the above factors.

One experimental group and one control group all of which were intact classes was used for the study. The experimental group was University Practice SHS and the control group was Ghana National College. Participants in the experimental group were taught section five unit four of the third year SHS Elective Biology syllabus, which deals with 'photosynthesis', using the multimedia instructional approach. The participants in the Control group were however, taught the same section and unit of the SHS elective biology syllabus using the traditional instructional approach. The photosynthesis courseware package used in this study was downloaded from the internet. So was the video based instructions. The PowerPoint presentation used in the research was however designed by the researcher.

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The post-test instrument, Student's Achievement in Photosynthesis Test –SAPT (Appendix D), was administered to all the participants after the intervention.

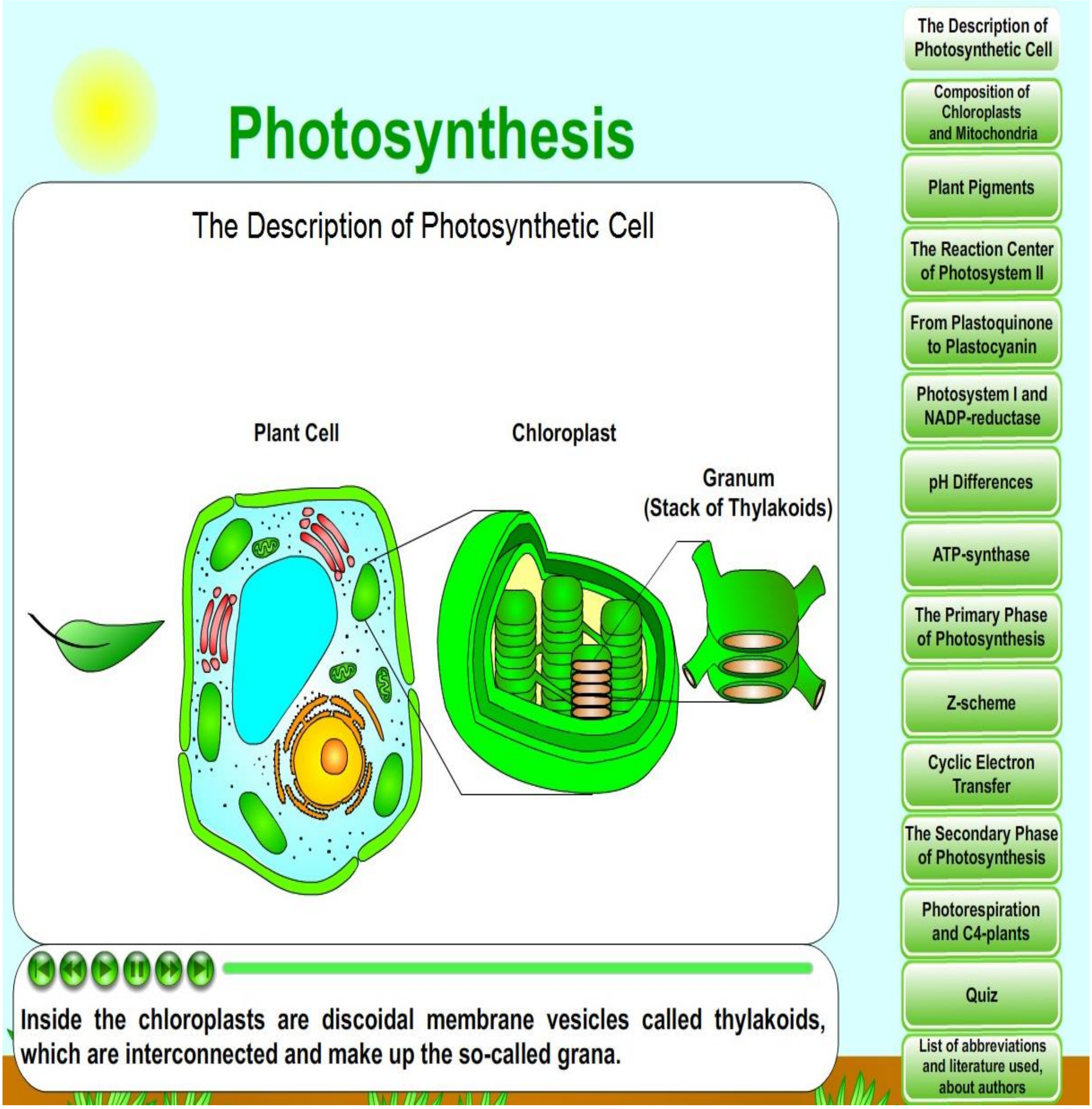

Figure 4: Screen Captured image of the Photosynthesis Courseware.

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Population

The population is the target group on which the experiment was conducted and findings generalized. Since the purpose of this study was to find out the impact of multimedia instruction in biology on senior high schools, elective science students in Senior High Schools with computer facilities formed the population of the study. These students study Chemistry, Biology, Physics and Mathematics aside the general or the core subjects. Other groups of students in the SHS such as Agricultural science and Home Economics may study one or two of the science subjects. However the target population was the SHS Form 3 elective science students who study biology in schools that have computers in the Cape Coast township irrespective of whether it was single sex school or co-educational. The SHS Form 3 students were chosen because they had done ICT as a course of study and were therefore trusted to be familiar with the use of computer. Another reason was the fact that Form Three SHS students have also covered quite a lot as far as the SHS biology syllabus was concerned.

Sample and Sampling Procedure

The sample for this study was made up of one SHS form 3 class from the schools. The intact SHS 3 classes were made up of students who offered Biology as an elective subject. All the schools included in the study were selected by purposive sampling. The intact SHS 3 classes included in the study were also selected by purposive sampling. Third year SHS students were used in the study because photosynthesis is taught during the third year of the SHS

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science programme as it forms part of the SHS 3 Elective Biology syllabus. Also, SHS 3 students in both selected schools were yet to be taught ‘photosynthesis’ in elective biology as at the time the study commenced.

Participants in this study were all of similar educational background as they had all passed the Basic Education Certificate Examination (BECE) at the Junior High School (JHS) level as well as their year one and year two integrated science and year two Elective Biology examinations. Also, they had some basic knowledge of the concept of photosynthesis as they had been introduced to it both at the JHS and SHS levels in integrated science.

The total sample size was one hundred and seven (107) elective biology students. This comprised fifty (50) students from University Practice Senior High School and fifty seven (57) from Ghana National College Senior High School.

Research Instruments

The instruments used in the data collection were two test instruments of comparable standard, which were used to collect quantitative data from all participants. The test instruments were named “Students’ Knowledge of Photosynthesis Test” – SKPT and “Students’ Achievement in Photosynthesis Test” – SAPT, which were both developed by the Researcher. The SKPT and SAPT were used as the pre-test and post-test instruments respectively. The SKPT was used to assess the participants’ knowledge and difficulty with the concept of ‘photosynthesis’ in order to have a baseline about all participants

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before the implementation of the interventions. The SAPT was however, designed to measure participants' achievement after the implementation of the interventions. The SKPT and SAPT were both 20 item paper and pencil tests, which were made up of three sections – A, B and C.

Preceding section A of each test instruments was a portion that briefly stated the purpose of the test and also asked participants to provide personal data, such as, name, gender, class and school of participants. This portion also contained general instructions to answering items in all three sections of the test instruments. Additionally, each section of the SKPT and SAPT begins with specific instructions regarding how to respond to items in that section.

Section A of the SKPT and SAPT were both made up of 10 multiple choice items, numbered as items 1 to 10. Each of the multiple choice items in the SKPT and SAPT has a stem about an aspect of the concept of photosynthesis followed by four options or alternatives. The options comprised one correct answer and three plausible distracters. Each correct answer circled or chosen was awarded one mark, resulting in a total score of 10 marks for section A.

Section B was made up of five true-false items, which appeared as items 11 to 15 on the SKPT and SAPT. Each of the five true-false items has a statement about an aspect of the concept of photosynthesis followed by True or False. Participants were required to circle True if they agreed with a statement or False if they disagreed with it. Each correct option circled or chosen was awarded one mark, giving a total score of five marks for section B of the SKPT and SAPT.

