EFFECTS OF ANIMATION AND VIDEO-BASED FLIPPED CLASSROOM STRATEGIES ON PRE-DEGREE STUDENTS' LEARNING OUTCOMES IN PRACTICAL BIOLOGY IN SOUTHWESTERN NIGERIA

BY

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CERTIFICATION

I certify that the research work that culminated in the writing of this doctoral thesis was carried out by Abiola Afolabi AKINGBEMISILU (Matric Number 142239) under my supervision.

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DEDICATION

This work is dedicated to God almighty, the giver of life. Also, to my ever-supportive and caring wife, Temitope; my lovely sons, Omokayode, Omotayo and Ayomide.

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ABSTRACT

Biology is a compulsory subject for pre-degree science students in Nigerian universities; however, a decline in students' performance in practical biology has been observed. Previous studies focused on strategies of teaching practical biology with little attention on animation and video-based flipped strategies. This study, therefore, determined the effects of Animation-based Flipped Classroom Strategy (AFCS) and Video-based Flipped Classroom Strategy (VFCS) on pre-degree students learning outcomes (achievement in, attitude to and practical skills) in practical biology in Southwestern Nigeria. The moderating effects of gender and computer self-efficacy were also examined.

Constructivist social learning theory provided the framework, while the pretest-posttest control group quasi-experimental of 3x3x2 factorial matrix was adopted. Purposive sampling technique was used to select 174 pre-degree students (69 males, 105 females) from three state universities (Adekunle Ajasin,Tai Solarin and Osun State) offering pre-degree programme. The universities were selected based on availability of functional Science laboratories. Participants were assigned into AFCS (71), VFCS (51) and control (52) groups, while treatment lasted eight weeks. Instruments used were Biology Practical Achievement Test (r=0.82), Students Attitude to Biology Questionnaire (r=0.73), Biology Practical Rating Skill Scale (r=0.81), Computer Self-efficacy Questionnaire (r=0.88) and instructional guides. Data were analysed using Analysis of covariance and Scheffe post-hoc test at 0.05 level of significance.

There were significant main effect of treatments on achievement ($F_{(2,155)}$ =4.08, partial η^2 = 0.05), attitude ($F_{(2,155)}$ = 2.93,partial η^2 = 0.04) and practical skills ($F_{(2,155)}$ = 23.90, partial η^2 = 0.24) in practical Biology. Students in the AFCS had the highest achievement mean score (23.48) followed by VFCS (21.05) and the control (19.11) groups. There was a significant main effect of gender on students' Achievement ($F_{(1,155)}$ = 4.08, partial η^2 = .03). While the female participants scored the higher mean score (22.60) than their male (19.83) counterparts. There was a significant two-way interaction effects of treatment and gender on students' practical skills in Biology ($F_{(2,155)}$ = 4.10, partial η^2 = 0.05), in favour of female students in the animation-based group. There were no three-way interaction effects of treatment, gender and computer self-efficacy on students' learning outcomes in practical Biology.

Animation and video-based flipped strategies were effective in improving pre-degree students' achievement, practical skills and attitude to practical Biology in Southwestern Nigeria. There is the need to adopt these strategies for teaching pre-degree Biology students.

Keywords: Animation and video-based flipped classroom strategies, Achievement and practical skills in and attitude to Practical Biology, Pre-degree students

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Biology, generally defined as the study of life, is one of the major subjects offered at both the Senior Secondary School level and at higher institutions in Nigeria. Biology as a subject is of paramount importance to any nation. It is a vital Science subject in the Nigerian school system. Ukoh and Ade (2015) said that the introduction of Science in school curriculum was done with a view to developing scientific attitude, scientific nature, critical thinking, active inquiry, independent work and understanding the physical world from different perspectives. According to the Federal Ministry of Education FME(2014), the curricula at Senior Secondary School (SSS) level comprise compulsory subjects which are English Language and Mathematics, one major Nigerian language, one vocational subject and a selection of three subjects from the subject area of interest in the Arts and Social Sciences, Sciences, Vocational Studies or Technical Education. This indirectly makes Biology a necessary subject for most students in the Science class at Senior Secondary School level. A credit pass in Biology is required for admission into Nigerian universities to study Science related courses such as Medicine, Pharmacy, Agriculture, Nursing and Biochemistry, to mention a few. Biology as a Science discipline in the Nigerian schools is, therefore of great importance to the nation.

Biology is a course that connects almost all the Science undergraduates together; it prepares the future scientists not only for the laboratory experience but also for industrial and educational sectors. A sound theoretical and practical knowledge of Biology is very necessary for the provision of good health facilities as well as adequate food supply and favourable life environment (Olagunju, 2002). According to Ojo (2009) many of the most exciting discoveries in the biological sciences during the second half of the 20th century occurred at the intersections of established disciplines. These new integrated fields across the diversity of life sciences are leading to a vast array of practical applications, ranging from new medical approaches to alternative sources of energy to new theoretical bases in the behavioural and social sciences. Abiona (2008) said that advances in the life sciences require new approaches to preparing Biology major students; they also call out for new ways to prepare all science undergraduates regardless of their eventual career paths. As a growing number of societal challenges, from environmental stewardship to human health and quality of life, intersect with Biology, future scientists and non-scientists alike must become adept at making connections among seemingly disparate pieces of information, concepts, and questions, as well as being able to understand and evaluate evidence. They must possess enough knowledge about related disciplines (both across sub-disciplines within the life sciences and across the physical, natural and social sciences) to bring the requisite expertise to address complex issues.

Today's biologists require new skills to address the challenges of the 21st century, including the ability to think and contribute outside their disciplinary boundaries. Nigerian undergraduates in the Faculty of Science and Science Education programmes usually take at least a Biology course (Odili, 2006). These introductory classes often stand as gateways into science, introducing scientific inquiry, the use of evidence, and the core biological concepts that can help students make informed decisions about the complex Biology related problems in their daily lives. Biology Departments, therefore, have a unique opportunity and responsibility to ensure that all undergraduates taking their courses gain a basic understanding of science as a way to learn about the natural world. Biology course designs have helped students develop critical-thinking skills, and have resulted in increased interest and/or persistence in science courses in general, and Biology majors in particular, with some approaches proving helpful in improving participation of under-represented groups and increasing student confidence in their ability to understand and excel in the study of Biology (Summer and Hrabowski, 2006; Laursen, 2010).

Success in all the biological science courses in the university is largely dependent on the practical dexterity and knowledge of the students (Olagunju, 2002). Similarly Olutola, Daramola and Bamidele (2016) also emphasised that practical activities constitute an important aspect in Biology class and that no student can avoid it if he/she wants to pass with good grade. However this practical aspect of Biology often requires a lot of extra effort for the course contents to be completed in the stipulated time. Unfortunately, it appears that not many Biology teachers always complete their course contents before examinations especially the practical aspect which usually requires a lot of skills, natural science drawing and the collection or gathering of specimen and equipment to be used for these numerous practical works. The practical component of Biology is a feature that makes the subject/course unique. Many aspects of the theoretical Biology have a practical section involved in them and not only does Biology require a lot of practical work, it equally requires a lot of skills needed for the practical aspect; such as natural drawing, measuring, heating, observing, dissecting among others.

The importance of practical to Biology has informed its inclusion in the subject at ordinary level of study such as the West Africa Senior School Certificate Examination (WASSCE), the National Examination Council (NECO), Senior School Certificate Examinations among others. The marks allotted to Biology practical in these examinations have revealed the importance of practical to the subject. For instance Danmole (2012) reported that the justification for practical work in Biology at the senior secondary school level is supported by the aims of practical Biology in the West Africa Examinations Council (WAEC) syllabus which are as follows: i. to acquire the power of observation ii. to develop the ability to related observation by illustration iii. to develop the ability to recognize general characteristics of plants and animals iv. to be able to interpret and illustrate knowledge of Biology principles and to develop the ability to perform simple experiments and make inference from the result established. Ghartey-Ampiah, Tufuor and Gadzekpo (2004) also said that WAEC emphasises the acquisition of practical skill in Biology as : i. acquisition of adequate laboratory and field skills in order to carry out and evaluate experiments and projects in Biology ii. acquisition of the necessary scientific skills for example, observing, classifying and interpreting biological data. Because of these, the score or mark allotted to the practical examination paper in Biology in the WAEC in Nigeria is higher than those of objective test (multiple choice) and the essay papers.

Ehikhamenor and Emeke (2015) when reporting the WAEC Chief Examiner's reports of 1990, 1992, 1995, 2002, 2005 and 2011said emphasis was laid on the inability of students to answer practical questions especially questions drawn from skeletal system correctly. The report stated that students generally demonstrated the following inadequacy in answering practical questions; i. not drawing to proportion ii. inability to draw relationship between parts iii. inability to state magnification iv. students' dependence on rote memory rather than understanding biological concepts to reason out solutions. All these inadequacies and more had made many students to fail Biology in WAEC examination. Thus, the implication is that a failure in practical Biology may imply a failure in the subject. Omilani and Udofia (2015) reported that frequent practical is the only means of assuring quality in Science Education. They stated further that students' non willingness to study Chemistry at higher degree level has been traced to their poor performance in Chemistry practical, and that practical works help students construct a meaningful concept from the laboratory experience which is useful either for further scientific study or everyday life.

However, the challenges associated with the numerous practicals involved in Biology, the problem of large volume of contents in Biology courses, the need to constantly organise practical sections and how to get enough facilities and equipment to be used in every Biology practical lesson, bearing in mind the large population of students usually involved, among many other factors identified by researchers have led to poor performances of undergraduates in Biology practical courses. For example results of a foundational Biology practical course (Introductory Biology Practical) for Biology Education students in sampled South-Western Universities in Nigeria presented in Table 1.1 revealed a poor performance of students in Biology practical.

Table 1.1: Biology Education Students' Scores in Introductory Biology Practical Course, in three SouthWestern State Universities in Nigeria between 2008 and 2015

Session	UNIVERSITY A							UNIVERSITY B							UNIVERSITY C						
	A-C		D-E		F		TOTAL	A-C		D-E		F		TOTAL	A-C		D-E		F		TOTAL
	NO.	%	NO.	%	NO	%		NO.	%	NO.	%	NO.	%		NO.	%	NO.	%	NO.	%	
2008/2009	8	17.0	10	21.3	29	61.7	47	50	98.0	0	0	1	2.0	51	4	12.5	22	68.7	6	18.8	32
2009/2010	9	23.0	11	28.0	19	49.0	39	8	25.0	21	66.0	3	9.0	32	4	50.0	4	50.0	0	0	8
2010/2011	10	16.0	31	48.0	23	36.0	64	15	48.0	16	52.0	0	0	31	1	4.8	2	9.5	18	85.7	21
2011/2012	3	7.0	26	62.0	13	31.0	42	13	52.0	9	36.0	3	12	25	0	0	2	14.3	12	85.7	14
2012/2013	7	50.0	6	43.0	1	7.0	14	10	38.0	14	54.0	2	8.0	26	-	-	-	-	-	-	-
2013/2014	-	-	-	-	-	-	-	14	33.0	25	60	3	7.0	42	18	37.5	26	54.2	4	8.3	48
2014/2015	0	0	8	42.0	11	58.0	19	21	45.0	10	23.0	15	32.0	46	0	0	4	50	4	50	8

Source: Field work (2016) **NB**: A-C=50% and above, D- E=49-40% and F= 0-39%

Note: Names of universities in Appendix XIII

Table 1.1 revealed that the performance of students in this practical course is generally weak. Over 50% of the students scored between the grades D and F in all the years except for the year 2008/2009, when only 2% had weak scores in University B but in that same session 83% and 87.5% of the students had weak scores in Universities A and C respectively. Also, in the year 2012/2013 where the students that had weak scores were 50% in University A, 62% did not do well in the course at University B. It appears therefore that for over seven years now the performance of students in the foundational Biology practical course offered at 100level has been very poor in sampled Nigerian State Universities. This calls for a concern and the need to find what could have been responsible for these poor Biology practical skills that resulted in poor performance in Biology. Authors and researchers have identified some factors that are responsible for the poor performance in Biology and other related sciences. These factors may cut across all levels of education where Biology is offered because Biology generally contains large volumes. The identified factors include, textbook and laboratory based reasons (Ivowi, 2000), misconceptions of concepts identified (Olagunju and Abiona, 2004; D'Avanzo, 2008), large class size (Olagunju, 2005), inadequacy of teaching material/ resources, laboratory equipment /reagents / chemical, and laboratory space (Olagunju and Abiona 2004; Aremu and Sangodoyin 2010) and insufficient practical skills (Danmole, 2012).

The conventional teacher-centred approach for teaching practical aspects of Biology could also be a factor that has contributed to poor performance of students in Biology. Whenever students are not involved in hands-on activities with equipment during practical sessions, they are likely to retain very little of what is taught and this has implication for understanding of the concepts (Danmole, 2012). Facilities/resources available in sampled Biology laboratories in Nigerian State Universities presented in Table 1.2 equally revealed that there are insufficient equipment for Biology practical that can go round all the students on roll. This may be responsible for poor practical skills and eventually poor performance in Biology.

Table 1.2: Quantity of Facilities Available in Three Biology Laboratories from Three Southwestern State Universities in Nigeria

Equipment/Facility/Resources	Quantity (Number)			Remark
	UNI. A	UNI. B	UNI. C	
Laboratory	1	1	1	Inadequate
Carrying capacity of laboratory	52	52	52	-
Number of students on roll	1344	850	1410	-
Number of students that uses the laboratory at a time	96	85	94	Inadequate
Number of lecturers taking part in general Biology practical course	2	1	2	Inadequate
Number of technologists taking part in general Biology practical course	2	2	2	Inadequate
Number of microscopes available for general Biology practical	6	10	6	Inadequate
Glass wares available: Petri dishes	52	42	50	Inadequate
Glass slide,	50	46	44	Inadequate
Cover slips	47	30	49	Inadequate
Beaker	60	15	70	Inadequate
Conical flask	39	40	44	Inadequate
Test tube	223	250	48	Inadequate
Measuring cylinder	19	20	22	Inadequate
Round bottom flask	15	21	17	Inadequate
Water tap and sewage Sinks	8	8	8	Inadequate
Number of ovens available	2	1	1	Inadequate
Number of Bunsen burner available	5	4	8	Inadequate
Number of gas cylinder available	2	3	1	Adequate
Number of hot plates available	3	3	4	Inadequate
Number of stools available	75	60	72	Inadequate
Number of working tables	4	4	4	Inadequate

Source: Field work (2016). Note: Names of Universities in Appendix XIII

The use of Biology laboratories for practical in sampled universities in the South-West Nigeria appears not to be at the optimum level. In few of the Universities, students' practical sessions could not regularly hold not only because there are insufficient spaces but also due to unavailability of appropriate equipment needed for the practical (Table 1.2). In situations where practical class holds there are usually non completions of the required contents (Field work, 2016). The reports obtained from a baseline study (Table 1.2 and 1.3) showed that due to too many students that are required to use the limited facilities in Biology laboratories for Biology practical that is meant for one hour per week, there are usually insufficient time and insufficient practical materials to go round all the students on roll. These challenges of very voluminous subject area, insufficient time to complete the required content, lack of enough facilities to enhance good mastery of practical works and insufficient opportunity for students to have a hands-on experience during practical could be eliminated using the help of more proven strategy of educational technology for effective instruction that is based on modern technology to support the instructional process, this meshes well with the suggestions of Ajitoni, (2005); Olagunju, (2005); Abiona, (2008) and Adedoja, (2016)