Section C was made up of five short essay or short - answer items numbered as items 16 to 20 on the SKPT and SAPT. Item 18 on the SKPT consisted of two

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sub-questions, 18(i) and 18(ii). Item 19 on the SAPT also consisted of two sub-questions, 19(i) and 19(ii). All participants' responses to one short essay or short - answer item were scored before scoring participants' responses on the next short essay or short – answer items. This helped to keep one frame of reference and one set of criteria in mind while scoring responses to a particular short – answer or short essay item by all participants. It also prevented carrying over impressions formed while scoring the response of a participant to a particular item to the participant's next response(s). Also, to ensure uniformity in the scoring of all items, marking guides were prepared for the marking and scoring the SKPT and SAPT. Items in section C had a maximum score of two, three or four marks giving total scores of 12 marks and 13 marks for the SKPT and SAPT respectively. The SKPT and SAPT therefore, had an overall total scores of 27 and 28 marks. The total score was rounded up to 30 for both tests.

Validity of Research Instruments

To ensure that participants' scores from the SKPT and SAPT were valid, meaningful and to ensure good conclusions from the sample studied and the research population, both test instruments were presented to one senior biology lecturer in the science education department of the University of Cape Coast, and two SHS elective biology teachers with considerable teaching experience in the Cape Coast Metropolis for their comments and suggestions in order to correct the errors that were associated with items on the SKPT and SAPT.

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Reliability of Research Instruments

In order to ensure that the research instruments produced scores that are stable and consistent and their test items are devoid of any ambiguities (Creswell, 2008) as much as possible, the SKPT and SAPT were pilot-tested using 29 SHS elective biology students in Aggrey Memorial SHS in the Central Region. Data from the pilot test were statistically analyzed to determine the reliability of the test instruments using the Spearman-Brown prophecy formula since all items on both SKPT and SAPT were dichotomously scored. The analysis yielded reliability coefficients of .59 and .62 for the SKPT and SAPT respectively. According to Ary, Lucy and Asghar (2002), if the measurement results are to be used for making a decision about a group or for research purposes, or if an erroneous initial decision can be easily corrected, then scores with modest reliability coefficients in the range of .50 to .60 may be acceptable. The above reliability coefficients for the SKPT and SAPT therefore, signify that both test instruments are considerably reliable.

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Data Collection Procedure

Data were collected by the researcher himself through the Non-Equivalent Group Design (NEGD) pre-test post-test procedure. The data collection procedure was divided into three phases: pre-treatment phase, treatment phase and post-treatment phase. This is illustrated diagrammatically below:

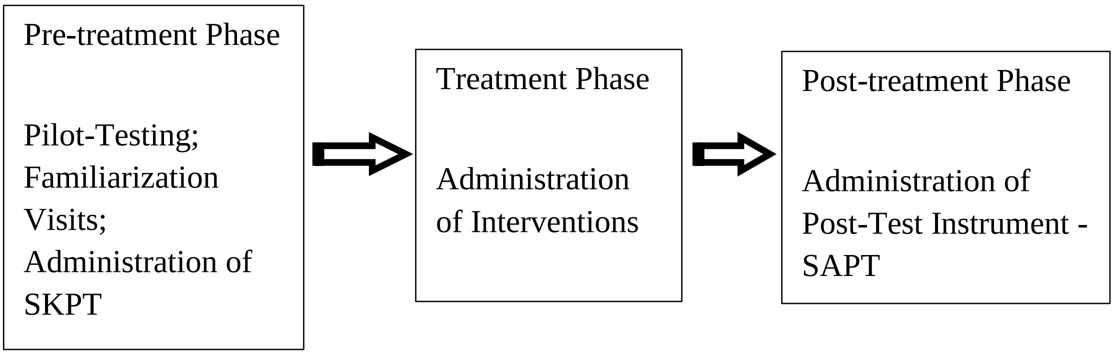

Figure 5: The Process of Data Collection.

Data Analysis Procedure

The study collected only quantitative data and employed quantitative method of data analysis. Data obtained from participants in both experimental and control groups on the SAPT were analyzed statistically using independent sample *t*-Test. The difference between the mean scores of both groups on the pre-test-post-test scores was tested at a 0.05 significant level. The independent sample *t*-Test was used to investigate whether any differences existed between experimental and control groups' mean scores on the SAPT. This was done to answer the research questions and either reject or fail to reject the null hypotheses formulated for the study.

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Again, to verify the intervention effects on the male and female students of the groups, the independent sample t-test was applied.

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CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

This chapter deals with discussion of data and presentation of the results and findings of the study. The Statistical Programme for Social Sciences (SPSS) software was employed to determine the relationship between the hypotheses. Two comparable classrooms from two different schools which were as similar as possible were purposefully selected for the study to make fair comparison between the experimental and control groups. The independent-sample t-test statistic was used to test the hypotheses at significance level of 0.05.

Table 1: Summary of Participants in the Study

School	Class	Boys (%)	Girls (%)	Total
University Practice Senior High School	Science 3	23 (43.39)	30 (56.60)	53
Ghana National College SHS	Science 3	25 (43.86)	32 (56.14)	57
		48 (43.64)	62 (56.36)	110

Source: Field Data 2015

Analysis of Research Questions:

Research Question One: What are the differences in achievement scores between students taught using multimedia approach and those taught using the traditional approach in selected schools in Cape Coast metropolis?

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Tables 2 and 3 show the means between the control group and the experimental group after both the Pre-test and Post-test. It also indicates standard deviation differences between the control and experimental groups after both the Pre-test and Post-test. In addition, the number of respondents in each case were 53 and 57 for the control group and experimental group respectively.

Table 2: Comparison of Mean Scores on Pre-test of Control Group and Experimental Group.

	Name of Group	N	Mean	Std. Deviation	Std. Error Mean
Pre-	Control Group	53	12.38	2.46	.32
test	Exp. Group	57	12.58	2.98	.40

Source: Field Data 2015

In Table 2 above, the pre-test mean for the control and experimental groups were 12.38 and 12.58 with standard deviations of 2.46 and 2.98 respectively. The results from the pre-test in the group statistics showed that the control group and the experimental group were just about the same with a mean difference of 0.18 points in the pre-test. This means the groups were homogeneous at the beginning of the study.

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Table 3: Comparison of Mean Scores on Post-test of Control Group and Experimental Group.

	Nam of Group	N	Mean	Std. Deviation	Std. Error Mean
Post-test	Control Group	53	20.36	4.45	.59
	Exp. Group	57	23.32	3.17	.43

Source: Field Data 2015

However, in the post-test, Table 3 evidently showed that there was a marginal 2.95 point difference between the means. This implies that the intervention did actually improve the students performance and therefore can be concluded that the use of multimedia in teaching had a marginal effect on the academic achievement of students studying Biology.

Research Question Two:

What are the differences in achievement scores between male and female students taught using multimedia approach and those taught using the traditional approach in selected schools in Cape Coast metropolis?

Table 4 shows the means between the male and the female after both the Pre-test and Post-test. It also indicates standard deviation differences between the male and female after both the Pre-test and Post-test. In addition, the number of respondents in each case were 48 and 62 for the male and female respectively.

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Table 4: Mean and Standard Deviation Differences by Gender

	Name of Group	N	Mean	Std. Deviation	Std. Error Mean
Pre-test	Male	48	12.39	2.56	.37
	Female	62	12.54	2.84	.36
Post-test	Male	48	21.02	4.67	.67
	Female	62	22.38	3.61	.45

Source: Field Data 2015

In Table 4, the male and female pre-test mean scores were 12.39 and 12.54 while the standard deviation were 2.56 and 2.84 respectively. Again, in the post-test, the mean scores were 21.02 and 22.38 and standard deviations of 4.67 and 3.61 respectively.

Analysis of Research Hypothesis:

Research Hypothesis One:

There is no statistically significant difference between the academic achievement scores of students taught photosynthesis using multimedia approach and those taught using the traditional approach.

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Table 5: Comparison of Mean Scores of Pre-test and Post-test Scores based on Groups.