According to a baseline field survey in respect of this study that involved universities randomly selected from three States in the South-West geo-political zone of Nigeria (Table 1.3), sampled Biology lecturers and students (68.0% and 90.1% respectively) are of the opinion that biological courses in their Universities are usually very voluminous and with several practical aspects. How to complete these large volumes and exercise the practical involved has constituted a problem for both lecturers and students. In the sampled universities, the spaces available for instruction and practical in Biology are very small when compared with the number of students that are required to use the available space/facility; this has led to the incompletion of some Biology courses contents in many of these Universities. (Table 1.2 and 1.3)

Table 1.3: Percentage Distributions of Lecturers, Technologist and Students Responses to Biology Instruction and Practice from three States Universities in the South-West Nigeria

s/n	Statements	Lecturer and Technologist Responses				Students Responses			
		Agree		**Disagree**		**Agree**		**Disagree**	
		No	%	No.	%	No	%	No	%
1	Biology courses are usually voluminous	17	68.0	8	32.0	82	90.1	9	9.9
2	Biology lecturers always complete the course content before examination	11	44.0	14	56.0	44	48.3	47	51.7
3	Biology students have enough time to do tutorials and group revision before examination	9	36.0	16	64.0	44	48.3	47	51.7
4	Students usually read up biology course content because of the inability to complete the content	6	24.0	19	76.0	77	84.6	14	15.4
5	Biology involves a lot of practical work	24	96.0	1	4.0	87	95.6	4	4.4
6	Biology practical is frequently done in schools	17	68.0	8	32.0	37	40.7	54	59.3
7	Insufficient practical equipment is a reason why Biology practical class is not frequent	18	72.0	7	28.0	64	70.3	27	29.7
8	Unavailability of sufficient laboratory space is a reason why Biology practical is not frequent	16	64.0	9	36.0	75	82.4	16	17.6
9	Skills gained in Biology practical help students in their examination performance	24	96.0	1	4.0	87	95.6	4	4.4
10	Students usually have a hand-on experience whenever there is practical lesson in Biology	17	68.0	8	32.0	78	85.7	13	14.3

Source: Field work (2016)

Due to insufficient practical learning resources in schools, the instructions that are required to be practical based in Biology, appears to have become merely theoretical especially for the pre-degree students. Reports from several authors on preliminary students (pre-degree) have revealed that they are grossly unattended to, especially with respect to their practical works, and so much is expected from them when they eventually gain admission into the main stream of the university. Tenibiaje (2009) described the pre-degree programme as the one that is provided for candidates that are deficient in entry qualification for degree programme in the university. The programme provides remedial courses for candidates who have 5 credit passes and have not been admitted into the university. To salvage this deficiency there is the need for a more proven effective instructional strategy that would not only involve the students largely in their learning process but also empower them, arouse their interest and also play a major role in improving their interaction among themselves and with their teacher. This is the reason this study is being embarked upon. The conventional model of classroom instruction involves the teacher as the central focus of a classroom setting and lesson. Most often, the teacher is the primary disseminator of information, the answerer of questions, and the controller of behaviour. Students depend directly on the teacher for guidance, instruction and feedback. In a classroom that operates within a radically conventional style of instruction, lessons are teacher-centred and discipline oriented (Okoye, 2010). These deficiencies of the teaching and learning situations in many Nigerian schools have called for more alternatives and era4A4aeffective approaches that will provide an environment for growth and development (Ajitoni, 2005; Olagunju, 2005; Abiona, 2008; Adedoja, 2016).

Earlier studies have attempted to solve this problem but they largely focused on effective strategies of teaching practical Biology. These studies were found inadequate for large class size as typical of practical Biology. For example Olutola *et. al.* (2016) while quoting the WAEC Chief examiners report of November/ December 2004 said that students' percentage failure rate in Biology is higher than other science subjects. This failure rate is attributed to the poor practical skill of students in Biology, because many students do not have opportunity to have a hand-on experience during Biology practical and this deficiency has reflected in their performance. Similarly, Danmole (2012) explained that Biology practical work is supposed to make students have experiences such as observing, counting, measuring, experimentation, recording, carrying out field work etc and that when the population is high students should be divided into groups to work. However, this group work strategy may not be able to salvage the problem of insufficient resources needed for effective practical sessions.

New technologies are invented everyday and they have tremendous effect on every aspect of the society, Aremu, Olaosebikan, Fakolujo and Oluleye, (2013) and Aremu and Obideyi, (2014) reported that Higher education students are already active learners, using e-books, Web content and social media to explore and discover in their daily lives. Also, that the acceptance and usability of modern technology for classroom instructions by students is high. However, AbdulRahaman (2014) as well as Akingbemisilu (2014) observed that the effect of these technologies has not been noticeable in the teaching-learning process in Nigeria. Tom (2012) posited that students sometimes experience the curiosity-stifling thud of having to listen to and take notes on a lecture, with its mostly one-way communication format coupled with limited opportunities for questions and answers during the class session and no ability to review the lecture content later in order to study a difficult concept. It is no wonder students may become discouraged and disengaged in many conventional methods of instruction. Students increasingly expect a classroom experience that helps them develop knowledge for themselves, not just passively receiving one-dimensional information. Students want to do something meaningful with content instead of just listening to a lecture. They also expect to meet with discussion groups and project teams and do much of their assigned work during class time instead of meeting separately (Tom, 2012).

In the study of Adedoja, (2016) the report showed that flipped classroom actually allowed pre-service teachers at the University of Ibadan to study at their own paces, it created an avenue for them to acquire relevant and specific support and gave opportunity for deep interaction not only with the learning contents but also with colleagues and the teacher.

Meanwhile, there are several technology-driven strategies that have surfaced recently. These, according to Gladys and Cheta, (2015) and Akingbemisilu, (2016), include web questing, podcast, flipped classroom, cloud computing, mobile learning, assistive technology among others. The effects of these recent technology driven strategies on instruction has been considered significant. However, each of these technologies has peculiar characteristics that make them unique. Web quest helps to harness social networking for business goals. Its podcast, which is any series of audio files that can be downloaded from the Internet, often released on some regular schedule, is particularly useful for lessons that centre on listening skills such as in language, storytelling and pronunciations as well as for the visually impaired learners. Another technology is the Cloud computing that is useful for ICT lessons which help users to store information that are vital to them on a secured world wide web that can be retrieved easily. This encompasses a number of different services: one set of services, sometimes called software as a service (SaaS), involves the supply of a discrete application to outside users. The application can be geared either to business users (such as an accounting application) or to consumers (such as an application for storing and sharing personal photographs). Another set of services, variously called utility computing, grid computing, and hardware as a service (HaaS), involves the provision of computer processing and data storage to outside users, who are able to run their own applications and store their own data on the remote system. A third set of services, sometimes called platform as a service (PaaS), involves the supply of remote computing capacity along with a set of software-development tools for use by outside software programmers.

As noted earlier, cloud computing helps users to store important information on a secured world wide web which could be retrieved easily. Sclater (2010) noted some benefits of cloud computing to education. They are as follows:

1. The primary advantage for many institutions is economic. This is particularly clear where services such as email are offered for free by external providers.
2. It allows institutions to begin with small-scale services and builds them up gradually without significant up-front investment.
3. Availability may be higher with less downtime due to the superior resources and skills available to cloud providers.
4. It enables educational institutions to reduce their own electricity consumption.
5. It allows institutions to concentrate on their core business of education and research.

Mobile learning is unique for distant education where lesson contents can be accessed on the mobile platform, it has become major resource for teaching and learning in higher education (Adedoja, Egbokhare, and Oluleye, 2013). Mobile learning is well suited for theoretical concepts and it serves mainly as support tool for learning (Adedoja, Omotunde and Adelore, 2010). According to Bilquis and Jamal

(2015) the integration of emerging mobile technology is now inevitable in every sphere of life. Bilquis *et al.* (2015) identified the roles of mobile technology in education to include; enhance mobility and accessibility, personalised learning, collaborative learning, situated learning and communication. Mobile technology has multiple capabilities to support different instructional strategies and provide an efficient way of delivering course materials. Assistive technology has to do with the use of educational technologies for the physically challenged thereby enhancing their rate of comprehension of what the teacher teaches.

Of these strategies, the flipped classroom strategy has been found to be particularly useful for lessons that are practical based which do not always have the materials needed readily available, and also with a large number of students to cater for (Mike, 2012). Flipped learning is also suitable for courses that are voluminous such as Biology: whose content is usually difficult to complete during regular classroom periods, as well as for concepts that have more of practical work and that involve students' hands-on experience on equipment. The flipped strategy, also known as 'flip teaching', the 'inverted classroom', or 'reverse instruction' is a pedagogical model in which educational technology is used to leverage the learning in a classroom, so that a teacher can spend more time interacting with students instead of lecturing (Bergmann and Sams, 2012). The typical lecture and homework elements of a course are reversed or inverted. The home aspect of the work now constitutes the major instructional part usually without the life teacher but with any media that would enhance the instructional process, while the contact class aspect is more of collaboration and assistance to complete given assignment. Short video lectures (usually used for flip) are viewed by students at home before the class session, while in-class time is devoted to exercise, projects or discussions. The video is often seen as the key ingredient in the flipped approach, with such lectures being either created by the instructor and posted online or selected from an online repository. Flipped classroom is designed to help students participate in their learning process. It emphasizes the need to provide students with facilities to work with as well as opportunities to think about and work on problems in a collaborative manner. This allows teachers to move from a role as "professor of knowledge in the classroom" to that of coach or mentor (Berrett, 2012).

Flipped strategy for instruction arose to solve the many needs of educators such as limited instruction time and need to cover more contents faster, need to constantly and regularly repeat practical centred lesson over and over again, attempt to make information and learning more relevant, useful, and meaningful; giving students an appreciation for the power of common concepts and cross contextual applications, and the adoption of multiple perspectives when solving problems. It would also solve the problem of the need to constantly set up the laboratory for practical sessions (Lage, Platt and Treglia, 2000; Bergmann and Sams, 2012; Mike, 2012).

Key benefits of the flipped classroom as indicated by some authors include:

1. increased classroom time to present content, discuss complex topics and work with students - either individually or in small groups (Mike, 2012).
2. students are more willing to ask questions in class (Lage *et al*., 2000).
3. the use of technology integrates the digital language of today's students (Bergmann and Sams, 2012)
4. reduced time spent answering basic and repetitive questions- due to students' ability to review lectures online. (Mike, 2012).
5. the ability to use recorded lectures in multiple course sections- year over year, with easy tools for updating content; and
6. quick adaptation of lecture content to respond to new learning needs (Mike, 2012).

The flipped classroom is a blended teaching-learning approach. Flipped strategy has been found to be effective in many institutions around the world for example in the North Arkansas College, 90 courses are already recorded and flipped. The highly demanded classrooms are now easier to schedule which in turn enhance the performance of students in these courses (Tom, 2012). Pace University, New York maintained that lecture captured on technology has made them competitive in that, it is important in their distance learning courses which attract students from all over the world (Mike, 2012). The situation is not different in the nursing and pharmacy schools of St. John Fisher College, New York, where extensive use of lecture recordings are done to help students understand complex course contents (Mike, 2012). Jerry (2013) reported that the adoption of Flipped Classroom Model for the teaching of College algebra has positive effects on students' achievement a situation that has provided valuable insight into the best practices of technology in Mathematics Education.

Upon applying an "inverted" model of learning or flipped classroom model, in an electrical engineering class, Jason (2012) saw that students progressed through materials faster, students understood topics in greater depth, and additional content could be covered without sacrificing the quality of the course as a whole. Additionally, it was found that 75% of students frequently or always help other students in the class. In terms of students' performance, test scores exceeded those in the conventional learning environment. At California State University, Los Angele, Alvarez (2011) reported that in 2008 freshman and sophomore Introduction to Digital Engineering course was flipped in order to increase opportunities for collaborative project-based learning. The shift was intended to address what was perceived to be the limited professor-student interaction and the prevalence of passive learning in engineering classroom. In a post-course analysis, flipping the classroom seemed to be effective in helping students understand course material and develop design skills. Flipped classroom experience makes optimal use of instructor and student time, provides increased access to the instructor's expertise and enables better scalability of instructional resources to support high-enrolment demands.

While flipping the classroom, several media such as print, visual, audio-visual, animation, video or audio could be used for the flipped classroom based on the subject involved. For a course like Biology that involves a lot of practical work, video and animation media are considered suitable to flip the class (Tom, 2012) because it gives the learner the ample opportunity of seeing the procedure of the practical. Pre-recorded video sessions by the teacher or a free available video online in the area of the content could be used for instruction. Video lesson in Biology makes the most challenging topics easy to understand and enjoyable to learn. Animation package is particularly useful for flipping concepts that are centred on practical, and with drills or exercises; it often comes with a sense of humour and it usually virtually-based or participatory i.e. it often involves the user to progress in its use. Aremu *et al.*, (2010) reported that animation package usually comes with the immediate knowledge of result and this helps to motivate its user as he/she uses the package. Therefore in this study, video and animation would be used in a flip learning classroom to teach the selected Biology concepts.

The concepts of Biology selected for this study are Animal nutrition, (Food: classes and test). Food as a main topic in Pre-degree Biology is selected because it is practical centred, and so requires more time to teach for good understanding. It could be more difficult to present the concept within the conventional period of teaching. The peculiar colour change that characterises each food test cannot be obtained in a mere theoretical class. Food test is particularly chosen because there are many experiments to carry out and these may serve as sample for other practical based area of Biology. Thus, the need to use a flipped approach of pre-recorded video instructions, animation based instruction where the experiments are performed and then to be followed by a face-to-face collaborative classroom sessions.

The justification for choosing flipped classroom for the identified concept is as supported by Bergmann and Sams (2012) where they said that as the classroom has modernized particularly within the last decade and with the rise of educational technologies, for some teachers frustration has risen as content delivery in lesson is not always translated into meaningful knowledge at home. Strayer (2012) opined that apart from the fact that the flipped model video as obtained in the selected concept can be used to enhance examination preparation, it could also arouse the interest of students towards learning. Sadaghiani (2012) equally said the multi modal learning of flipped classroom comprising animations and video always enhance retention. These are some of the reasons why the concept selected requires a flipped approach. There will also be the need for personal re-tutoring in the concepts selected, thus flipped strategy provides such. Koller (2011) said that flipping provides a personalised experience similar to individual tutoring.

While considering using flip classroom strategy for Biology courses so many variables may interfere with the communication process but gender and computer self efficacy are considered so critical to this study because previous studies have established that gender is a very important variable to be considered while researching on ICT based instructional strategies; as females are erroneously believed to have phobia for ICT gadget. Similarly, the level of students self confidence to use the ICT gadget for learning may impede their learning. So gender and computer self efficacy are moderated in this study.

Gender is a variable whose influence on students' learning outcomes has been vigorously examined by researchers. Divergent reports abound from fields of research on gender issue. Efuwape and Aremu (2013) concluded that there is no disparity in the use and acceptability of technology and science based equipment on gender. Studies have shown significant difference in favour of boys (Bilesanmi-Awoderu, 2002; Aremu and John, 2005; Abiona, 2008; Ojo, 2009): sometimes in favour of girls (Olatundun, 2008) and sometimes have shown no significant difference between boys and girls in relation to their achievement in and attitude to different science subjects (Raimi and Adeoye, 2002; Owoyemi, 2007; Okoye, 2010). The findings of Ajitoni (2005); Bolorunduro (2005) revealed that there were significant differences between female and male students in terms of attitude in favour of the female. Aremu and John (2005) in their study have stated that the search for strategies to bridge the gap in the achievement of males and females is an ongoing one. Gender as a moderating variable therefore attracts further investigation in this study because of the conflicting nature of results (above) as revealed from researches that focused on gender and science subjects. The need arises therefore for further studies to consider this moderating variable in an attempt to build a body of more consistent evidence on the influence of this important factor on achievement of students in and their attitude to Biology. This study is interested in the influence of gender on the learning outcomes in Biology selected concepts with the belief that more studies on this learner characteristic can bring about to some degree, a resolution of the conflicting nature of the subject and a discovery of strategies that can bridge the gap between achievement and attitudes of male and female students in Biology.