		Pre-Test		Post-Test	
Group	N	Mean	Std. Deviation	Mean	Std. Deviation
Experimental	57	12.58	2.98	23.32	3.17
Control	53	12.38	2.46	20.36	4.45

Source: Field Data 2015

Table 6: Independent Sample T-test by Groups

		T-test for Equality of Means			
		T	Df	Sig. 2-tailed	Mean Difference
Pre-test	Equal Variances assumed	-.382	108	.703	-.19
	Equal variances not assumed	-.379	101.214	.705	-.19
Post-test	Equal Variances assumed	-3.974	108	.000	-2.95
	Equal variances not assumed	-4.022	101.264	.000	-2.95

Source: Field Data 2015

The data in Tables 5 and 6 were used to test Hypothesis One. The data in Table 6 above indicates that both the Control and Experimental groups differ in the pre-test mean scores with .19 point difference. They also differ in their standard deviation scores. However, the difference between the Control and

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Experimental groups in the pre-test was not significant at level .05. In Table 6, the t (-.382), df (108) and (p=.703).

Again, the data in Table 6 indicates that both Control and Experimental groups differ in the post-test mean scores with 2.95 point difference. They also differ in their standard deviation scores.

When the t-values were computed it yielded a t-value of (-.382), df (108) and sig. value of p=.703 in the pre-test. The conclusion is that there was no significant difference between experimental and control groups in the pre-test. However, the difference between the Control and Experimental groups in the post-test was not significant at .05 levels. In Table 6, the t (-3.974), df (108) and (p=.000).

When the t-values were computed for the post-test, it was evident that the performance of the experimental group was significantly better than the control group as evidenced by the independent student t-test. The t (-3.974) df (108) and the significant value of p = .000 as shown in Table 6 is a clear indication that the difference between the two means was statistically significant at 0.05 levels.

Thus, the hypothesis that "There is no statistically significant difference between the academic achievement scores of students taught photosynthesis using multimedia approach and those taught using the traditional approach" is rejected at 0.05 level. It therefore, means that there was a significant difference between the academic achievement of students exposed to multimedia

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instruction and those not exposed to in the study of Photosynthesis. This implies that the intervention did actually improve the students performance and therefore can be concluded that the use of multimedia in teaching had a marginal effect on the academic achievement of students studying Biology.

Research Hypothesis Two:

There is no statistically significant difference between the academic achievement scores of male and female students taught using multimedia approach and those taught using the traditional approach.

Table 7: Comparison of Mean Scores of Pre-test and Post-test based on Gender.

		Pre-Test		Post-Test	
Gender	N	Mean	Std. Deviation	Mean	Std. Deviation
Males	48	12.39	2.56	21.02	4.67
Females	62	12.54	2.84	22.38	3.61

Source: Field Data 2015

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Table 8: Independent Sample T-test by Gender

		T-test for Equality of Means			
		t	df	Sig. 2-tailed	Mean Difference
Pre-test	Equal Variances assumed	-.291	108	.772	.15
	Equal variances not assumed	- .295	105.496	.769	.15
Post-test	Equal Variances assumed	-1.728	108	.087	-1.36
	Equal variances not assumed	-1.673	86.263	.098	-1.36

Source: Field Data 2015

The data in Tables 7 and 8 were used to test hypothesis two. The data in Table 8 shows that both the female and male students differ in the pre-test with .15 and .28 point differences on both the means and standard deviations respectively. When the t-values were computed on the pre-test, the t-value was t (.291), df (108) and significant value of p = .772, (Table 8). This shows that there was no significant difference between the academic achievement of females and males students exposed to multimedia instruction and those not exposed to in the study of Photosynthesis.

In the post-test however, the difference in the mean and standard deviation scores were 1.36 and 1.06 respectively as shown in Table 8. When the t-values were computed in Table 8, the t-value was t (-1.728), df (108) and a significant

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value of p = .087 respectively. Again, it was evident in the post-test that there was no significant difference between the female and male SHS students exposed to multimedia instruction and those not exposed to in the study of Photosynthesis

From Tables 7 and 8, it is clear that there was no significant difference between the female and male achievement scores after being exposed to multimedia instruction and those not exposed to in the study of photosynthesis. The following details indicated that there was no significant difference in the males ($\underline{M}$ = 21.02, $\underline{SD}$ = 4.67) and females ($\underline{M}$ = 22.38, $\underline{SD}$ = 3.61), $\underline{t}$ (.-1.728) df (108), $p = .087$.

Therefore Hypothesis Two which states that “There is no statistically significant difference between the academic achievement scores of male and female students taught using multimedia approach and those taught using the traditional approach is not rejected at 0.05 significance level.

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Summary of Findings

From the analysis of data gathered, the following summary of findings is arrived at:

1. There is a significant difference between the academic achievement scores of students taught photosynthesis using multimedia approach and those taught using the traditional approach.
2. There is no significant difference between the academic achievement scores of male and female students taught using multimedia approach and those taught using the traditional approach.

Discussion of Findings

The results are discussed in relation to the research hypothesis. The results of the pre-test which showed that there was no significant difference between the experimental group and the control group affirms that the groups were homogenous at the beginning of the study. In other words before the experimental and control groups were exposed to the intervention, the groups were similar in spite of the very slight (almost insignificant) difference their mean scores.

However, when the experimental group was exposed to the intervention (thus multimedia instruction), the differences, as compared to the control group who received the traditional method of instruction, were significant. This means that the intervention improved the performance of the experimental group more than the control group.

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This finding is affirmed by the study undertaken by Adegoke (2011), which examined the effect of multimedia instruction on senior secondary school students' achievement in Physics**.**

On the other hand, when the pre-test and post-test scores were analysed based on the gender of the student, the study showed that there was no significant difference in the mean scores of male and female students. The achievement scores of girls and boys may be attributed to the changing socio-cultural environment which has widened the scope for equal educational opportunities. Education systems have made significant strides towards closing the gender gap in educational attainment in recent decades (OECD, 2001). Males generally have a more positive attitude toward computers and primary medium for digital images, than females (Butler, 2000). Males are generally more sensitive to visual stimuli (i.e., graphics, images, charts, etc.) than females (Chanlin, & Chuang, 2001). Male students prefer multimodal instruction whereas most female students prefer single mode instruction (Wehrwein, Lujan and DiCarlo 2007). However the higher performance of girls in the post-test of the experimental group over their counterparts in control group can be credited to the combined use of various tools in multimedia presentation, thus going a long way to facilitate the acquisition of biological concepts by catering to their needs with varied attitudes and learning styles. The findings of this study are supported by many other studies which revealed no statistically significant mean difference between boys and girls with respect to achievement and attitude toward biology (Soyibo, 1999; Sungur and Tekkaya, 2003).

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The overall results of the study indicated that the use of multimedia in teaching improved students' achievement in the subject of Biology at senior high school level with higher achievement gains by the experimental group. The results of the study were in line with those of previous researches carried out in other cultures.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This is the final chapter that summarizes the research design and its findings. It also looks at all aspect of the research for its conclusion and recommendations which are crucial for possible adaptation and incorporation.

The purpose of the study was to ascertain the effectiveness of teaching students studying photosynthesis in biology by using multimedia. This included PowerPoint presentations, video and courseware materials on photosynthesis. The research design for this study was an experimental research, which employed the quasi-experimental design. One hundred and ten biology students were selected for this study and were divided into two groups (experimental group and control group). The experimental group was taught using multimedia materials while those in the control group were taught photosynthesis using the traditional approach.The instruments used for this study was a pre-test and post-test made of 20 items.

The following are the main findings of the study:

1. Differences in Performance between Experimental and Control Groups

The performances of the experimental groups were significantly better than that of the control group on the SAPT, signifying that SHS students exposed to the multimedia instructional approach performed significantly better than their counterparts exposed to the traditional instructional approach. This indicates

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that the use of materials with high multimedia content appears to have a positive influence on students' understanding of the concept of photosynthesis.

2. Differences in Performance between Male and Female Students.

Gender proved redundant in the acquisition of biological concepts in photosynthesis.

Female students performed marginally better than male students although the t test showed insignificant difference in the mean scores of male and female students.

This indicates that the use of multimedia in teaching and learning of photosynthesis is equally favoured by both male and female students.

Conclusion

The following conclusions were drawn on the basis of statistical analysis and the findings of the study. The results of the study imply that students exposed to the teaching and learning of photosynthesis through the use of multimedia content performed significantly better than their counterparts exposed to the traditional instructional approach.

On the bases of achievement of pre-test and post-test scores by gender, the study concluded that the use of multimedia in teaching and learning of concepts in biology such as photosynthesis is equally favoured by both male and female students

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Recommendations

Based on the major findings of this study, the following recommendations are offered.

1. Teachers should expose students to CBI (multimedia instructional strategies) so as to promote effective and active learning and learning by experience among students.

2. According to Anamuah-Mensah, Mereku & Asabere-Ameyaw (2004), the poor performance of Ghana's eight grade in Trends in International Mathematics and. Science Study (TIMSS) (2003), was attributed to the less usage of technology in the classroom. This should be taken seriously and an attempt to integrate computer technology in education should be a priority of education policy makers.

3. Teachers should use different approaches to teaching so as to reach out to students with different learning styles. This will go a long way to improve the performance of students.

4. Also, teacher education programmes in Ghanaian tertiary institutions should prepare teachers who can apply innovative approaches (multimedia instructional strategies) that will promote effective teaching and learning.
5. Technology in teaching and learning should be limited as an instructional delivery medium and not a key determinant of learning (Ali & Elfessi, 2004).

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Suggestion for Further Research

The results gathered from the study show the positive outcomes that multimedia usage in class rooms can have on the academic achievements of the Senior High students. More of this study and varied kinds must be researched into from the basic to advanced levels of our educational system in all subjects, especially Mathematics, Science, Vocational and Technical programmes.

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Appendix A

UNIVERSITY OF CAPE COAST

(College of Distance Education)

Tel No: 03321 - 36947
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University Post Office
Cape Coast

Our Ref. No: CCE/MED/17/Vol.1/033

8th September, 2015

Your Ref. No:

TO WHOM IT MAY CONCERN

This is to certify that **Mr. Allan Ayittey** with registration number **ED/ITP/13/0027** is pursuing a two year Master of Education Degree in Information Technology at the University of Cape Coast.

He is conducting a research on the topic **"The impact of multimedia Instruction in Biology on Senior High School Students Achievement and Retention"**
We will strongly appreciate any courtesy extended to him.
Thank you.

Paul Nyagorme (PhD)
(Coordinator, eLearning and Technology

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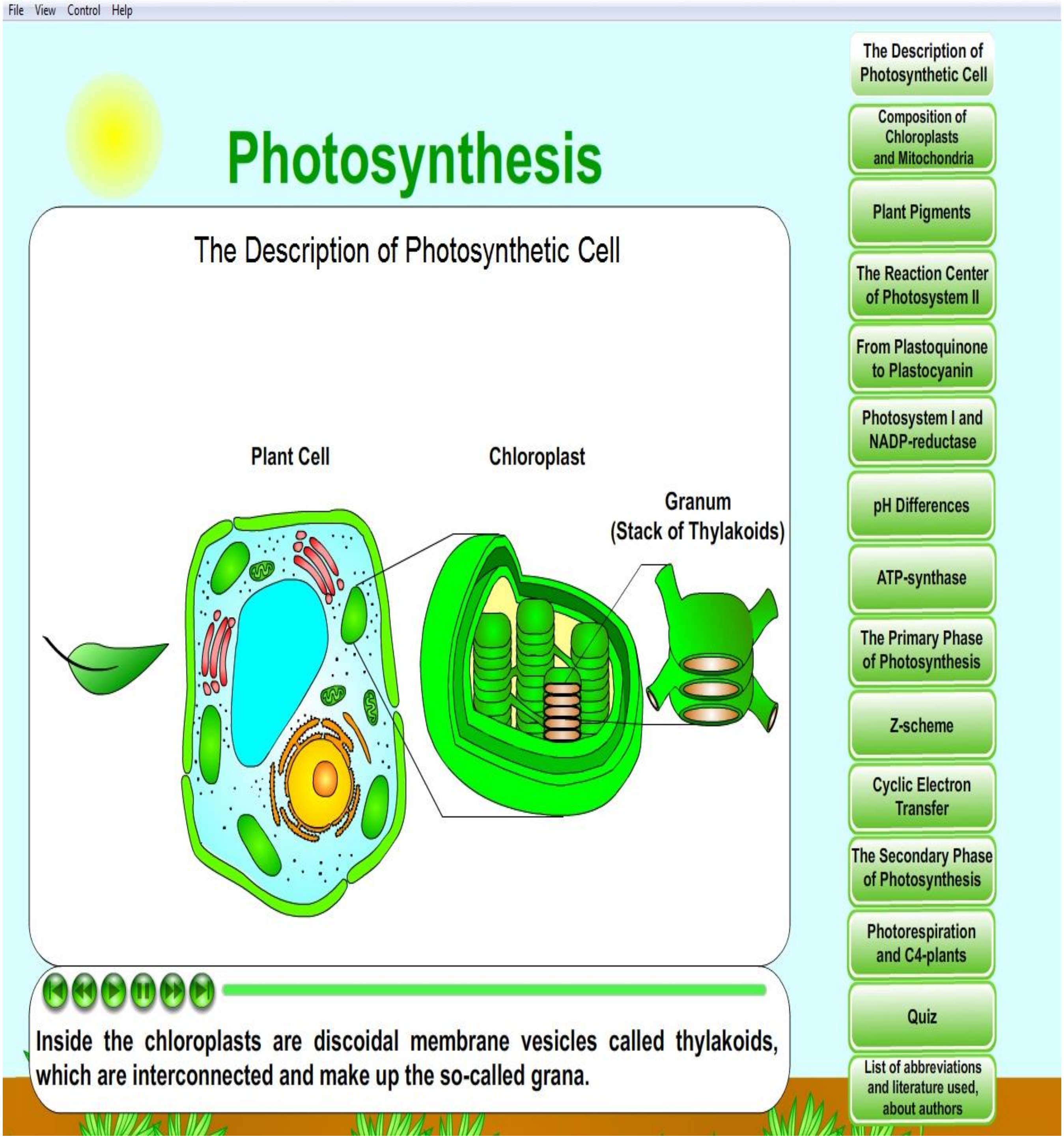
Appendix B1