Computer self efficacy recently has been proposed as important to the study of individual behaviour toward information technology. The level of computer literacy and mastery of an individual may affect his/her disposition toward the use of computer or information technology gadget for his/her instruction. Aremu and Fasan (2011) while investigating the use of technology in Nigerian Secondary Schools discovered that most teachers are confident that they can use computer, implying that they have at least a moderate computer self efficacy level. In the study of Wallace reported by Laursen (2010) four main factors that influenced the development of computer self-efficacy were investigated and described as: computer anxiety, computer confidence, computer liking and computer knowledge. Wallace reported that there is a significant correlation between the computer self-efficacy model (composed of the four mentioned factors) and a 3-item measure of computer self-efficacy; comparisons were made between the computer self-efficacy of education and computing students. Toppo (2011) reported that computing students expressed low levels of computer anxiety, and higher levels of computer knowledge, computer liking, and computer confidence in comparison with education students. This implies that the level of computer literacy of a student may influence his disposition, interest and performance in a course work that is solely reliant on the use of computer.

So, based on the need to complete Biology courses and also to involve all students in the practical lessons in order to have a hands-on experience(practical skills), to improve the performance of the students and to enhance a positive attitude towards Biology. As the poor science skill acquisition by students is not in accordance with the aims and objectives of education in Nigeria.

The aims and objectives of education in Nigeria states that ‘education should aim at helping the child to acquire appropriate skills, abilities and competencies, both mental and physical as equipment for the individual to live in and contribute to the development of his society’’ (Section 1 (7): 3; FME 2014), the present study deployed a designed Biology instruction on video and animation formats using the flipped strategy of instruction to determine their effects on the achievement of pre-degree students in practical Biology.

Whatever divide the argument goes, we need to find whether the flipped strategy would consolidate previous studies to enhance achievement in Biology and improve students' practical skills or would debunk the previous claims that ICT based strategies cannot enhance instruction. The aim of this study was to determine whether the flipped strategy using animation and video packages would be able to influence students' achievement significantly thereby leading to remedying the problem of poor practical skills of students which often leads to their poor performance in Biology.

1.2 Statement of the Problem

Biology is a course that almost all the Science undergraduates offer; it prepares the future scientists not only for the laboratory experience but also for industrial and educational sectors where practical skills learnt during lessons would be used. Despite the emerging trend in technology-assisted learning, researcher observed that not so much has been done to ameliorate the problems of large number of students offering Biology courses in higher education in Nigeria with emphasis on the teaching and learning of practical Biology. In recent years, the use of technology for lesson delivery has always been to compliment what a conventional teacher would teach; technology has also been used to enhance student's personal learning by enquiry. Few scholars and agencies have also tried to get a solution to the problem of the large volume of content in Biology courses by introducing electronic contents and making it available to the students on various electronic media. These efforts revealed that the inability to complete course contents in Biology is really a critical problem in many Nigerian universities thereby leading to poor performance. Insufficient laboratory space, equipment and apparatus needed for numerous Biology practical lessons have also been traced by researchers to be factors responsible for low practical skills in students which in turn also lead to poor performance.

There is therefore the need to explore more effective strategies that will be learner- centered and activity based. This will enable the theoretical contents as well as the practical work involved to be covered in record time no matter the number of students on roll and also to provide opportunity for students to see how practical work is being done as well as to acquire the necessary practical skills. The effect of a technology based strategy: flipped strategy, using animation packages and video on Nigeria State Universities Pre-degree students Biology achievement, practical skills and attitude to Biology was determined in this study.

1.3 Hypotheses

The study tested the following null hypotheses at 0.05 level of significance

H_O1: There is no significant main effect of treatment (instructional strategy) on students'

(a) achievement in practical Biology
(b) practical skill in Biology
(c) attitude to Biology

H_O2: There is no significant main effect of gender (male and female) on students'

(a) achievement in practical Biology
(b) practical skill in Biology
(c) attitude to Biology

H_O3: There is no significant main effect of level of computer self efficacy on students'

(a) achievement in practical Biology
(b) practical skill in Biology
(c) attitude to Biology

H_O4: There is no significant interaction effects of treatment (instructional strategy) and gender on students'

(a) achievement in practical Biology
(b) practical skill in Biology
(c) attitude to Biology

H_O5: There is no significant interaction effects of treatment (Instructional strategy) and level of computer self efficacy on students'

(a) achievement in practical Biology

(b) practical skill in Biology

(c) attitude to Biology

H_O6: There is no significant interaction effects of gender and level of computer self efficacy on students'

(a) achievement in practical Biology

(b) practical skill in Biology

(c) attitude to Biology

H_O7: There is no significant interaction effects of treatment (instructional strategy), gender and level of computer self efficacy on students'

(a) achievement in practical Biology

(b) practical skill in Biology

(c) attitude to Biology

1.4 Scope of the Study

The study determined the main and interactive effects of flipped classroom instructional strategy using (animation and video media) and conventional strategy on the learning outcomes (achievement, practical skills and attitude) of pre-degree students in Biology. The main and interactive effect of gender and computer self efficacy on the learning outcomes of participants in Biology were determined. The study covered State Universities in the South-West geopolitical zone of Nigeria. Animal nutrition, food classes and food test which are Biology concepts that centre on practical sessions were selected from the pre-degree curriculum.

1.5 Significance of the Study

Findings from this study has provided evidence that could be used to encourage as well as support Biology lecturers in Universities to practice flipped classroom, thereby, spurring them to get actively involved in continuous improvement of classroom teaching and students' achievement. The information from this study formed a basis for pedagogical reorientation of University dons especially in relation to courses presumed to be difficult to teach as a result of its large volume contents and practical works involved. Furthermore, results from this study has exposed the need for the inclusion of flipped strategy into the curriculum of teacher preparation at Nigerian Colleges of Education (NCE programme) and Faculties of Education in Nigerian

Universities (B.Sc. Ed./ B.Ed. programme). The findings from this study, served as a motivating factor for teacher educators to be Information and Communication Technology (ICT) compliant in order to serve as role models to their students and mentees. Findings from this study also provided evidence to Science students to use ICT form of learning in their source for knowledge.

1.6 Operational Definition of Terms

The following terms are operationally defined as used in the study:

Achievement in Biology: This refers to the pretest and posttest scores obtained from Biology Practical Achievement Test (BPAT)

Flipped Classroom: A device through which course contents/materials are viewed/accessed in a form of video/animation before the contact class by the students and the assignment and activities are done collaboratively in the contact classroom.

Flipped Strategy: An instructional plan that provides the learners with the content of the lesson before the face-to-face lesson where instruction is merely guided by the teacher but largely dependent on interaction among learners.

Flipped Biology Education: An instructional plan in pre-degree Biology that provide the learners with the learning contents ahead of the contact lesson where instruction is only guided by the teacher.

Practical Skills in Biology: This refers to the laboratory practical activities performed by the students and eventual scores from the pretest and posttest scores obtained from the Biology Practical Skills Rating Scale (BPSRS)

Student Attitude: This refers to the disposition and willingness that a student has towards Biology as a subject/course as determined by pretest and posttest scores in Student Attitude to Biology Questionnaire (SABQ)

Student Computer Self Efficacy: This is the student's judgement of his or her computer capabilities

Learning Outcomes: These are the achievements and practical skill and, attitude of students scores in Biology. These are measured by Biology Practical Achievement Test, Biology Practical Skills Rating Scale and Students Attitude to Biology Questionnaire respectively.

Animation-Based Instruction: Teaching-learning activities practised using the researchers designed animation package

Video-Based Instruction: Teaching-learning activities practised using the researcher's pre- recorded video package

Conventional classroom: This refers to the chalk and talk method of instruction where the teacher is the controller of the entire activities in the class. The teacher is responsible for dissemination of learning experience (contents) in the entire lesson.

Podcast – Any series of audio files that can be downloaded from the Internet, often released on some regular schedule. Podcasts are named after Apple Computer, Inc.'s iPod portable audio players, though most podcasts are in a format that can be played on virtually any computer or smart phone.

Podcasting refers to teachers making and posting online audios.

Smartphone – A cellular phone offering advanced capabilities, such as a PC-like operating system and Internet access.

Pre-degree Students: Undergraduates that are at the pre-degree level in Nigerian State University

CHAPTER TWO

LITERATURE REVIEW

Relevant literatures for this study were reviewed under the following sub-headings:

2.1 Theoretical Framework

Several theories underpin the use of flipped strategies for instruction. These theories have significant implication for science concepts teaching and science learning. Specifically for this study, the constructivist social learning theory propounded by Kolb and Vygotsky are relevant. Constructivism is a recent approach in education which poised that learners are better able to understand the information they have constructed by themselves. Kolb's experiential learning theory is typically represented by a four-stage learning cycle in which the learner touches all the bases: Concrete Experience (having an experience), Reflective Observation (reflecting on the experience), Abstract Conceptualisation (learning from the experience) and Active Experimentation (trying out what you have learned). The zone of proximal development theory has been defined as:

> *"the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peer" Vygotsky 1978, p 86*

Constructivism argues that the use of interactive activities in which learners play active roles can engage and motivate learning more effectively than activities where learners are passive and rely more on their hearing faculties than their limbs. The flipped model and animation package support the tenets of constructivism by freeing class time for inquiry-based learning (Brandt, 1997). In the constructivist theory, the learners are considered to be central in the learning process.

According to Daniel and Canjander (2010), constructive controversy is on the basis that discussions and controversies may create a good starting point in an attempt to understand a complex problem. Students will improve their skills to constructively and by innovation, think and find solutions to complex problems. When one person's ideas, information, conclusions, theories, or opinions are incompatible with those of another and the two seek to reach an agreement (Smith, 2013). This is the ultimate goal of the constructive controversy theory. Constructivist or inquiry-based learning is the philosophy that learning is the formation of abstract concepts in the mind to represent reality (Bruner, 1996). The flipped model supported by the constructivist theory should enable learners to engage in interactive, creative, and collaborative activities during knowledge construction (Kim and Bonk, 2006).Constructivist transform today's classroom into a knowledge-construction site where information is absorbed and knowledge is built by the learner. This they do by helping one another out in the process of knowledge construction. According to Brooks and Brooks (1999), teachers generally behave in an interactive manner, in constructivist classrooms; teacher mediates the environment for students as opposed to behaving in a didactic manner, disseminating information to students. In addition, teachers in constructivist classrooms seek the students' points of view and not to seek the correct answer to validate student learning. In this study, the role of the research assistants were to provide individualized instruction in response to student misunderstandings since the majority of skill attainment was designed to occur outside of contact class time.

The flipped classroom model is poised on peer support while constructing knowledge, members of the class are all actively involved under the leadership and support of the teacher. The teacher here is not a disseminator of knowledge but a guide and coach in the process of knowledge acquisition. Bloom's Taxonomy (Bloom, 1978, p.578) identifies different domains of learning, from the basic retention of facts to the application of knowledge which creates something new. Each domain has different levels; Six of these levels are revealed in fig. 2.1 for example where (Anderson, 1993; 2000) presented a revised version of the Bloom's taxonomy for cognitive learning: "Creating" which is at the base of the pyramid and "Remembering" which is at the pick of the learning pyramid by Blooms are now inverted. Applying revised Bloom's taxonomy to a flipped classroom, students are doing the lower levels of cognitive work (remembering and understanding) outside of class, and focusing on the higher forms of cognitive work (applying, analyzing, evaluating, and creating) in class, where they have the support of their peers and instructor (Brame, 2013).

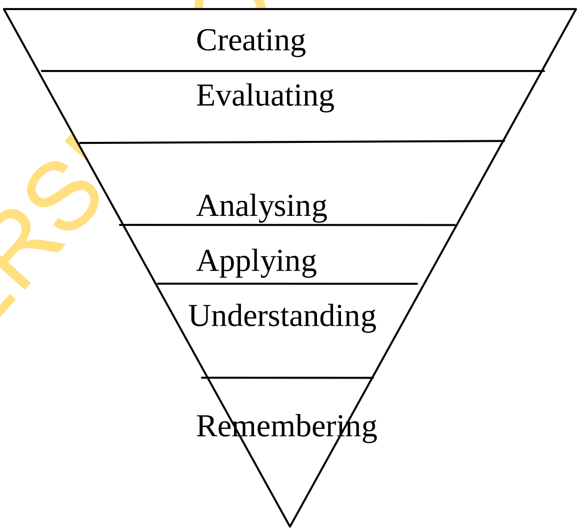


Fig. 2.1. A Revised Version of Bloom's Taxonomy for Cognitive Learning.

In the constructivist theories, the teacher plays the role of facilitator, whose function is to guide, plan, organize and provide direction to the learner (who is accountable for his own learning). The teacher is expected to also support the learner by means of suggestions that arises out of ordinary activities, by challenges that inspire creativity and with projects that allow for independent thinking and new ways of learning information. The constructivist insists that knowledge is produced by the learner (Berrett, 2012; Moyer *et. al.*, 2007; Trowbridge and Bybee, 1996). The Constructivist theories have found more popularity with the advent of personal computer (PC) in classrooms and homes. PC provide individual learner with tools like watch video or play compact disk to build their own learning at their own pace. The flipped class model also meshes well with Vygotsky's theory of zone of proximal development. Vygotsky believed that when a student is at the zone of proximal development for a particular task, providing the appropriate assistance will give the student enough of a "boost" to achieve the task (Vygotsky, 1978). Vygotsky views interaction with peers as an effective way of developing skills and strategies. He suggests that teachers use cooperative learning exercises where less competent learner develop with help from more skilful peers within the zone of proximal development. This matches well with the philosophy of the flipped classroom, where a teacher can utilize freed-up class time for collaborative work and individualized scaffolding of tasks. Phillips (as cited in Milbrandt, 2004) identified three distinct student roles in constructivism: the active learner, the social learner, and the creative learner. The Constructivist theory is interpreted in many ways, but students in control of their own learning are at the heart of the model. The flipped classroom model allows for the dissemination of information outside of class time so our active, social, and creative learners can experience "puzzlement" in a controlled, cooperative setting.

Conceptual Framework

The framework indicates both active and passive students had classroom experience. There is a link between active participation in the class and being able to solve real-world problems. The flipped classroom students (group) are active because they are involved in the learning process, they do not depend on the teacher to supply all the content in the class, because they are active learner, they are able to apply everything learnt both within and without the classroom settings. On the other hand, when the students are passive (i.e. not involved in the learning process) as it is common to the conventional group, it may lead to memorising what the teacher has said which may leads to rote learning. A student who can use what he or she learned to solve the real-world problem may always have a high retention. However, students who always learned by memorizing may have low retention. The end result of high retention is usually good performance while poor performance is usually the end result of low retention.