Screen Captured Picture of courseware on photosynthesis

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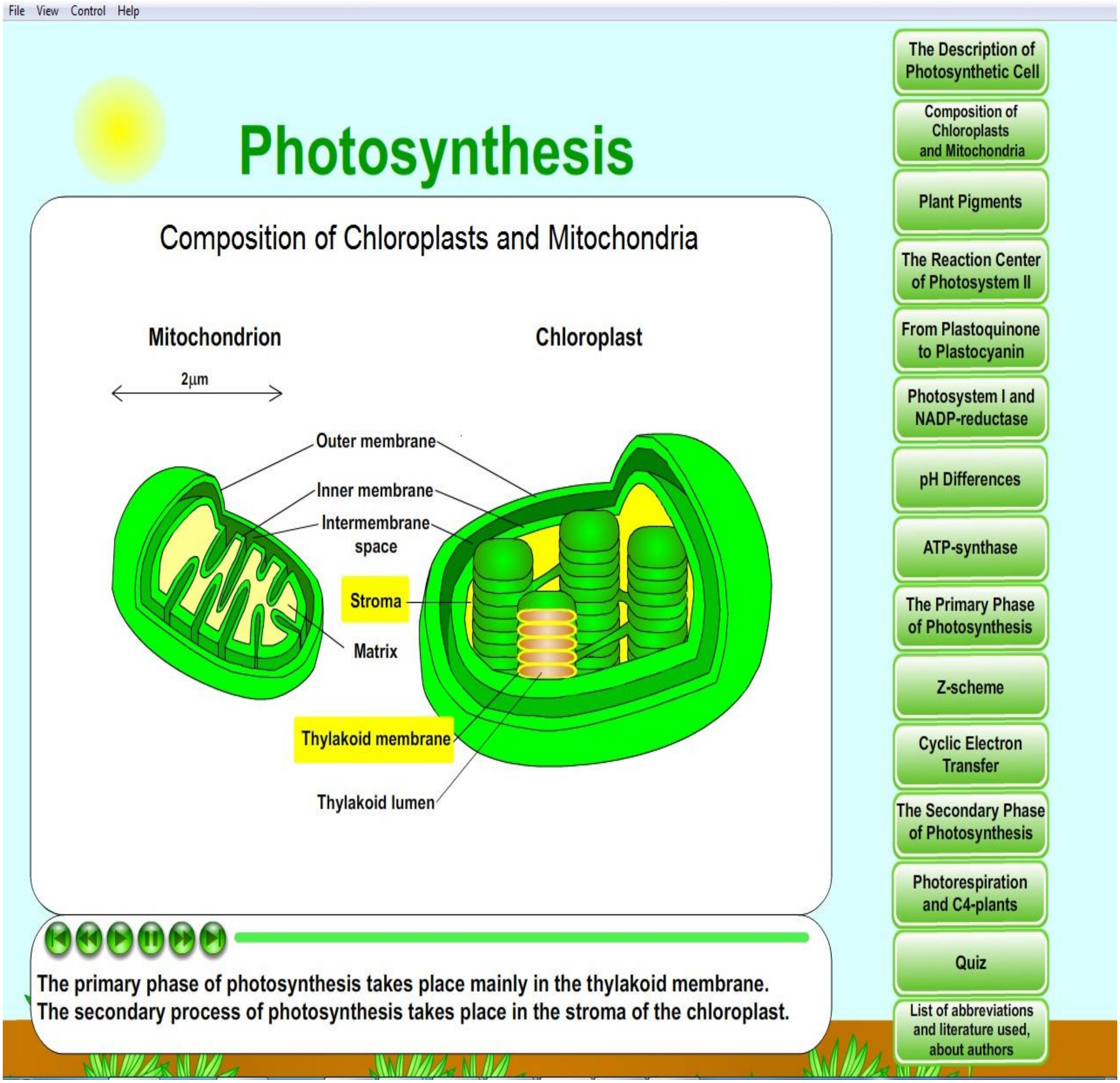
Appendix B2



Screen Captured Picture of courseware on photosynthesis

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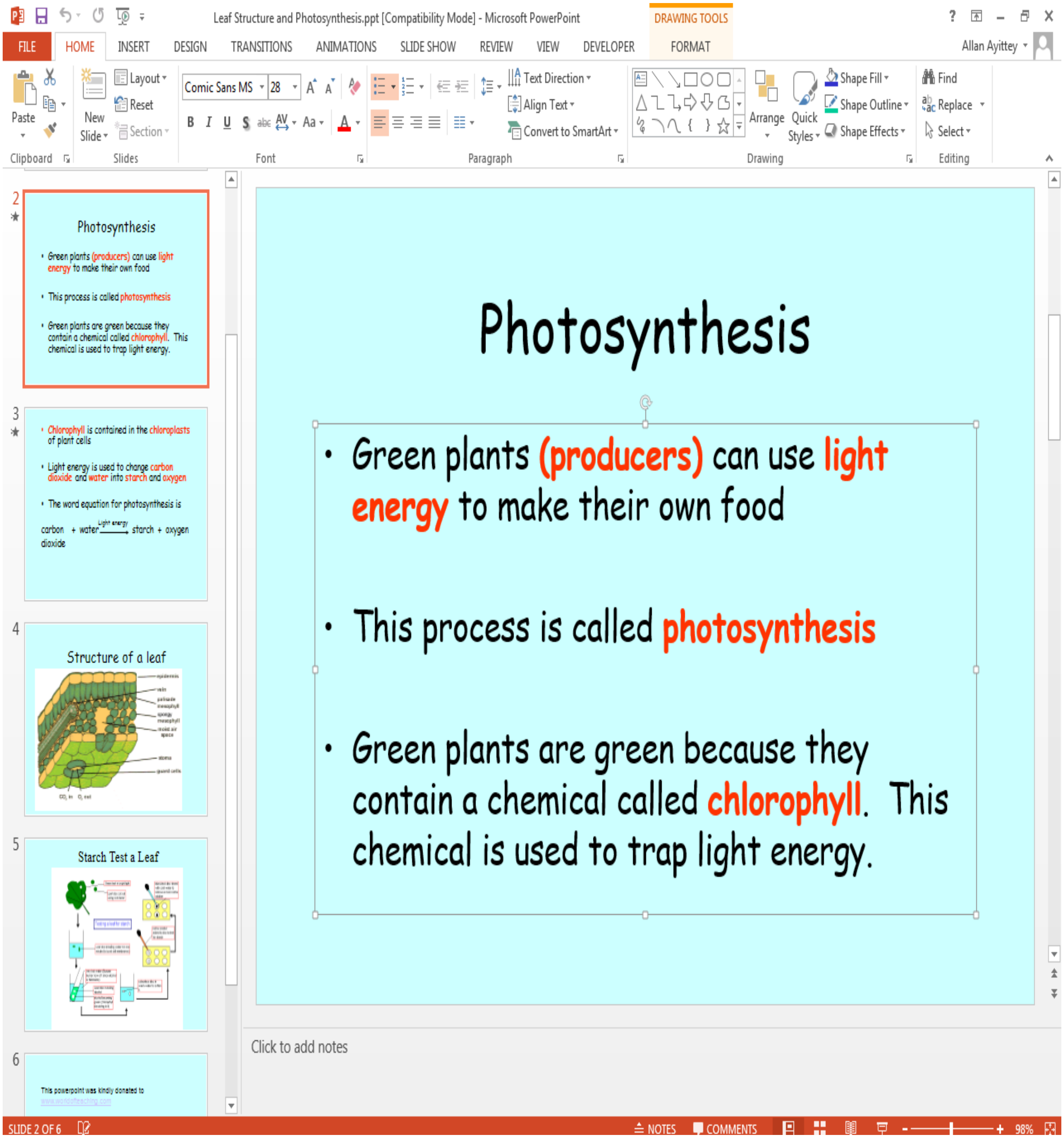
Appendix B3