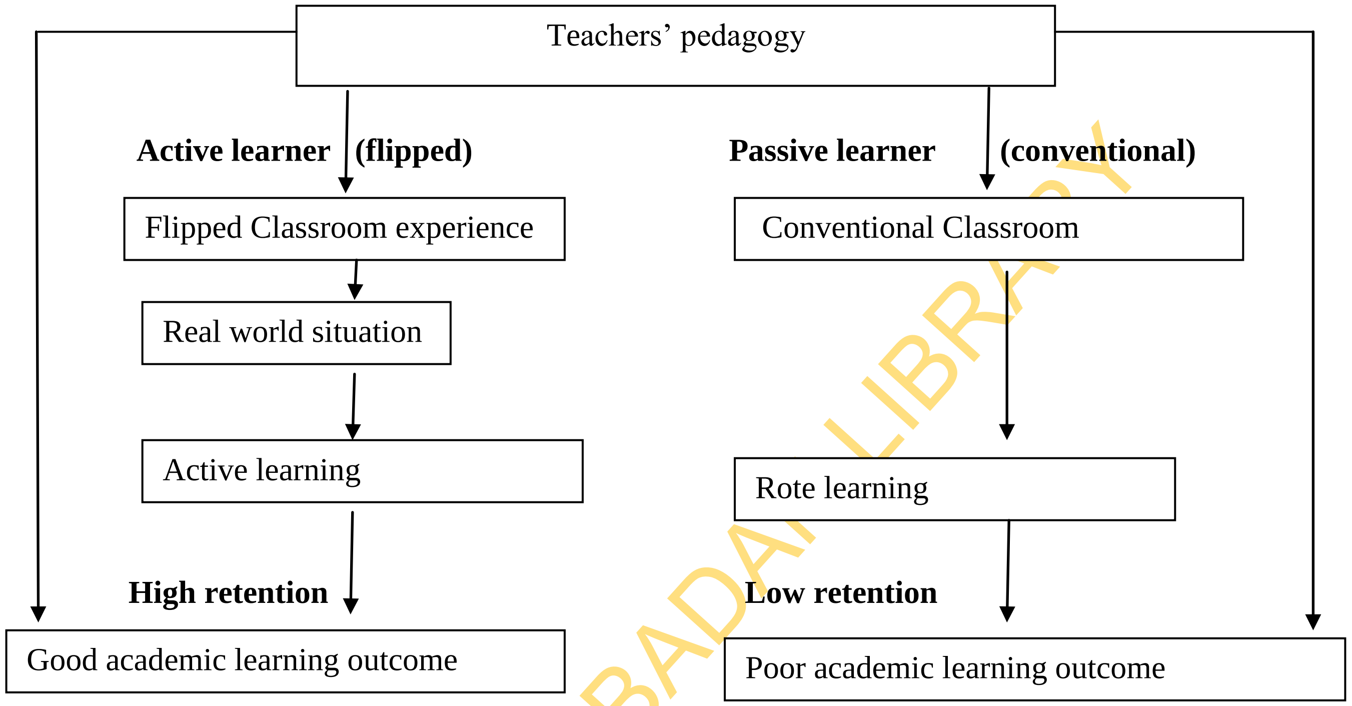
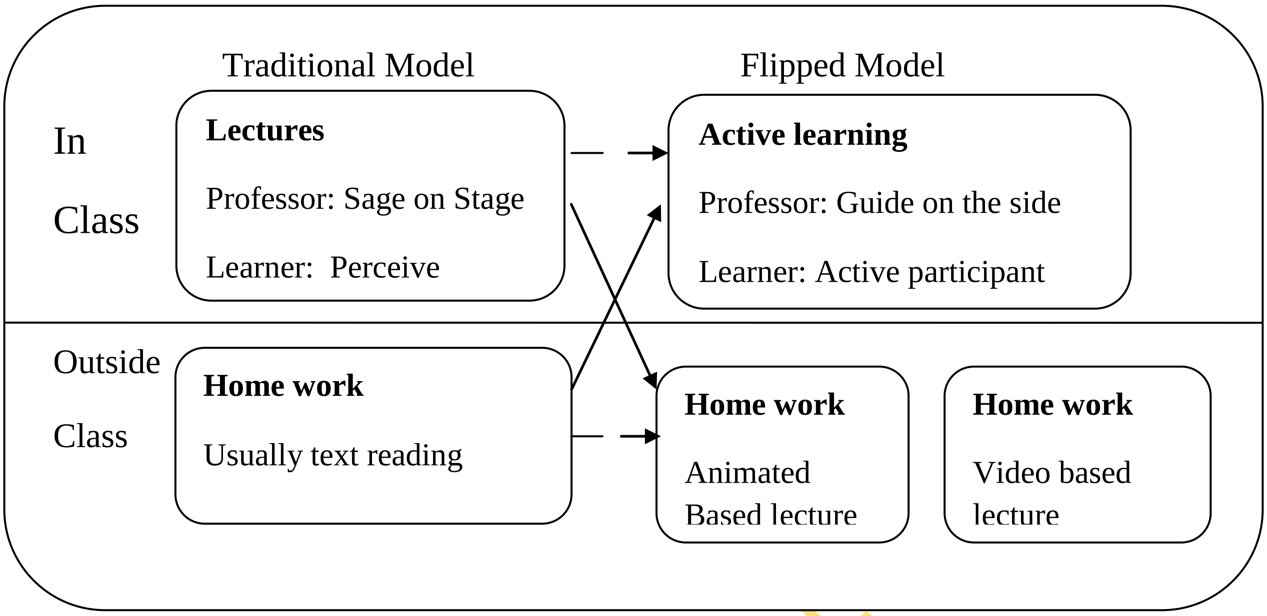


Fig. 2.2 Conceptual Frame Work of Flipped learning (Active) and Conventional Learning (Passive)

The conceptual frame work in Fig. 2.3 gives a detailed explanation of the flipped strategy, it is a method of introducing Active Learning (AL) pedagogy to the undergraduate instruction in Biology this approach is known as class inversion or "flipping," i.e. assigning material as homework that is usually covered in lecture and engaging students in AL during class. This approach to classroom inversion may have different models of class flipping (e.g., Baker, 2000; Lage and Platt, 2000; Sams, 2011), but this study would embrace the use of rewind-able video and engaging animation lectures outside of class, which enables the transformation of classrooms into arenas of inquiry and active learning.



Source: Adapted from David and Michael CLIC Model of 2014

Fig.2.3 Conceptual Framework for Traditional and Flipped Models using Animated and Video Lectures for Biology Instruction

2.2 Conceptual Review

2.2.1 The Subject Biology

Biology is a science subject that derives its name from two main words “Bio” and “logy”. “Bio” means life while “logy” means study, it therefore implies that Biology is the study of life. Ambuno, Egunyomi and Osakwe (2008) defined Biology as the study of living things which concerns their structure, behaviour, distribution, origin and relationship with their environment. Biology is one of the major subjects offered at both the senior secondary school level and at higher institutions in Nigeria. Biology as a subject is of paramount importance to any nation. Being dynamic, Biology is always expanding as new discoveries are made. Olagunju (2007) identified that the Biology curriculum is designed to prepare students to attain:

i. adequate laboratory and field skills in Biology
ii. meaningful and relevant knowledge in Biology
iii. ability to apply acquired scientific knowledge to everyday life in matters of personal and community health, and Agriculture and
iv. reasonable and functional scientific attitudes (FME, 1985)

Biology can be divided broadly into two namely, zoology (study of animals) and botany (study of plants) However, there are over fifteen specific branches of biology (Ambuno *et al.*, 2008). It is a vital science subject in the Nigerian school system. The

National Policy on Education (2014 Edition) revealed that the curriculum at the Senior Secondary School (SSS) level comprise compulsory subjects which are English Language and Mathematics, one major Nigerian language, one vocational subject and a selection of three subjects from the subject area of interest in the Arts and Social Sciences, Sciences, Vocational studies or Technical Education. This indirectly makes Biology a necessary subject for students in the science class at senior secondary school level. A credit pass in Biology is required for admission into Nigerian universities to study science related course such as medicine, pharmacy, agriculture, nursing and biochemistry to mention a few.

The importance of Biology as a science subject in the Nigerian schools as identified by Science Teachers Association of Nigeria (STAN, 2013) includes:

i. Biology helps in the promotion of sexual health by providing learners with opportunities to:
   a. Develop a positive and factual view of sexuality
   b. Acquire the information and skills they need to take care of their sexual health, including preventing HIV/AID
   c. Respect and value themselves and others and
   d. Acquire the skill needed to make healthy decision about their sexual health and behaviour

ii. Biology has duly found application in Medicine, Public Health, Dentistry, Veterinary Medicine, Agriculture, Animal Husbandry, Horticulture, Pest control and other related fields.

iii. Biology helps in the area of production of single cell protein by micro organism and this saves many people from dying of protein deficiency

iv. Biological research and development of new tools and techniques have led to an improvement in the quality of life.

v. Biology proves the fact that when living things die, their substances return to the realm of the non-living things

vi. Biology makes us to learn more about ourselves and the world we live in. It promotes understanding of the relationship of man to his immediate environment.

STAN (2013) also described Biology as a science from which one can learn scientific skills, values, attitude and interest as well as understanding more about other living things. Applied biological research has duly help in:

a. the development of drugs and vaccines for preventing and curing serious diseases.

b. the use of naturally occurring bacteria to clean up oil spills and toxic chemicals

c. reproduction of high-bred crop plants and animals in desirable qualities

d. in vitro fertilization(i.e fertilization of the egg outside the body)helps infertile couples to have children.

A sound theoretical and practical knowledge of Biology is very necessary for the management of our natural resources, provision of good health facilities for the masses, adequate food supply and favourable life environment (STAN,2013). General Biology and practical Biology courses usually connects almost all the science undergraduates together especially at their 100 level in the university; it prepares the future scientists not only for the laboratory experience but also for industrial and educational sector. Nigeria science undergraduates, regardless of their majors, usually take at least a biology course as an undergraduate. These introductory classes often stand as gateways into the sciences by introducing scientific inquiry, the use of evidence, and the core biological concepts that can help students make informed decisions about the complex biology related problems in their daily lives.

Success in all the biological science courses in the university is largely dependent on the practical dexterity and knowledge of the students (Ibe, 2015). Biology, generally considered as one of the most voluminous course in the sciences contains a lot of practical work, which often requires a lot of extra effort for the course content to be completed in the stipulated time, because of this; it appears that not many Biology lecturers/teachers always complete their course content before examinations. Most theoretical aspects of Biology has a practical section involved in it and not only does Biology require a lot of practical work, it equally requires the collection or gathering of specimen and equipment to be used for these numerous practical works. More often than not, there is always the need to draw and label in every Biology practical lessons.

2.2.2 The Concept of Flipped Classroom and History of Flipped Classroom

Flipped classroom is an instructional strategy where the conventional classroom activity and the home work activity are reversed. The flipped classroom label is most often assigned to courses that use activities made up of asynchronous web-based video lectures and closed-ended problems or quizzes. The flipped classroom actually represents an expansion of the curriculum, rather than a mere re-arrangement of activities. Its origin could be traced to 2007, when science teachers Jonathan Bergman and Aaron Sams were looking for a way to provide lectures to their students who missed class due to travel for athletics or other activities, what they created is a new movement in education called the flipped classroom. Articles on the flipped classroom have appeared in USA Today (Dell Cava, 2012), The New York Times (Rosenberg, 2013), The Economist (Flipping the Classroom, 2011), the Washington Post (Strauss, 2012) and on a number of other national dailies. Also, educators and researchers have appeared on so many mass media platforms endorsing the flipped classroom concept. In early 2010, a professional learning network that provides both pedagogical and best-practice discussions as well as pragmatic support on technology and implementation was created for educators interested in the flipped model and in December 2013, the network has over 16,000 members worldwide (Overmyer, 2013).

The flipped model is most commonly being done using teacher created videos that students view outside of class time. It is called the flipped class model because the whole classroom/homework paradigm is "flipped". In simplest terms, what used to be class work (the lecture) is done at home via media such as teacher-created videos, animated lessons etc and what used to be homework (assigned problems) is now done in class (Bergmann and Sams, 2012a). However, the flipped model is much more than the videos. The flipped classroom model encompasses any use of modern technology to leverage the learning in a classroom, allowing the teacher more time interacting with students instead of lecturing.

With the proliferation of Internet technology, virtual communications, and learning management systems, many educators are interested in a flipped classroom (Berrett, 2012). With advances in Internet and communications technology, it is becoming easier for teachers to offer dynamic multi-media educational resources and the capability to support both content and assessment between instructors and learners. Cloud computing and services such as YouTube, Teacher Tube, and Screencast.com make the sharing of video resources increasing accessible for all teachers and students. Technology educators predict that within a few years, tablet PCs, laptop computers or smartphones with wireless Internet will be carried by nearly all students (Levy, 2010). The current method of using online videos to flip learning was developed by Jonathan Bergmann and Aaron Sams in Woodland Park, Colorado in 2007 (Bergmann, 2011).

Bergmann and Sams were looking for a way to provide lectures to their students who missed classes due to travel for athletics or activities. Jon Bergmann recalls: In the spring of 2007 Aaron was thumbing through a technology magazine and showed me an article about some software that would record a PowerPoint slideshow including voice and any annotations, and then it converted the recording into a video file that could be easily distributed online. As we discussed the potential of such software we realized this might be a way for our students who missed class to not miss out on learning. Thus, we began to record our live lessons using screen capture software. We posted our lectures online so our students could access them. When we did this, YouTube was just getting started and the world of online video was just in its infancy. In all honesty, we recorded our lessons out of selfishness. We were spending inordinate amounts of time re-teaching lessons to students who missed class, and the recorded lectures became our first line of defence. (p.1).

Buzz about the Flipped Classroom: There is a considerable amount of buzz in academic circles at all levels that focused around the flipped classroom. These appear mainly as newspaper articles (particularly academically-oriented ones) and online blogs. In addition to news articles and blog posts, there are also complete websites starting to pop up, dedicated to promoting the flipped classroom ideology. The online buzz is not only limited to promotional websites and informational articles. Several organizations are beginning to market materials to help instructors who want to implement the flipped model in their classroom. Flipped classroom is a form of blended learning which means rethinking how class is structured, how time is used, and how limited resources are allocated. Compared to high-access environments, which simply provide devices for every student, blended learning includes an intentional shift to online instructional delivery for a portion of the day in order to boost learning and productivity. Productivity in this sense includes improvements to teacher access of data and its potential to inform instruction. Greater student productivity includes less time wasted on skills already mastered. Increased learning opportunities and improved a student outcome that leads to an enhancement of overall system productivity.

2.3 Empirical Review

2.3.1 Methods of Teaching Biology

Study after study has made it clear that there is an alarming crisis in relation to students' interest in science, either as a possible future career, or as an intrinsic interest that will continue after school" (Fensham, 2008, p. 20). According to Aina and Keith (2015) The performance of students in science subjects in the recent time has not been very good. The concern for every Nigerian is what the causes of this poor performance are. Among the causes of this poor performance is the teachers' method of teaching (Wanbugu, Changeiywo and Ndritu, 2013). Based on this, it is important to review the different type of teaching methods in science education, their disadvantages and the need for a shift of paradigm. The list of countries experiencing declining interest of students in science is on the increase particularly among the developed countries (Fensham, 2008). One factor which has contributed to low interest in science by students is the method adopted for teaching and learning science. Fensham (2008) listed four views of students which contribute directly to low interest in science:

i. Science teaching is predominantly transmissive,

ii. The content of school science has an abstractness that makes it irrelevant,

iii. Learning science is relatively difficult, for both successful and unsuccessful students, and

iv. Hence, it is not surprising that many students in considering the senior secondary years are saying: Why should I continue studying science subjects when there are more interactive, interesting and less difficult ones to study?

This unhealthy development in the disposition of students towards science has sparked the search for and development of alternative methods of science teaching and learning which can stimulate students' interest and guarantee an educational system that offers equal opportunities for all sexes. Science education as a field of study is therefore in dire need of strategies and methods with qualities such as lesson clarity, promotion of self-activity, promotion of self-development, stimulation of interest and curiosity and relying on the psychological process of teaching and learning to recommend to science teachers. The methods should encourage science teaching and learning that is better than it is now.

It is important to note that no particular method is the best method for instruction in Biology; it depends on the content, level of learners, available learning resources and the uniqueness of the teachers. Several methods have been considered by researchers as appropriate for instruction in Biology. These include Practical method, laboratory method, field trip method, demonstration method etc. According to

Stone (2012) one of the primary objectives of the high school course in biology is to develop scientific attitudes in students. The teacher must be informed on the problems of the nature and meaning of science and the methods of science. Experience has demonstrated the necessity for the use of many methods and techniques in the teaching of Biology. Rosenberg (2013) said that one of the primary objectives of the high school course in biology is to develop scientific attitudes in students. The teacher must be informed on the problem of the nature and meaning of science and the methods of science.

Many teachers handling the science subject in most of Nigeria secondary schools and universities specialize in science and not science education (Omosewo, 2009; Ibe, 2015). Therefore, these teachers lacked appropriate instructional methodology for teaching and often used lecture method solely. These categories of teachers need a change of teaching method. The lecture method has been criticized for lack of effective interactive approach and caused poor academic performance in science education (Aina *et.al.*, 2015). The performance of students in science subject in the recent time has not been very good (Erinsho, 2013.). The concern for many Nigerian is what the causes of this poor performance are? Among the causes of this poor performance is the teachers' method of teaching in science. Miles (2015) asserted that it is expected of a teacher to implement a range of instructional strategies that will bring academic success to all the science students. For any method to be able to bring good result in the present age, it should be a method that promotes maximum social interaction. Social interaction among students and between teacher and student plays a crucial role in learning (Nguyen, Williams, and Nguyen, 2014; Aremu, 2015). These authors further stressed the need for the students to be provided with a supportive, open and interactive environment as this could help them discover knowledge.

Lecture method is often used to deliver a large amount of information to the students in a short period (Berry, 2008). According to Gehlen-Bauum and Weinberger (2008), lectures are designed to deliver new information to a large group of students. This method is known to be effective in dealing with a large class. However, it could also be used for a small class. Research indicates that this method dominates most of the tertiary institutions (Deslauriers, and Wieman, 2011). Demonstration teaching method is a useful method of teaching because it improves students' understanding and retention. (McKee, Williamson and Ruebush, 2007). According to Al- Rawi (2013), demonstration is effective in teaching skills of using tools and laboratory experiment in science. However, the time available to perform this demonstration is very limited in a classroom setting. Therefore, demonstration is often designed to allow students to make observations rather than through hands-on laboratory (McKee, Williamson and Ruebush, 2007). The traditional or conventional model of classroom instruction therefore involves the teacher as the central focus of a classroom setting and lesson. Most often, the teacher is the primary disseminator of information, the answerer of questions, and the controller of behaviour. Students depend directly on the teacher for guidance, instruction and feedback. In a classroom that operates within a radically traditional style of instruction, lessons are teacher-centred and discipline oriented. (Ryback and Sanders,1980). Learning by memorization which is peculiar to conventional biology classroom and in science classes is common because students have not been actively involved in the classroom activities (Mazur, 1997). It is not surprising to see in science education a student with a good grade but cannot link his or her classroom experience with the real-world problem (Crouch *et. al.*, 2007). The reason is that he or she has not learned through active learning instruction. Active learning and flipped learning strategy have several common characteristics, and that is why it is important to have a review of it.

The Conventional Lecture Method

Research shows that students' retention in a lecture-based science courses is weak. In the studies of Aremu and Sangodoyin (2010) Computer animation made a significant effect on students' academic achievement in Biology but the conventional lecture method did not. According to Bok (2006), an average student only retains 42% of what he or she learned after the end of the lecture and 20% one week later. Further research equally shows that teaching method like the lecture method commonly used does not help the students to acquire sufficient functional understanding (Barmby *et. al.*, 2008). Berry (2008) argued that lecture method lacks the effectiveness of an active learning approach. In the opinion of Fagen and Mazur (2003), lecture method causes the bad reading habit among the students. Franklin, Sayre, and Clark (2014) say that students taught in lecture-based classes learn less than those taught with activity-based reformed methods. For most students, lecturing promotes memorization of facts rather than fostering deep understanding, and even high academic achievers sometimes gain little understanding of basic science concepts through traditional didactic lectures (Sundberg, 2002).

Lecture method is frequently a one – way process unaccompanied by discussion, questioning or immediate practices that makes it a poor teaching method

(Hatim, 2001; Al-Rawi, 2013). Lecture method concentrates on information rather than learners (Danmole, 2012). In the lecture method the teacher tell the students what to do instead of activating them to discover for themselves (Miles, 2014). Ajaja, (2014) concluded after his study that better methods for teaching and learning Biology could be either the learning cycle or cooperative learning. These methods will however be very effective only if the laboratory facilities for science teaching and learning are available in schools, considering the numerous steps involved in their use. In schools where laboratory facilities for Biology teaching and learning are not available, a better alternative to the lecture method remains the concept mapping since the method does not essentially demand the use of laboratories for practice.

Research shows that teaching method like the lecture method commonly used does not help the students to acquire sufficient functional understanding (Bernhard *et al*., 2007). Berry (2008) argued that lecture method lacks the effectiveness of an active learning approach. In the opinion of Fagen and Mazur (2003), lecture method causes the bad reading habit among the students. Franklin, Sayre, and Clark (2014), students taught in lecture-based classes learn less than those taught with activity-based reformed methods. Lecture method is frequently a one – way process unaccompanied by discussion, questioning or immediate practice that makes it a poor teaching method (Hatim, 2001; Al-Rawi, 2013). Lecture method concentrates on information rather than learners (Al-Rawi, 2013). In the lecture method the teacher tell the students what to do instead of activating them to discover for themselves (Miles, 2015).

However, before the adoption of the method as an appropriate instructional strategy, both the teachers and students should be well trained to acquire the skills necessary for its use. The efficient acquisition of the skills necessary for its use both by the Biology teachers and students will reduce the limitations associated with the method. Lecture method could still be used to teach very abstract topics to enable students easily acquire knowledge, new information, and explanation of events or things. It will reduce the frustration students will experience with the other methods when dealing with very novel concepts. The advent of innovative pedagogy in the field of science has revealed the limitation of the conventional lecture method in science courses, many researchers have demonstrated that the level of students achievement when instruction is done using the conventional method is dangling and that in other to have a learning where students can favourably apply classroom theory to real - world problems and improve students' academic performance in science education(biology), there is the need for a shift of paradigm of pedagogy. The shift must be to an activity-oriented classroom practice. Miles (2014) supported this that science teachers should incorporate methodologies that require a greater level of students' activity. It should be a research-based instruction that allows maximum student-to-student interaction for learning purpose.

2.3.2 Practical Approach to Biology Instruction and its Problems

Practical Approach

Practical work is defined to be any science teaching and learning activity which involves students, working individually or in small groups, manipulating and/or observing real objects and materials, as opposed to the virtual world (Science Community Representing Education (SCORE), 2008). Abdulrahaman (2014) poised that active involvement of the students in an opened process oriented and practical activities is necessary for the development of creative thinking in learners. In the words of Jimmi (2014) Science subjects require practical training as well as theoretical studies. Therefore, to be competent, teachers need to be efficient in designing, planning and implementing the lesson. A part from that, teachers need to assess the practical training and laboratory experiment. The country needs more scientific-minded people to accomplish the national mission for the nation to be a developed one. Therefore, students need to be nurtured to love science and to positively practice scientific culture. However, the importance of the study of sciences in Nigerian tertiary institutions and handling of the science courses the way it ought to be handled are issues of continuous concern.

The need for students to develop practical skills through the process of problem solving in biology has been emphasized by science educators (Okeke, Akusola and Okafor, 2004). Practical activities in biology provide opportunities for students to actually do science as opposed to learning about science, Akolade, (2013) asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher (teaching) more real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters. The development of these skills is basic to scientific inquiry and the development of intellectual skills needed to learn concepts (Ibe and Madyabum, 2003). They also believed that the process skills can increase students' capabilities to answer questions and solve problems. Raimi and Fabiyi (2008); The use of the process of science can bring about students' development of practical skills. Raimi and Fabiyi, (2008) also observed that not much work has been carried out on students acquisition of practical skills.

Jegede and Ayeni (2013) asserted that field work, an example of practical in Biology has a way of influencing teachers' attitude positively to the subject. According to Waston (1994) the two main methods that have been proved to be useful in teaching science concept include the act of:

1. Informing the students about some selected facts, principles, laws and concepts so that students only have to listen and memorize where necessary.

2. Providing experiences or appropriate situation that could encourage the students to discover by themselves through observation, manipulation, experimentation and discovery. The progress made so far in the advanced countries like China, Japan, UK and America are as a result of the efforts and emphasis put in to science practical learning.(Nwagbo *et.al.* 2012) Practical Skills in Biology are indispensable for students in the life sciences, (*Jones et.al.*, 2007).

Problems of Practical Approach

Authors have identified several problems that inhibit the smooth use of practical sessions in Nigerian secondary and post secondary schools instruction of Biology. The problems can be grouped into three main categories:

(i) Teachers based problem

(ii) Facilities/ equipment based problem

(iii) Learners based problem

Teachers based problem centers on the problems encountered by the teacher or caused by the teacher during the Biology practical lessons, these includes; qualification of the teachers, phobia for specimen and biology practical, teachers interest, laziness on the part of the teacher etc.

Facilities /equipment based problems ranges from unavailability of the required equipment or facilities to inappropriate use of facilities/ equipment when available. Salient facilities that should be available for practical Biology lessons include the laboratory, reagents, specimens, microscope, glass wares(beakers, test tubes, conical flask, glass slides, cover slips, etc) Handling of reagent bottles for example is a problem for most students according to Adams *et.al.* (2014) most students do not know how to handle reagent bottles during biology practical lessons. Learners based problem has to do with the attitude and interest of the learners towards biology practical lesson, phobia for specimen and some of the equipment often used for biology practical lesson could influence the attitude and interest of learners towards biology practical lessons. Although authors have identified how to cope with the challenges of science practical and laboratory experiences, not so much has been salvage by these suggestions, for example Jimmy (2014) said that due to limitations of the state resources, teachers need to use their own creativity and initiative in dealing with practical. Teachers should take the initiative to cleverly use the existing resources in the school environment and surrounding to make practical and experiments authentic with human life. Despite this advocacy teachers are still constraint majorly with the setting up laboratory for practical over and over again.

Therefore, not only does the factor of human(teacher and student) competency a factor militating against the effective actualisation of practical in Biology in many schools, the unavailability of the required resources is also a hindering factor.

2.3.3 Students Practical Skills and their Learning Outcomes

While the value and purpose of practical work has been continuously debated, it has nevertheless remained a core component of school science education. Indeed, the inclusion of practical work within an academic subject is a significant feature that distinguishes science from the majority of other subjects/ courses in schools. Trowbridge *et.al*. (1996), reported that practical work is rated highly by students in terms of their attitudes to, and enjoyment of school science. Nwagbo *et.al.*, (2012) explained that whilst students' attitudes to practical work in science were seen positively, the evidence is currently "equivocal" . Abraham *et.al.* (2010) indicate, many teachers view practical work "as central to the appeal and effectiveness of science education". Indeed, reference is often made to the adage, 'I hear and I forget, I see and I remember, I do and I understand' written originally by Confucius. However, Danmole (2012) explained how doing practical work does not always indicate progression in learning science. Indeed, practical work does not always produce the results or the phenomena desired by the teacher. This then has the potential to either confuse or disengage students as they may begin to think either that the theory is incorrect or that the practical is providing them with incorrect or contradictory results to those predicted by the scientific theory.

2.3.4 Attitude of Teachers and Students to Biology Practical Instructions

The study by Abraham *et al.*, (2010) which compared current teachers' attitudes with those teachers in the twentieth century in the study by Kerr (1963), found that, regardless of the changes within the last 46 years, teachers' attitudes on the important aims of practical work remained constant. Similar findings were noted in Swain *et al*., (2000) that found after 35 years teachers had been "fairly consistent in their attitudes to the teaching of Biology" (p. 291). Abraham *et al.,* (2010) justify the similarities by explaining that it is merely "a reflection of the fact that there is less perceived competition between the aims" (p. 13) but not across all Key Stages. Similarly, Olagunju (2007) reported that teachers especially the feminine gender possessed significant attitude to the teaching of Biology. Her suggested reasons are perhaps high potential abilities in verbal expression and the ability to use technology. Olagunju equally identified that the teaching of science (Biology) requires the ability to read and understand scientific materials as well as the ability to use scientific equipment to communicate science concepts.

Jegede and Ayeni (2013) commented that the use of practical approach such as field work in the instruction of Biology improves the attitude of teachers toward the teaching of biology. Another report says that in the United Kingdom Practical work in school science has consistently been a part of the National Curriculum since the 1999 version and until recently has been an essential part of the assessment of science. However, the nature of practical work conducted in accordance with the National Curriculum resulted in teachers conducting routine practical work due to the perceived assessment requirement that teachers had to ensure their students met (Millar and Osborne, 1998). Indeed, the assessment criteria, known as Sc1, led some teachers to focus primarily on meeting the needs of the assessed types of practical work (Kind and Taber, 2005), rather than using it as a method of learning science. A comment made by a science teacher in Donnelly and Jenkins (2001) encapsulated the dullness that had come from the assessment of students' practical work (Sc1) at the time, "we now teach to pass the exam, and not for enjoyment" (p. 135). More recently, changes in the way Sc1 is assessed has to some extent changed the way teachers see practical work, from being on the one hand, entirely focussed on meeting the needs of assessment, and on the other, using it as a teaching method to aid general learning of science (Abraham *et al.*, 2010).

Attitude of Teachers to Biology Practical Lesson

Teachers see no reason to question why they do what they do with practical work. According to Gott and Duggan (2002) teachers were "confused as to the role and purpose" (p. 63) concerning the investigations that had become part of the Science

National Curriculum. Perhaps the fact teachers are not thinking about the reasons for the implementation of practical work would explain for the appeared confusion. Such an issue also places uncertainty on the reliability of their attitudes within studies relating to attitudes of the purpose of practical work. Certainly, Parkinson (2004, p. 185) justifies a variety of factors from personal to societal issues (relating mainly within their respective schools) explaining that teachers are usually in the habit of not involving the students in biology practical. Wabuke as cited by Nwagbo *et al.*, (2012) suggested that regular inspection be always done in other to ensure compliance with the rules that governs biology practical lessons. Jimmi (2014) stated that Teachers have a greater role to play in the scientific practice. An effective teacher should be able to give a step by step instruction especially for inactive students, who just wait for the teacher to guide them in performing the experiment

Attitude of Students to Biology Practical Lessons

Many studies in the last two decades have examined students' attitudes towards science and science education (Osborne *et al.*, 1985; Nieswandt, 2005; Barmby *et al.*, 2008; Kim and Song, 2009). The importance of researching students' attitudes towards science has been highlighted by the Organisation for Economic Co-operation and Development (OECD, 2010) who believe that a student's 'scientific literacy' should include certain attitudes, beliefs which by possessing and utilising effectively, it is believed this will benefit the individual, the society and the worldwide. Yet the importance of attitudinal research, primarily attitudes towards science, is not a recent area in science education. Work by Dewey (1916 and 1934) highlighted the importance of scientific attitudes whilst work on attitude measurement instruments such as the Likert (1932) and Thurstone (1928) along with theoretical ideas (Sherif, Sherif and Nebergall, 1965) influenced the research into attitudes towards science which by the 1960s had become something of a regularity (Koballa and Glynn, 2007).