Screen Captured Picture of power point presentation lesson on photosynthesis

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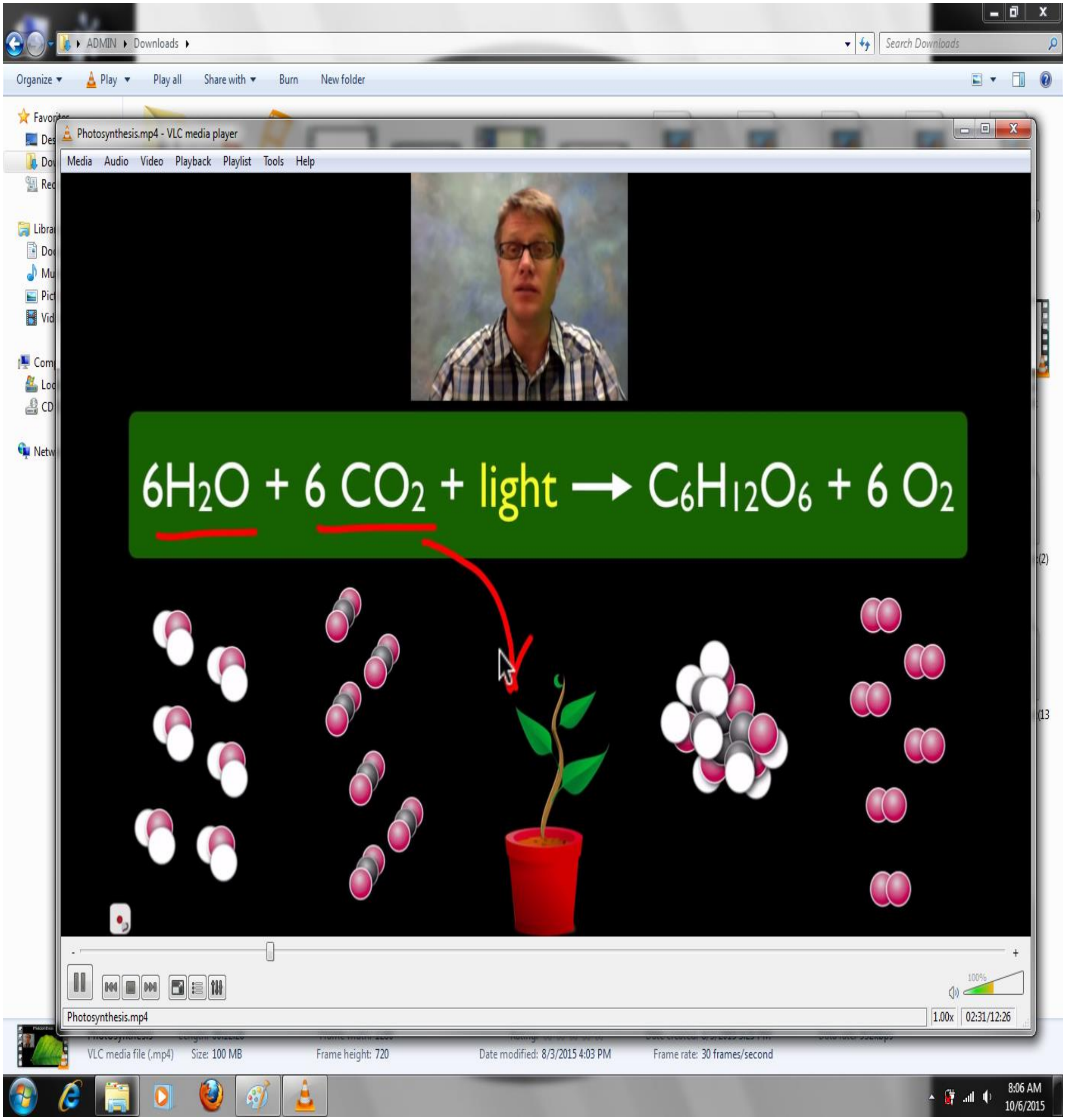
Appendix B4



Screen Captured Picture of video based lesson on photosynthesis

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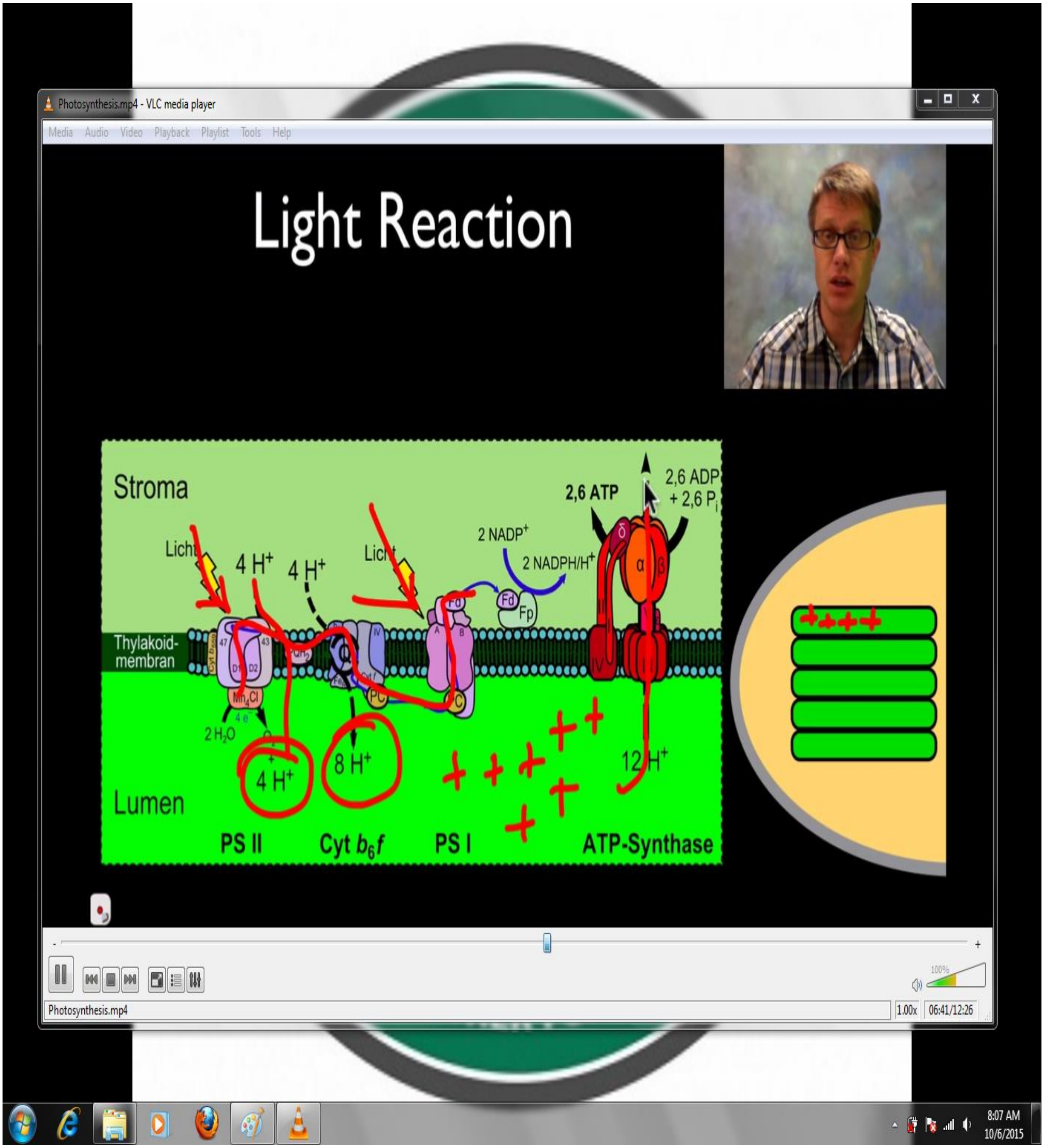
Appendix B5



Screen Captured Picture of video based lesson on photosynthesis

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Appendix C

STATISTICAL DATA

Collected data for both experimental and control groups

CONTROL GROUP				EXPERIMENTAL GROUP			
LEARNER	GENDER	PRE	POST	LEARNER	GENDER	PRE	POST
1	F	12.00	17.00	1	F	10.00	27.00
2	F	15.00	24.00	2	M	13.00	26.00
3	F	13.00	19.00	3	F	14.00	26.00
4	M	10.00	26.00	4	M	13.00	26.00
5	M	16.00	24.00	5	M	12.00	24.00
6	F	16.00	27.00	6	M	10.00	26.00
7	M	15.00	18.00	7	F	12.00	25.00
8	M	15.00	16.00	8	M	12.00	25.00
9	F	15.00	25.00	9	F	11.00	25.00
10	F	14.00	22.00	10	F	14.00	24.00
11	F	14.00	19.00	11	F	11.00	24.00
12	M	14.00	19.00	12	F	8.00	24.00
13	F	15.00	21.00	13	F	11.00	24.00
14	F	13.00	20.00	14	F	10.00	23.00
15	M	14.00	29.00	15	F	8.00	23.00
16	F	13.00	27.00	16	M	10.00	23.00
17	M	15.00	18.00	17	M	9.00	25.00
18	M	13.00	18.00	18	M	10.00	20.00
19	M	11.00	15.00	19	M	8.00	12.00
20	M	10.00	15.00	20	M	18.00	28.00
21	M	12.00	14.00	21	M	9.00	20.00
22	M	13.00	17.00	22	M	10.00	21.00
23	F	14.00	19.00	23	F	10.00	22.00
24	F	12.00	17.00	24	F	19.00	24.00
25	F	12.00	16.00	25	M	10.00	23.00
26	M	10.00	17.00	26	F	17.00	24.00
27	M	9.00	14.00	27	F	10.00	25.00
28	M	10.00	19.00	28	M	15.00	21.00
29	F	12.00	24.00	29	F	19.00	23.00
30	M	10.00	14.00	30	F	10.00	24.00
31	M	9.00	14.00	31	M	17.00	27.00
32	F	10.00	29.00	32	F	15.00	23.00
33	F	10.00	16.00	33	M	12.00	26.00
34	M	12.00	15.00	34	M	14.00	20.00

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Continuation of Appendix C

CONTROL GROUP				EXPERIMENTAL GROUP			
LEARNER	GENDER	PRE	POST	LEARNER	GENDER	PRE	POST
35	F	13.00	29.00	35	F	10.00	17.00
36	M	12.00	21.00	36	M	10.00	19.00
37	M	14.00	19.00	37	M	11.00	25.00
38	M	10.00	15.00	38	F	11.00	20.00
39	F	9.00	15.00	39	M	12.00	26.00
40	M	15.00	28.00	40	F	13.00	15.00
41	M	17.00	25.00	41	M	14.00	20.00
42	F	6.00	15.00	42	F	10.00	26.00
43	F	8.00	19.00	43	F	15.00	25.00
44	F	10.00	20.00	44	F	15.00	20.00
45	F	11.00	27.00	45	F	16.00	24.00
46	M	13.00	22.00	46	F	17.00	25.00
47	F	7.00	19.00	47	F	18.00	25.00
48	F	12.00	25.00	48	F	12.00	22.00
49	F	14.00	23.00	49	F	14.00	20.00
50	F	13.00	17.00	50	F	14.00	28.00
51	F	16.00	20.00	51	M	17.00	25.00
52	F	13.00	24.00	52	F	12.00	23.00
53	F	9.00	20.00	53	M	15.00	28.00
54	F	13.00	26.00				
55	F	16.00	25.00				
56	F	12.00	22.00				
57	M	15.00	21.00				

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Appendix D$_1$

UNIVERSITY OF CAPE COAST, CAPE COAST

COLLEGE OF DISTANCE EDUCATION

M.ED I.T

PRETEST DATA COLLECTING INSTRUMENT - STUDENTS' KNOWLEDGE OF PHOTOSYNTHESIS TEST (SKPT)

Participant Number: ……………………………………………………………………………..

Gender of Participant: ………………… Class of Participant: ………………………………

School of Participant: …………………………………………………………………………….

GENERAL INSTRUCTIONS: This test contains twenty (20) questions grouped in three (3) sections, namely Sections A, B and C. Please answer ALL the questions in ALL three (3) sections of the test.

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SECTION A

MULTIPLE CHOICE QUESTIONS

INSTRUCTIONS: The following questions are followed by four (4) options lettered A to D. Find out the correct option and circle A, B, C or D to indicate your answer.

1. The net reaction for photosynthesis produces

   A. water and carbon dioxide

   B. water and Oxygen

   C. carbohydrate and carbon dioxide

   D. carbohydrate and Oxygen

2. As far as the light reaction of photosynthesis is concerned, what is the role of oxygen?

   A. It is a necessary reactant.

   B. It is a waste product.

   C. It is a product that is then utilized in the dark reaction.

   D. It is not involved as a product or a reactant.

3. The essential initial role of light in initiating the light reaction of photosynthesis is to produce

   A. free neutrons

   B. free electrons

   C. free Oxygen

   D. free energy in the form of ATP

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4. The main purpose of the dark reaction of photosynthesis is the production of

   A. Oxygen.

   B. $NADP^+$.

   C. carbohydrate.

   D. carbon dioxide.

5. The function of water in photosynthesis is to

   A. combine with carbon dioxide.

   B. supply electrons in the light-dependent reactions.

   C. transport H^+ ions in the light-independent (dark) reactions.

   D. provide molecular oxygen for the light-independent (dark) reactions.

6. All the following statements are correct regarding the light-independent (dark) reactions of photosynthesis **EXCEPT**

   A. the energy source utilized is the ATP and NADPH obtained through the light reaction.

   B. the reaction begins soon after sundown and ends before sunrise.

   C. the five Carbon sugar is constantly being regenerated.

   D. one of the end products is PGAL.

7. Which of these statements about photosynthesis is **FALSE**?

   A. Photosynthesis is initiated by the absorption of light energy by chlorophyll molecules.

   B. The chlorophyll molecules of illuminated chloroplasts are raised to a higher energy level.

   C. The biochemical activities of the light reaction occur in the granae.

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D. Some of the energy of the excited electrons is used to split carbon dioxide into Carbon and Oxygen.

8. Which of these statements concerning chloroplasts is **FALSE**?

A. They make some amounts of ATP to drive some of the photosynthetic process.

B. They have DNA separate from nucleic DNA.

C. They contain granae.

D. They have a fluid matrix called stroma.

9. A well-watered potted green plant is kept in a brightly lighted area for 48 hours. What will most likely occur if the light intensity is then reduced slightly during the next 48 hours?

A. Photosynthesis will stop completely.

B. The rate at which nitrogen is used by the plant will increase.

C. The rate at which Oxygen is released from the plant will decrease.

D. Glucose production inside each plant cell will increase.

10. Photophosphorylation involves ATP

A. production during the light reaction of photosynthesis

B. Breakdown during the light reaction of photosynthesis

C. Formation during the dark reaction of photosynthesis

D. Breakdown during the dark reaction of photosynthesis

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SECTION B

TRUE/FALSE QUESTIONS

INSTRUCTIONS: The following statements are either **True** or **False**. State whether each of the statements is **TRUE** or **FALSE** by circling **True** or **False** to indicate your answer.

11. Both NADP and ATP molecules are formed in the light stage of photosynthesis.

    True or **False**

12. The palisade mesophyll cells possess more chloroplasts and smaller inter-cellular air spaces between them than the spongy mesophyll cells. **True** or **False**

13. Photosynthesis plays an important role in both carbon dioxide and Oxygen cycles in the environment. **True** or **False**

14. Possession of a network of veins adapts the leaf for the process of photosynthesis.

    True or **False**

15. The palisade mesophyll cell differs from the spongy mesophyll cell in the same plant by the possession of a thicker wall. **True** or **False**

SECTION C

ESSAY QUESTIONS

INSTRUCTION: Answer **ALL** questions in this section.

16. Briefly define what you understand by the process of photosynthesis.

17. Mention two (2) events which take place during the dark stage of photosynthesis.

18. (i) Which substance is tested for to determine that photosynthesis has taken place in a leaf.

    (ii) Which chemical test is usually carried out to test for the substance in (i) above.

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19. Briefly mention two (2) things that happen to the chlorophyll molecule when it absorbs light energy.

20. Mention three (3) factors that affect the rate of photosynthesis in plants.

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Appendix D2

UNIVERSITY OF CAPE COAST, CAPE COAST

COLLEGE OF DISTANCE EDUCATION

M.ED I.T

POSTTEST DATA COLLECTING INSTRUMENT - STUDENTS' ACHIEVEMENT IN PHOTOSYNTHESIS TEST (SAPT)

Participant Number: ……………………………………………….

Gender of Participant: ……………………… Class of Participant: …………………………..

School of Participant: …………………………………………………………………………….

GENERAL INSTRUCTIONS: This test contains twenty (20) questions grouped in three (3) sections, namely Sections A, B and C. Please answer **ALL** the questions in **ALL** three (3) sections of the test.

SECTION A

MULTIPLE CHOICE QUESTIONS

INSTRUCTIONS: The following questions are followed by four (4) options lettered A to D. Find out the correct option and circle A, B, C or D to indicate your answer.