The Dainton Report of 1968 highlighted the issue regarding scientific attitudes moving away from science and by the mid-1970s Ormerod and Duckworth (1975) began researching into students attitudes to science. Student attitudes toward science have been investigated since the mid-1960s (Osborne *et al.*, 1985; Ramsden, 1998; Reid, 2006), when educators started seeing a decrease in enrolment in science courses and decreased interest in science and technology–related disciplines among youth. As the association between attitudes and learning recently has become clearer, new instruments and methods to measure the impact of courses and programs on student attitudes have been developed for various science disciplines such as biology (Russell and Hollander, 1975 ; Quinnell *et al.*, 2005 ; Semsar *et al.*, 2011), physics (Redish *et al.*, 2009 ; Adams *et al.*, 2014), statistics (Besterfield-Sacre *et al.*, 2001), and chemistry (Bauer, 2005 ; Berg, 2005) Many factors are correlated with student attitudes, among them are performance (Weinburgh, 1995), interest (Perkins *et al.*, 2006), gender (Felder *et al.*,2003 ;Besterfield-Sacre *et al.*, 2001; Aremu *et. al.* 2005 Adesoji 2008,), ethnicity (Besterfield-Sacre *et al.*, 2001), and teaching strategies (Felder *et al.*, 2003; Armbruster *et al.*, 2009 ; Brewer, 2009). For some factors, such as performance, it is often difficult to distinguish between correlation and causation, which means that one has to be careful when drawing conclusions from survey results.

However, there is evidence in the science education literature that teaching strategies may affect student attitudes, while it is common for courses to shift their focus from being teacher-centric to learner-centric by implementing activities to engage students, interactive activities may not be enough to improve student attitudes (Perkins *et al.*, 2006 ; Redish and Hammer, 2009). According to Ajaja(2013), study after study since 2000 has made it clear that there is an alarming crisis in relation to students' interest in science, either as a possible future career, or as an intrinsic interest that will continue after school" (Fensham, 2008, p. 20). Still citing Fensham (2008), Ajaja said that in the UK in the late 1960s, the publication of the Dainton report (Department of Education Science (DES), 1968) which examined the flow of candidates in science and technology into higher education documented a swing from science in the school-age population as a whole. The list of countries experiencing declining interest of students in science is on the increase particularly among the developed countries (Fensham, 2008). And that One factor which has contributed to low interest in science by students is the methods adopted for teaching and learning science which contribute directly to low interest in science: viz

(i) Science teaching is predominantly transmissive, (ii) The content of school science has an abstractness that makes it irrelevant, (iii) Learning science is relatively difficult, for both successful and unsuccessful students, and (iv) Hence, it is not surprising that many students in considering the senior secondary years are saying: Why should I continue studying science subjects when there are more interactive, interesting and less difficult ones to study?

This unhealthy development in the disposition of students towards science has sparked the search for and development of alternative methods of science teaching and learning which can stimulate students' interest and guarantee an educational system that offers equal opportunities for all sexes. Most recently the findings of Owino, Yungungu, Ahmed and Ogolla (2015) shows that student had positive attitude towards the use of practical to learn Biology and that students also have positive attitude and enjoyed Laboratory work when engaged in hands on activities compared to teacher demonstrations

Attitude of students towards practical lessons always influence their overall performance in the science courses. Barmby *et al.* (2008) reported that students with positive attitude always register better performance in Biology than those who had negative attitude. Those with positive attitude are motivated to work hard and this is reflected in the good marks scored in their examinations. According to Jimmi (2014), Science subjects require practical training as well as theoretical studies. Therefore, to be competent, teachers need to be efficient in designing, planning and implementing the lesson. A part from that, teachers need to assess the practical training and laboratory experiment Inadequacy of Biology practical facilities has been traced to always influence the attitude of students towards Biology practical. Nwagbo and Chukelu (2012) reported in their study that students do not make effective use of biology laboratory resources because they are usually inadequate.

Generally, attitude is one of the variables that always influence learning outcomes in many subjects. Attitude plays a vital role in the life of an individual. Adediwura and Bada (2007) defined attitude as a consistent tendency to react in a particular way-often positively or negatively towards any matter. Adesoji (2008) in his study have revealed a relationship between attitude and methods of instruction and also between attitude and achievement. The study of Ojo (2009) on the impact of video CD and Audiocassette based instructions on secondary school students' learning outcomes in selected topics in Biology revealed a gain in students' attitude scores. The study of Abiona (2008) has equally revealed an improvement in the attitude of students, after using some instructional strategies in Biology. However, there was no significant change in the attitude of students in some researches. The different contradictory findings on students' attitude is inconclusive, therefore it calls for more investigations on this important variable. The poor science skill acquisition by students is not in keeping with the aims and objectives of education in Nigeria which states that" education should aim at helping the child to acquire appropriate skills, abilities and competencies, both mental and physical as equipment for the individual to live in and contribute to the development of his society'' (Section 1 (7): 3; FME 2014). There seems to be a consensus of opinions among science educators concerning the important role played by instructional strategy adopted as a classroom variable in affecting students' achievement, attitude including practices towards Biology (Ige, 2001; Nwosu, 2003 and Olagunju, 2002).

2.3.5 Flipped Classroom Practices and its Possible Benefits

The flipped classroom model may provide many benefits for instruction that are not possible with traditional instruction. Supporters argue that the videos maximize class time to promote the exact deeper, inquiry-based learning. After flipping his classroom, Bergmann (2011) says he can more easily query individual students, probe for misconceptions around scientific concepts, and clear up incorrect notions. By instinct, Bergmann says the most important benefits of the video lessons are profoundly human: "I now have time to work individually with students. I talk to every student in every classroom every day."

Proponents of the flipped model argue that it is how a teacher uses the newly freed class-time that is most important (Bergmann and Sams, 2012). Offloading direct instruction to videos allows teachers to reconsider how to maximize individual face-to-face time with students. With flipped classroom approach there is now enough time for students to collaborate with peers, engage more deeply with content, and receive immediate feedback from their instructor says Hamden, McKnight, McKnight, and Argstrom, (2013). One very important feature of the flipped class model is to increase teacher-to-student and student-to-student interaction during class time. Teachers using the flipped method say that the best benefit is that for the first time in their teaching careers, they have some one-on-one contact with every student during every class period (Moore, Gillett and Steele, 2014).

Ideally, the flipped model is a blending of direct instruction with inquiry-based learning; this allows more time for the development of 21st century skills such as critical thinking, collaboration and self-direction (Framework for 21st Century Learning, 2010). The Flipped Manifest (Bennett, 2005) states that: Practitioners of the various flipped classroom models are constantly tweaking, changing, rejecting, adding to, and generally trying to improve the model through direct experience with how effective it is for kids. It's not "record your lecture once" and you're done; it's part of a comprehensive instructional model that includes direct instruction, inquiry, practice, formative and summative assessment and much more. It also allows teachers to reflect on and develop quality and engaging learning opportunities and options for internalization, creation, and application of content rather than just fluff or time filling assignments. (p.1) Salman Khan has endorsed the flipped model and has stated that his videos allow the teacher to focus on higher-level learning activities, such as running simulations and labs with students, doing individual interventions, and facilitating peer-to-peer learning (Fink, 2011). This emphasizes why the changes that occur in the classroom are the most important aspects of the flipped model.

The flipped classroom model may also have benefits in reducing anxiety in difficult, content heavy courses. The Washington Post (Strauss, 2012) article details Stacy Roshan who teaches AP Calculus using the flipped classroom model at a private school in Potomac, Maryland. "My AP Calc class was a really anxious environment," said Roshan. "It was weird trying to get through way too much material with not enough time. It was exactly the opposite of what I was looking for when I got into teaching (Strauss, 2012, p. 1)." She learned about the flipped classroom at a technology conference and realized that it would allow her to get the lecture out of the classroom and provide one-on-one time with students. Because it is an intensive AP course, Roshan creates about 4 videos per week with a length of 20 to 30 minutes each. Students say they often spend much more time than this viewing, as they rewind to parts they didn't understand the first time through. In class, student work with Roshan and other students on problems. Students like the method because they no longer have to sit at home and struggle with confusing homework. Students also feel that it is much easier to learn calculus, and that the method has reduced math anxiety (Strauss, 2012).

Another benefit of the flipped method is that the at-risk students can now learn with ease. Green (2012) states: By reversing our instructional procedures so that students do their homework at school, we can appropriately align our learning support and resources for all of our students, and eliminate the inequality that currently plagues our schools. When students do homework at school, they can receive a meal and access to technology (during a declining economy), and an overwhelming amount of support and expertise. When students do their homework at school, we can ensure that they will be able to learn in a supportive environment that's conducive to their education and well-being. For the first time in history, we can provide a level playing field for students in all neighbourhoods, no matter what their financial situation is. (p. 10).

It is important to state and reiterate at this level that a flipped classroom model does not change the amount of face-to-face time that a student spends in a classroom when compared to a traditional classroom. For the flipped classroom to have possible benefits the goal of online videos is not to replace in-class learning, but to instead supplement and enhance the learning and, face-to-face time should promote deeper, inquiry-based learning.

2.3.6 Key Researches on Flipped Classroom Model

This literature review will summarize and discuss some of the key findings in the research on flipped learning in undergraduate (Science, Technology, Engineering and Mathematics) (STEM) education. Nearly all of the studies found on the flipped classroom model in undergraduate education were in the STEM fields. This is not surprising since these are the subjects which are most commonly flipped (Overmyer, 2013). Studies such as introductory biology and pharmacy therapeutics are reviewed here. Students in introductory biology taught at the University of California, Irvine were taught using "learn before lecture" techniques between 2007 and 2009 (Moravec, Williams, Aguilar-Roca, O'Dowd, 2010). The researchers did not use the term "flipped" or "inverted", but the methods had similarities. Their method was quite basic, and simply involved removing 4 or 5 lecture slides from the previous year's lectures and creating narrated PowerPoint videos. One of their concerns was that teachers of large introductory classes at research universities have little interest in making major revisions to their courses. Instead of a complete overhaul of the course, they created pre-class assignments that combined narrated video with note taking sheet. The school was interested in implementing higher-level concepts during engagement exercises already scheduled into the class, but did not want to have to create additional lab sections. The course designers stated: Theoretically, this could be accomplished by students completing assigned readings before class but it appeared this rarely occurs, even when coupled with pre-class quizzes worth a small number of points. The researchers therefore created pre-class assignments designed to help students learn knowledge-level material in preparation for lecture. (Moravec, *et. al.*, 2010, p. 3). The intervention group consisted of students who received the pre-class video assignments in 2009 and the control group was classes from 2007 and 2008, before the pre-class video assignments. The measure of learning was related question pairs, matched by level and format. The mean increase in performance was 21%, and the percentage of students who correctly answered five of six exam questions was significantly higher (p<.001) in 2009 versus the previous years.

Another study compared students' course achievement in computer literacy at Uludag University in Turkey. The researcher used two instructional methods. The first method was a traditional face-to-face lecture and the second method was a blended model that had some similarities to a flipped learning format. The research used a pretest posttest model with a control group/intervention group design. The participants were assigned to groups purposefully to achieve group equivalency, based on test scores examining prior knowledge about computers. The face-to-face group had two hours of traditional classroom time and two hours of applied laboratory material per week. The traditional class time was not just lecture, but included classroom discussions, projects and collaborative learning. The blended classes only meet face-to-face for two hours per week. This differs from a flipped classroom model, where face-to-face time is not changed from the traditional model. However, similar to a flipped model, the blended classes had a website that provided multimedia components, such as screen casts, assessment simulations, and online tutorials. The achievement test consisted of questions from the courses final exam and was also used to test students' prior knowledge as the pretest. The same exam was given as the pretest and the posttest. The test was prepared by four instructors of the course. The course ran for fourteen weeks with 86 students finishing the blended model and 93 students taught in the traditional model. An independent samples t-test was applied to the mean post test scores to examine the differences in course achievement. There was a statistically significant difference, t (177) =6.913, $p<.001$, with the blended group outperforming the strictly face-to-face group. This results in a Cohen's d=1.04. This indicated that treatment had a "large" effect using Cohen's terminology. The results indicate that the combination of online and face-to-face instruction had a positive influence on student achievement. The report claims that the "benefits of blended learning environment with interactive materials including instructional videos, screen captures, and assessment simulations are the most effective factors for success " They also claim that students are much better equipped to learn procedural skills with video, as they are able to pause and rewind, which is not possible in a traditional teaching environment. All of these aspects of the blended model are also characteristics of the flipped learning model.

Another project in 2012 assessed the impact of the flipped classroom model on student performance and perceptions in an 8 week pharmacy integrated therapeutics course (Pierce and Fox, 2012). The course used Process-Oriented Guided Inquiry Learning (POGIL) which actively engages students to develop critical thinking and problem solving. Originally designed for college chemistry, the research compares students' achievement between a traditional pharmacy course from 2011 and a flipped classroom/POGIL based course in 2012. For the 2012 course, students viewed vodcasts of lectures prior to the scheduled class and then discussed interactive cases of patients in class. For each class, a POGIL activity was developed and implemented that supported and provided application of the material contained in the previously viewed vodcast lectures. The same instructor taught the courses in 2011 and 2012 and covered identical material and gave identical final exams. The final exam consisted of 16 multiple choice questions. A *t*-test was performed to analyze differences. It was found that the flipped class in 2012 performed statically significantly better than the traditional 2011 class with $p = 0.024$ (Pierce *et. al.* 2012). Student's perceptions of the flipped classroom were also explored. A ten question Likert scale survey instrument was administered. Results showed that 90% percent of the students agreed that the instructor made meaningful connections between the topics in the vodcasts and the class activities. Likewise, eighty percent agreed that the flipped model improved their self-efficacy and improved their confidence on the final exam. Nearly two-thirds expressed a desire for more instructors to use the flipped classroom model. The study concluded that the flipped model improved student performance and perceptions and felt that the contributing factors included student contact with the material prior to class (the vodcasts), frequent and formative assessments prior to the final exam, and interactive and group-based class activities (Pierce *et. al.* 2012).

A similar study was conducted on an honours analysis/pre-calculus classes for high school juniors and seniors (Kirch, 2012). During the 2010/11 school year the classes were not flipped and all lessons were taught in class, and all practice was done at home by students. During the 2011/12 school year, the teacher began a trial of the flipped classroom during the fall semester and transitioned to a fully flipped class during the spring semester.

This flipped classroom included all lesson instruction being done via video and most practice done in class. The instructor produced all of the videos. Students were required to watch the lesson, write a summary, and ask a higher-order thinking question at home. In class, students reviewed the lesson, answered their questions, and worked on practice. Activities and methods were structured, but "varied based on content and throughout the week to mix things up." (Kirch, 2012, p. 4)The teacher kept all instruction, supplementary materials, quizzes, tests, practice assignments, and online resources identical during the pre-flip year and in the flipped classroom. The study also stated that student demographics from both years were similar in terms of number of students, grade levels of students, and general class environment. Results showed a 5% increase in class averages from the pre-flip year to the flipped class using identical measures. Likewise, results showed in 12% increase in students receiving final grades of A or B, with a nearly 10% decrease in students failing the course. There were no reported means, sample sizes, or standard deviations, so statistical significance and effect sizes could not be determined. The flipped classroom model came about from a confluence of video lecture first seen in distance education, inquiry-based learning principles, learning management systems, and learning technologies that enabled teachers to create their own online videos.

2.3.6.1 Research on Flipped Biology Education

Surely, there are broad empirical reports that support the use of Active Learning (AL) in science classrooms [e.g., Handelsman, *et al.*, 2004; Prince, 2004; Knight 2004; Allen and Tanner 2005]. Specific benefits of AL in undergraduate Biology education include:

1) Haak, *et. al.* (2011) observation that substituting daily and weekly practice in problem solving, data analysis, and other higher-order cognitive skills for lecture-intensive course design improved the performance of all students and reduced the achievement gap between disadvantaged and non disadvantaged students;

2) Derting and Ebert-May's (2010) finding that an intense, inquiry-based, learner-centered experience was associated with long-term improvements in academic performance;

3) Knight and Wood's (2005) measurement of significantly higher learning gains and better conceptual understanding when student participation and cooperative problem solving during class time was substituted for traditional lecturing;

4) Burrowes (2003) evidence that teaching Biology in an AL environment is more effective than traditional instruction in promoting academic achievement, increasing conceptual understanding, developing higher level thinking skills, and enhancing students' interest in Biology;

5) Udovic, *et al.* (2000) observation of pronounced differences between students taught biology traditionally and those taught with a series of active, inquiry-based learning modules, termed "Workshop Biology."

Despite its documented value, there remain formidable barriers to incorporation of AL in the classroom, and traditional lectures remain the norm for most introductory science classes (Stokstad, 2001; Wood and Gentile, 2003; Allen and Tanner, 2005). These barriers include academic cultures that sometimes undervalue teaching innovations, professorial habits revolving around lecturer-centred education, the necessity of delivering copious amounts of content in a single quarter or semester, the perceived efficiency of lecturing to students in notoriously large introductory classes, and student scepticism regarding the value of and participation in active learning (Hanford, 2012).

> *"I think [the traditional lecture] is going to be kind of blown away in favour of a model where every student is working at their own pace and the teacher now has a much higher-value role…"* – (Khan, 2012)pp5
>
> *"The key to the flipped class is actually not the videos, it is the freedom those videos give the teacher to have engaging class activities and interaction with their students."*- (Bergmann, 2011). Pp9

2.3.6.2 Results of Flipped Classroom Strategy around the World

Flipped classroom strategy has gained attention in most parts of the world, some institutions and bodies that have embraced the use of flipped classroom are as follows: University of California at Irvine, traditional large-lecture introductory biology classes were switched to an inverted classroom format. Students in the inverted classroom (flipped) format showed an average increase of 21% on exam questions that were formerly covered in lecture but moved to pre-recorded videos watched outside of class and followed up by interactive exercises. (Moravec, *et. al.*, 2010). The case is similar at Miami University (Ohio), students in a software engineering course designed using the inverted classroom format showed strong self-ratings of their abilities to write application software and high levels of engagement. At Franklin College (Indiana), a linear algebra course taught by the author, revealed students who were given a choice of solution techniques to use on a final exam problem, one introduced in a traditional lecture and the other in a pre recorded video, and both rehearsed in class through group work. Students employing the solution technique from the video had a significantly higher success rate on the exam problem than those using the one from the in-class lecture. (Talbert) and in an inverted-classroom introductory scientific computing course also taught by the author, students attained a high level of work even though their computing backgrounds entering the course were minimal, and they showed a strong ability to acquire technical skills on their own one semester later (Talbert).

Flipping allows colleges, particularly large research institutions with big classes, to make the traditional lecture model more productive, says Harrison Keller, vice provost for higher-education policy at the University of Texas at Austin, which held a recent seminar on course flipping for its faculty. "If you do this well, you can use faculty members' time and expertise more appropriately, and you can also use your facilities more efficiently," he says. More important, "you can get better student-learning outcomes." Those forces are coming together to prompt a rethinking of the faculty member's role in the classroom. "I see a paradigm shift, and it's coming soon," says Michael S. Palmer, an associate professor of chemistry and assistant director of the Teaching Resource Centre at the University of Virginia. "Content is not going to be the thing we do. We're going to help unpack that content." A similar study reported on an implementation of the flipped classroom of three sections in an IT 101 (Introduction to Information Technology and Computing Concepts), an introductory IT course required by all first year students at a small business university (Frydenberg, 2012).The course covers digital literacy topics, basic web development, maintaining laptops, wireless networking, and current web trends. Approximately 40% of the course covers topics in Excel spreadsheet software, and this was the only part of the course flipped.

Before implementing the flipped model, the instructor would explain Excel concepts in class, or demonstrate a tutorial from the textbook during class, as students tried to follow along on their laptops. They would then go home to complete the mastery exercises. In implementing the flipped classroom, the students watched the instructional videos before class, and there were no in-class demonstrations or lectures. Students would work on completing an in-class group activity with the instructor readily available to complete the exercises. Classes met in 75-minute blocks with five minutes for announcements, five minutes for a quiz based on the videos, five minutes to explain the in-class activity, 45 minutes to complete the activity, and 15 minutes to debrief and have groups share their solutions. The researcher asserts that this created an active learning experience where students engaged in open-ended and learner-centred activities, collaborative problem solving and required public articulation of the concepts with the group sharing.

To confirm and access if students watched and retained the content of the videos, a five-minute, five-question multiple choice quiz was delivered in class. Students completed the quiz by logging onto the Blackboard learning management system online. The study did not state if the students were required to bring an Internet accessible device to class, or if the classroom had a one-to-one computers. The researcher states that the quizzes motivated students to watch the videos, as each quiz counted toward the course grade. To determine the impact of flipping the course, the author administered a voluntary online survey to all 66 students. There was no control group, and the research does not measure student achievement. All three sections were taught by the same instructor. Since there was no experimental design, all of the outcomes were descriptive. Over 90% of the students felt that the flipped classroom helped them learn the material better than a traditional classroom. Likewise, over 90% of the students agreed that the structure of the course made the class more personal and helped them connect with other students. The videos made by the student tutors were well received by the class with a strong majority responding that the videos were clear and short enough to convey the concepts. The only negative reported in the surveys was in the large lecture section. Students responded that the class was too big for one instructor to facilitate and groups had to wait too long for assistance. The lists of institutions and bodies that had used flipped classroom strategy and had gotten very impressing results are endless.

2.3.6.3 Flipped Classroom Strategy in Nigeria

Though there are similar strategies to flipped classroom strategy used in Nigeria as revealed by literature, not so much has been done or reported in Nigeria in respect to Flipping the classroom especially in the science courses (Biology). Recently, few studies have started to emerge on flipped classroom strategy in Nigeria but not Biology. Adedoja (2016) experimented flipped classroom in one of her courses for pre service teachers at the University of Ibadan; she concluded the study by saying

> *Evidence from this study suggests that the pre-service teachers have positive deposition toward flip learning. They express that the strategy promotes active learning and makes the learning content more accessible to them. However, some of the challenges they faced include: poor internet connection and power supply, incompatibility of mobile phones, and size of the video lessons. It is recommended*

that teachers should use the flip learning strategy for the pre-service teachers while considering challenges they might face. pp6.

Gladys and Cheta (2015) also used flipped approach for senior secondary school Mathematic in Port Harcourt, the study revealed that The flipped classroom encourages peer instruction, provides an opportunity for students to gain first exposure prior to class, provides incentives for students to prepare for class, provides a mechanism to assess students' comprehension and also provides activities that focus on higher-level cognitive activities. Gladys *et. al.* (2015) therefore posited that the advantages of the flipped classroom approach surpass that of the conventional, which informed the gain in mean scores of students taught mathematics via the flipped classroom approach, over their conventional counterparts. Nsofor, Bello, Ann and Oboh (2015) commented on flipped classroom model, saying if flipped classroom model is properly adopted in developing countries like Nigeria, classroom will become more flexible and student-centered as students move from being the product of teaching to the centre of learning

2.3.7 Flipped Classroom and Students' Achievement

Based on evidences from many institutions around the world, flipped classroom has been proven to be a strong strategy, capable of influencing students' achievement positively. At the University of California at Irvine, traditional large-lecture introductory biology classes that were switched to an inverted classroom format showed an average increase of 21% on exam questions that were formerly covered in lecture but moved to pre-recorded videos watched outside of class and followed up by interactive exercises. (Moravec, *et. al.*, 2010). This shows that once comprehension is improved achievement is likely to be improved. In spring 2010, Stone (2012) checked the impact of flipped classroom on undergraduates' general Biology course and find out that students perform over 10% better on assignment and as well or slightly better in harder, higher level thinking examinations. Many students agreed with statements that indicated the positive influence flipping the class had on their learning and performance in class.

2.3.8 Criticism and Misconceptions of the Flipped Classroom

One of the most common criticisms of the flipped model is that it is about replacing teachers with lecture videos. (Moravec, *et. al.*, 2010)There is a fear that the proliferation of online instructional videos will be used as leverage to diminish the roles of teachers and that videos are taking the poor pedagogy of lecture and simply putting it online (Khan, 2011). One example critics point to is Khan Academy, which is a repository of over 4000 videos made by Salman Khan, and whose videos have been viewed over 200 million times (Khan, 2012). The videos were originally created for Khan’s cousins to help him tutor them across the country. He started by posting 10 minute videos on YouTube. Eventually, these videos started to be viewed by the general public and were lauded for their clear explanations and easy conversational style of lecture. In 2010, the Bill and Melinda Gates foundation and Google became investors, and the Khan Academy has grown ever since (Dell, 2012). Their goal is to change education for the better by providing a free world-class education to anyone anywhere (Khan, 2011). Salman Khan has endorsed the flipped model and has stated that his videos allow the teacher to focus on higher-level learning activities, such running simulations and labs with students, doing individual interventions, and facilitating peer-to-peer learning (Fink, 2011).

This emphasizes why the changes that occur in the classroom are the most important aspects of the flipped model. The Khan Academy is receiving its share of criticism, mostly from people who claim that a classroom-based teacher’s importance is diminished by this technology. "If a teacher is just lecturing like a computer might, maybe that teacher should be replaced. But the truth is, most teachers don't just drone on, they educate, says Noschese, a physics teacher at John Jay High in Cross River, N.Y., whose personal website dedicates a tab to Khan Academy criticism (Dell, 2012). The Khan style of teaching is the same step-by-step process that students have seen for generations. “Khan Academy is great for what it is a supplemental resource; homework help, but we have turned it into something it is not. Indeed, something it was never intended to be (Khan, 2012)”

Bergmann and Sams argue that in a flipped learning environment, the role of teacher is amplified, in that all teachers now must know the individual learning needs of each student as their daily interactions increase. This actually increases the need for qualified, professional and caring educators. “Although video can be leveraged to deliver direct instruction, it does not, and cannot, replace the teacher as the facilitator of learning. (Bergman and Sams, 2012,)”

Another misconception is that flipped learning is similar to an online course (Fink, 2011). Although online learning is-and will-continue to have a valuable place in the education spectrum, it must be noted that a flipped model does not change the amount of face-to-face time that a student spends in a classroom compared to a traditional classroom.

Rosenberg (2013) argued that the videos are just taking a bad pedagogy (the in-class lecture) and putting it online. In fact, he argues that this is even worse as there is no chance during the videos for inquiry or collaboration. Critics also claim that it just reinforces the "sit-and-get" aspect of education without deeply engaging students. Capturing student and teacher perceptions, as well as the type and frequency of questions asked in a high school flipped classroom may provide previously unexplored insight into the full impact of this teaching method in K-12 education. Student perceptions of the flipped model have been studied at the post-secondary level, and found to be positive (Baker, 2000; Toto & Nguyen, 2009).

Additionally, there are pitfalls that educators must be aware of when attempting to implement the flipped classroom model. First, students new to the method may be initially resistant because this new type of schooling requires them to do work at home rather than first be exposed to content and subject matter in school. Likewise, video quality is important. Teachers need to either carefully curate the videos from pre-made video sites or make their own videos (Flipped Learning Network, 2014). Both of these methods require an ample commitment of time from educators, and teachers must be prepared for the increased workload (Frydenberg, 2012).

2.3.9 The Use of Video in Flipped Classroom

While a lecture can be extremely informative, a lecture that integrates pictures or video images can help an individual learn and retain information much more effectively. Using interactive CD-ROMs can be extremely effective in teaching students in a wide variety of disciplines (Oshinaike and Adekunmisi 2011). Aremu *et. al.* (2007) reported that over the years, classroom instructional video has been greatly used in the classroom and that the use of video can be very effective for teaching and motivation because it captivates and focus the attention of learners on what is being learnt, this confirms that the use of video for classroom instruction especially in Nigeria is not in operation, however, the use of video for flipping the lesson in Nigeria appears not to be in operation. Video has been used in other are of training apart from the formal classroom, Erwart (2007) identified that Video based training was used in Peru to reach the rural farmers as part of the government's effort to bring about agrarian reform. The video training help to overcome high illiteracy in rural areas and also maximised effectiveness of extension agents training activities; the programme was able to train one hundred and forty produces and one hundred and two thousand rural farmers (Yahaya, 2003). From the foregoing the use of video instruction is not only effective but it is able to influence a very large audience.

According to Akingbemisilu (2014). The use of video for flipping the classroom has got many advantages: it is particularly good for procedural lessons such as practical and experiments, whereby the learner can pause, rewind or replay the section that he/she does not understand in the first instance. Gee (2015) in his recent talk said "good commercial video games are designed around a good theory of learning-one supported by current research in cognitive science, the science that studies human thinking and learning". Videos that are used for flipping the classroom are usually short minutes video that addresses the content of the lesson straight.

The use of video for classroom flipping is of benefit to the learner because he/she has control over the pace of the lesson. Adedoja (2016) reported that pre service teachers loved to use video for most of their courses because of the impact video based flipped strategy made on their acquisition of knowledge in her TEE 353 course.

A multi-sensory experience as experienced in video can be created for the audience, which in turn, elicits positive attitudes towards its application (Neo and Neo, 2001). Multimedia has also been shown to elicit the highest rate of information retention and result in shorter learning time (Ng and Komiya, 2000). On the part of the creator, designing a multimedia application like a video that is interactive and multi-sensory can be both a challenge and thrill. These video application designs offer new insights into the learning process of the designer and forces him or her to represent information and knowledge in a new and innovative way (Agnew *et. al.*, 1996).

2.3.10 The Use of Animation in Flipped Classroom

Animations provide a valuable way to communicate dynamic, complex sequences of biological events more effectively than text or a static graphic (McLeod, 2010). Biology is a visual based subject that often involves complex sequences of events. Animations provide one way of communicating such complex sequences clearly and efficiently. To paraphrase the idea expressed by several students, "after viewing the animation, reading the textbook becomes easier and more enlightening."In spite of an increasing availability of animations, particularly as part of textbook packages, there has been little research into the value of animations versus static illustrations in science teaching. An animation can have a positive effect on learning as well. Sanger, Phelps, and Fienhold (2000) report on using a computer animation to increase student understanding of a difficult science concept. After a traditional lecture and quiz, analysis of the student responses revealed a sweeping lack of understanding of the concept taught. A control group received another lesson, with an overhead projector and diagrams as visual aids. A second group experienced an animated computer simulation explaining the concept. The results of a second exam revealed that the simulation was more effective for re-teaching than a second lecture.