1. Which reactions are involved in the process of photosynthesis?

   A. photochemical reactions, only

   B. carbon-fixation reactions, only

   C. both photochemical and carbon-fixation reactions

   D. neither photochemical nor carbon-fixation reactions

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2. An inorganic molecule required by green plants for the process of photosynthesis is

   A. Oxygen molecule

   B. starch

   C. carbon dioxide

   D. glucose

3. Which of the following activities occurs in the process of photosynthesis?

   A. Chemical energy from organic molecules is converted into light energy.

   B. Organic molecules are obtained from the environment.

   C. Organic molecules are converted into inorganic food molecules.

   D. Light energy is converted into the chemical energy of organic molecules.

4. The stacks of flattened membranous sacks in the chloroplast containing chlorophyll are called

   A. granae.

   B. lamellae.

   C. cristae.

   D. membranes.

5. The Oxygen given out during photosynthesis comes out from

   A. the breakdown of carbon dioxide.

   B. the breakdown of water.

   C. suplus Oxygen taken into the plant.

   D. the combination of carbon dioxide and water.

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6. What biological process is described by the equation below?

$$2H_2O \xrightarrow{\text{light}} 4H^+ + O_2 + 4e^-$$

A. Photolysis of water

B. Dehydration of water

C. Oxygen synthesis from water

D. Electron production from water

7. Which of the following processes does **NOT** occur in the Calvin cycle?

A. Production of glyceraldehyde-3-phosphate.

B. Formation of $NADPH^+$.

C. Formation of pyruvic acid.

D. Utilization of carbon dioxide.

8. The light stage of photosynthesis involves

A. fixation of carbon dioxide.

B. the reduction of ribulose diphosphate.

C. the breakdown of water.

D. oxidation of $NADPH^+$ to NADP.

9. A plant with pink leaves and stem is capable of photosynthesizing because it

A. has special cells which can photosynthesize.

B. has chlorophyll which has been masked.

C. uses the pink pigment to photosynthesize.

D. possesses carotene which is efficient in photosynthesizing.

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10. Which of the following cells of the leaf lack chloroplasts?

A. Guard cells

B. Ordinary epidermal cells

C. Palisade mesophyll cells

D. Spongy mesophyll cells

SECTION B

TRUE/FALSE QUESTIONS

INSTRUCTION: The following statements are either **True** or **False**. State whether each of the statements is **TRUE** or **FALSE**. Circle **True** or **False** to indicate your answer.

11. The importance of photosynthesis to life includes serving as a direct source of food for secondary consumers. **True** or **False**

12. Chloroplasts can photosynthesize mainly because they contain the enzymes for the light stage of photosynthesis. **True** or **False**

13. The first reaction of the light stage of photosynthesis is photolysis of water. **True** or **False**

14. The wavelengths of light in which the rate of photosynthesis is greatest are red and blue. **True** or **False**

15. The possession of numerous stomata is a feature that adapts the leaf for photosynthesis. **True** or **False**

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SECTION C

ESSAY QUESTIONS

INSTRUCTION: Answer **ALL** questions in this section.

16. Mention two (2) events that occur in the light stage of photosynthesis.

17. Describe two (2) features or structures of the leaf that adapt it for photosynthesis.

18. Describe briefly photolysis of water in photosynthesis.

19. (i) Mention the two (2) raw materials needed for photosynthesis.

    (ii) Describe briefly how plants obtain one (1) of the raw materials you have mentioned in (i) above from the environment for photosynthesis.

20. Mention two (2) substances that are formed during the dark stage of photosynthesis.

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Appendix D3

MARKING GUIDE FOR PRETEST (SKPT) ITEMS

1. **D**
2. **B**
3. **B**
4. **C**
5. **B**
6. **B**
7. **D**
8. **B**
9. **C**
10. **A**
11. **False**
12. **True**
13. **True**
14. **True**
15. **False**

(Scoring: 1 mark each) Sub-total=15

16. Photosynthesis is the process by which green plants manufacture their own food **(1mark);** using simple (inorganic substances like) carbon (IV) oxide and water **(1mark)**; in the presence of sunlight **(1 mark)**; producing oxygen as a by-product **(1 mark).**

Any 3 × 1 = 3

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17. Events which occur during the dark or light-independent stage of photosynthesis:

i) Fixation of carbon (IV) oxide or carbon-fixation (catalyzed by rubisco, producing 3-phosphoglycerate, 3PG). **(1 mark)**

ii) Reduction of 3PG (to form glyceraldehydes 3-phosphate). **(1 mark)**

iii) Regeneration of (the CO_2 acceptor) ribulose 1, 5-bisphosphate, RuBP, (by ATP). **(1 mark)** **Any 2 × 1 = 2**

18. (i) Starch **(1 mark)**

(ii) Iodine test **(1 mark)**

19. When the chlorophyll molecule absorbs a photon (light energy), it may be:

(i) Excited/activated/has some of its electrons move to higher energy levels or further away from the nucleus. **(1 mark)**

(ii) Lose electron(s) (to an oxidizing agent and becomes reducing agent which takes part in a redox reaction). **(1 mark)**

(iii) Give off some of the absorbed energy as heat and the rest as light energy (or it fluorescence). **(1 mark)** **Any 2 × 1 = 2**

20. Factors that affect photosynthesis include:

(i) Temperature. **(1 mark)**

(ii) Presence of chlorophyll. **(1 mark)**

(iii) Light intensity. **(1 mark)**

(iv) Carbon (IV) oxide concentration. **(1 mark)**

(v) Presence of water. **(1 mark)** **Any 2 × 1 = 2** **Sub-total = 11**

Grand Total = 26

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Appendix D4

MARKING GUIDE FOR POSTTEST (SAPT) ITEMS

1. C

2. C

3. D

4. A

5. B

6. A

7. B

8. C

9. B

10. B

11. False

12. True

13. False

14. True

15. True (Scoring: 1 mark each) **Sub-total = 15**

16. Events which take place during the light stage of photosynthesis include:

(i) Absorption of a photon or light energy by chlorophyll molecule, (which becomes excited or activated). **(1 mark)**

(ii) Release of electron(s). **(1 mark)**

(iii) Formation of ATP. **(1 mark)**

(iv) Formation of $NADPH^+$. **(1 mark)**

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(v) Photolysis of water. **(1 mark)** **Any 2 × 1 = 2**

17. Features of the leaf that adapt it for photosynthesis include:

i) The lamina is broad and flat for maximum absorption of (sun) light. **(1 mark)**

ii) The palisade mesophyll concentrates chlorophyll/chloroplasts in the upper surface of the leaf for maximum absorption of (sun) light. **(1 mark)**

iii) The transparent cuticle allows light to reach all parts of the leaf. **(1 mark)**

iv) The transparent epidermis allows light to reach the photosynthetic cells. **(1 mark)**

v) The thin lamina allows light to reach all parts of the leaf. **(1 mark)**

vi) The numerous stomata allow CO_2/gases to diffuse into the leaf for photosynthesis. **(1 mark)**

vii) The large intercellular spaces in the spongy mesophyll allow CO_2/gases to circulate freely in the leaf; and diffuse into photosynthetic cells. **(1 mark)**

viii) The network of veins allows water from the stem to reach every part of the leaf for photosynthesis. **(1 mark)**

ix) The network of veins transports products of photosynthesis from the leaf. **(1 mark)**

x) The mesophyll cells have thin walls which facilitates the movement of substances into and out of the cells. **(1 mark)** **Any 2 × 1 = 2**

18. Brief description of photolysis

(i) Photosystem II/P_{680}/chlorophyll molecule absorbs a photon or light energy and becomes excited or activated. **(1 mark)**

(ii) The absorbed (light) energy is used to oxidize a molecule of water. **(1 mark)**

(iii) This produces electrons/protons/ (a half molecule of) oxygen. **(1mark)**

19. (i) Carbon (IV) oxide; Water **(1 mark each)**

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(ii) α) Carbon (IV) oxide is absorbed by diffusion **(1 mark)** through the stomata from the atmosphere. **(1 mark)** **OR**

β) Water is absorbed by osmosis **(1 mark)** through the root (hairs) from the soil. **(1 mark)**

20. Substances formed during the dark or light-independent stage of photosynthesis include:

i) ADP. **(1 mark)**

ii) NADP. **(1 mark)**

iii) Carbohydrate/Sugar/Glucose/Triose sugar/3-phosphoglycerate (3PG/PGA)/Glyceraldehyde 3-phosphate (G3P/PGAL)/Starch. **(1 mark)**

iv) Ribulose 1, 5-bisphosphate (RuBP). **(1 mark)** **Any 2 × 1 = 2 Sub-total = 15**

Grand Total = 27

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