Stith (2004) has reviewed this issue with a focus on cell biology teaching animations. In that review, Stith reports on an initial study where, after a formal lecture on cell death (apoptosis) illustrated with static graphics, some students were subsequently shown an animation after which all students were tested. The students who viewed the animation scored significantly higher on the test than those who had not viewed the animation. (McLeod, 2010) did a more comprehensive study in which small groups of students viewed a three-dimensional animation of protein synthesis in various combinations of individual study and a formal lecture versus individual study followed by a lecture without the animation. In all cases, the groups viewing the animation scored significantly higher in the follow-up test than the group that did not view it. In a study using animations in a chemistry course, where students have difficulty with mental models about the particulate nature of matter, students obtained significantly higher test scores when the animation was viewed as part of a lecture or as a supplement to individual study compared with a control group of students who did not have access to the animation (Abraham, *et.al.*, 2010). In keeping with those studies, it was revealed that students understood a complex signal transduction pathway better after viewing a narrated animation compared with a graphic with an equivalent legend. Thus, the few studies that have been done indicate that animations provide students with insight into biological processes in a way that traditional lecturing and static graphics do not. In fact, Njoku and Eze-odurukwe (2015) reported that the use of computer animation teaching strategy helped to clarify to students the concepts that are difficult to learn; animation helped to reduce concept abstraction, concentrating them and making it possible for the students to effectively visualise the perceived difficult concepts. Njoku *et.al.* (2015) recommended that animation strategy should be used in teaching abstract aspects of science subjects.

An extensive review of the literature covering all educational disciplines has indicated that there are certain parameters that need to be considered when making a teaching animation, of relevance here is that animations are most effective when text is adjacent to important structures and is spoken simultaneously to reinforce the learning process ("spatial contiguity effect," "multimedia effect," and "personalization effect," respectively;) Many biological animations that are freely available online do not include narratives. Often, these animations are intended for in-class use with the instructor providing the narrative. Students who access these animations online do not have the benefit of the instructor's narration. However, research in other disciplines indicates that animations and graphics with a spoken or written narrative are more effective than those lacking a narrative (Mayer, 2003). Although the ever increasing demand for animation centered lesson by students may be anathema to teachers, it is a reality of academic life that needs to be considered as we develop new courses and curricula. If animations can assist students' learning, then developing more pedagogically meaningful animations to include in our teaching repertoires is worth considering. Research into the pedagogical value of biological animations in the sciences can serve as a guide to developing such animations.

Findings from literature revealed that in spite of the amount of research that has been done on the value of animations as tools of pedagogy, not so much has been done in using animation to flip biology concept/courses in Nigerian universities. This study would provide evidence that animations may lead to greater long-term memory retention than simple graphics or conventional lessons. This study therefore intends to fill this gap in literature and determine the effect of animated based flipped classroom strategy on Nigerian undergraduates especially in the south western universities.

2.3.11 Gender and Students' Learning Outcomes in Biology

Gender is a variable whose influence on students learning outcomes has been vigorously examined by researchers. Several studies had considered the effect of gender on students learning outcomes in Biology and divergent reports abound from fields of research on gender issue, Ganiyu and Isaac (2014) revealed in their study that there is no significant influence of gender on students performance in a concept of Biology, Okeke (2001) in his review of studies concluded that gender differences exist in student's achievement in science subjects. Studies have shown significant difference in favour of boys (Bilesanmi-Awoderu, 2002; Aremu, 2005; Abiona, 2008; Ojo 2009); sometimes in favour of girls (Ogunleye, 2002; Olatundun, 2008; Olagunju and Abiona, 2004) and sometimes have shown no significant difference between boys and girls in relation to their achievement and attitude in different science subjects (Raimi and Adeoye, 2002; Owoyemi, 2007; Oduwaiye, 2009; Okoye, 2010). The findings of Ajitoni, (2005), Bolorunduro, (2005) revealed that there were significant differences between female and male students in terms of attitude in favour of female. Aremu and John (2005) in their study have stated that the search for strategies to bridge the gap in the achievement of males and females is an ongoing one.

Gender as a moderating variable therefore attracted further investigation in this study because of the conflicting nature of results as revealed in the above from researches that focus on gender and science and science related subjects. The need arises therefore for further studies to consider this variable in an attempt to build a body of more consistent evidence on the influence of this important factor of gender on achievement in and attitude to Biology. This study is interested in influence of gender on the learning outcomes in the selected concepts in Biology with the belief that more studies on this learner characteristic can bring about to some degree a resolution of the conflicting nature of the subject and a discovery of strategies that can bridge the gap between achievement and attitudes of male and female students in Biology.

2.3.12 Students Level of Computer Efficacy and Participation in Flipped Classroom

Bandura (1977) was the first writer to use the term self-efficacy. The concept of self efficacy and computer self-efficacy are discussed.

The Concept of Self-Efficacy

Bandura (1986) defined self-efficacy as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses" (p. 391). Therefore, the concept of self-efficacy was context specific, or the valuing of self through specifically defined situations. The definition of self-efficacy provided by Bandura (1986) highlighted the importance of distinguishing between component skills and the ability to perform actions. Further studies by Bandura discussed the psychological construct of self-efficacy as a concept that referred to "beliefs in one's capabilities to mobilize the motivation, cognitive resources and courses of action needed to meet situational demands" (Bandura and Wood, 1989, p. 506). In addition, self-efficacy influenced people's decisions, goals, their amount of effort in conducting a task, and the length of time they would persevere through obstacles and difficulties. Oliver and Shapiro (1993) have described the importance of not confusing self-efficacy with self-esteem. Although self-efficacy and self-esteem are both concerned with the judgments of individuals, they do not share any direct relationship with each other. They noted that self efficacy was concerned with self-capability, whereas self-esteem was concerned with selfworth.

Computer Self-efficacy

The term *self-efficacy* was soon extended to particular domains, including the use of computers. Compeau and Higgins (1995) defined computer self-efficacy as "a judgment of one's capability to use a computer" (p. 192). Computer self-efficacy refers "*to a judgment of one's capability to use a computer*" (Compeau and Higgins, 1995 p.192). For example, Compeau and Higgins found that an individual's use of technology was affected by their self-efficacy and that participants with higher self-efficacy beliefs used computers more often and experienced less computer-related anxiety. The authors also noted that individuals with higher computer self-efficacy beliefs tend to see themselves as able to use computer technology. Those with lower computer self-efficacy beliefs tend to become more frustrated and anxious when working with computers; and hesitate to use computers when they encounter obstacles. Computer self-efficacy has a major impact on an individual's expectations towards using computers (Compeau and Higgins 1995) and individuals who did not see themselves as competent computer users tend not to use computers (Oliver and Shapiro, 1993). Studies conducted at the work force (Burkhardt and Brass 1990) found that computer self-efficacy increases performance and reduces computer induced anxiety. Albion (2001) has noted that teachers' computer self-efficacy is a significant factor determining their patterns of computer use.

A popular measure is the computer self-efficacy scale, created by Murphy (1989) for measuring individuals' perceptions of particular computer-related knowledge and skills. The 32-item scale measures three levels of computing skills: beginner's level, advanced level, and a level associated with mainframe computers. Since then, many researchers have adapted the original Murphy's computer self-efficacy scale (Davis and Davis, 1990), while others have adapted a slightly modified version of the Murphy scale (Torkzadeh and Koufteros, 1994; Zhang and Espinoza 1998). Computer self-efficacy scales have also been developed for teachers (Enochs *et al.*, 1993; Kinzie *et al.*, 1994; Ropp, 1999; Wang *et al.*, 2004). Studies of computer self-efficacy have been conducted on individuals in the work force (Gist *et al.*, 1989; Burkhardt and Brass, 1990; Compeau and Higgins, 1995; Harrison and Rainer, 1997). These studies demonstrated the impact that computer self-efficacy has on increasing performance and the technological innovation of employees, reducing computer induced anxiety, and promoting higher occupational positions. Other computer self-efficacy studies have used student subjects at a university level (Karsten and Roth, 1998a; 1998b; Langford and Reeves, 1998). Overall, these studies showed that higher levels of computer self-efficacy corresponded to increased performance in computer courses and a greater achievement of computer competency.

A study conducted by Wallace (1999) investigated and described four main factors that influenced the development of computer self-efficacy. These factors were computer anxiety, computer confidence, computer liking and computer knowledge. He demonstrated a significant correlation between the computer self-efficacy model (composed of the four mentioned factors) and a 3-item measure of computer self-efficacy, further confirming that the model was a valid means to explore components of the computer self-efficacy construct. Comparisons were made between the computer self-efficacy of education and computing students. Wallace (1999) reported that computing students expressed low levels of computer anxiety, and higher levels of computer knowledge, computer liking, and computer confidence in comparison with education students. Empirical studies (e.g. Hoffman and Spatariu, 2008) have demonstrated that students with higher self-efficacy gain better performance in contrast to those with lower self-efficacy in Internet-based settings.

2.4 Appraisal of the Reviewed Literature

Despite the emerging trends in technology-assisted learning, the reviewed literature established that not so much has been done in the use of technology to flip lessons in Nigeria. In recent years, the use of technology for lesson delivery has always been to compliment what a conventional teacher would teach; technology has also been used to enhance student's personal learning by enquiry. A number of scholars and agencies have also tried to get a solution to the problem of the large volume of content in Biology courses and the practical by introducing electronic content and making it available to the students on various electronic media. These efforts revealed that the inability to complete course content especially in Biology courses is really a critical problem in the university. The attempts made in the past by researchers to solve the problem of insufficient practical resources was to divide the students into groups while working on practical, but this has not been able to significantly influence the acquisition of Biology practical skill in students, because mere distribution of students into groups will not solve the problem of resources to use. There is therefore the need to explore more effective instructional strategies that will be learner-centered and activity based to make students actively participate in their learning process. Gender of students as well as the computer competence of students has also been identified by researchers as critical impediment towards their usage of Computer based media for learning. The argument on effect of gender on ICT usage for learning is however inconclusive. It appears that not so much has been done in the area of using technology to enhance practical Biology in such a way that students can cross pollinate their learning in a collaborative manner and to complete the course content in the required time as obtainable in the flipped strategy.

Therefore, this study determined the effects of flipped strategy using animation and video packages on Nigeria pre-degree Biology. The problem of inability to complete course contents due to its large volume, the problem of insufficient practical space and equipment were also examined.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

The study adopted the pretest-posttest control group quasi-experimental design. It determined the possible effects of animation-based flipped instructional strategy and video-based flipped instructional strategy on pre-degree students' achievement in practical Biology in Southwestern Nigeria. The design is symbolically represented as:

$O_1\ X_a\ O_2$ (E1)

$O_3\ X_b\ O_4$ (E2)

$O_5\ X_C\ O_6$ (C)

Where O_1, O_3 and O_5 represent the pretest scores for the experimental groups and control group respectively. While O_2, O_4 and O_6 represent the posttest scores for the experimental groups and the control group respectively.

X_a represents Treatment for experimental group E1 (Animation-based flipped instructional strategy)

X_b represents Treatment for experimental group E2 (Video-based flipped instructional strategy)

X_C represents the Treatment for the control group C (conventional instruction using print)

The study employed a 3x3x2 factorial matrix presented in Table3.1

Table 3.1: 3x3x2 factorial matrix

Treatment	**Computer Self Efficacy**			**Gender**
	Low	**Moderate**	**High**	
Experimental Group 1				**Male**
				Female
Experimental Group 2				**Male**
				Female
Control Group				**Male**
				Female

3.2 Variables in the Study

The variables in this study are:

3.2.1 Independent Variable

The study adopted one main independent variable (Instructional strategy) which is manipulated at three (3) levels

a. Flipped instructional strategy using Animation
b. Flipped instructional strategy using Video
c. Conventional instructional strategy using print

3.2.2 Moderator Variables

The following moderator variables were examined in the study

a. Computer self efficacy, occurring at three (3) levels (low, moderate and high)
b. Gender, occurring at two (2) levels (Male and Female)

3.2.3 Dependent Variables

Three specific learning outcomes constituted the dependent variables in the study, they are students':

a. achievement in practical Biology
b. practical skill in Biology
c. attitude to Biology

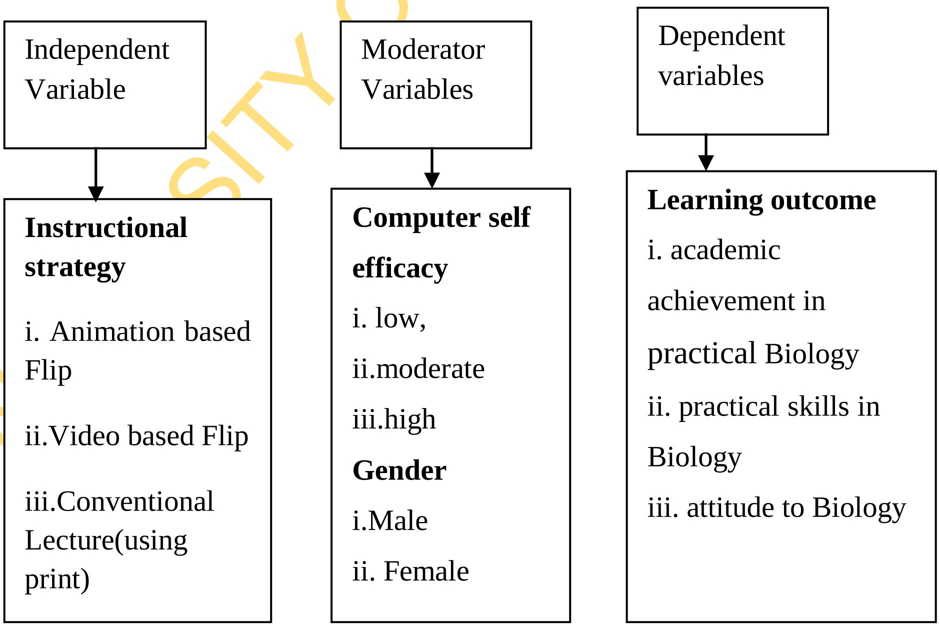


Fig.3.1: Schematic Representation of the Variables

3.3 Selection of Participants

A purposive sampling procedure was adopted in selecting universities and participants. Criteria for selecting universities are the availability of equipment that are necessary to enhance the study such as:

i. Availability of functional Science/Science Education laboratory
ii. Availability of hostel accommodation for students or private hostels where electricity generators are always put on at night for students to read (for the experimental group)
iii. Availability of pre-degree programme in Biology.

Three Universities out of the eight State Universities in the South-West, Nigeria constituting 37% participated in the study. The choice of state owned universities is to have a homogenous sample and study.

The criteria for selecting participants are:

i. Personal possession of a laptop computer or a desktop computer or mobile devices and the ability to use such computer/ devices to play video (mp4)
ii. Participants must be pre-degree students offering Biology
iii. Participants must be resident in University's hostels or nearby hostels that have regular power supply especially at night.

Pre-degree students were selected because there are usually many of them on roll offering Biology with limited facilities available for their practicals.

Criteria for selecting participants in the experimental groups are:

i. Personal possession of a laptop computer or a desktop computer, or a smart mobile device that has facilities to play video(mp4) and
ii. Residency on campus where electricity or power supply through generator is usually available for students' use especially at night or private hostels where generator is always available for students use at night.

These criteria were used to select the experimental sample because the respondents needed a computer device to flip the lesson, and also steady power supply especially at night, which is often obtainable in the hostels.

A simple random sampling method was however used to select the participants of the control group. A total of One hundred and seventy four (174) pre-degree students (69 males, 105females), aged ± 18years participated in the study; Seventy one (71) in the Animation-based flipped group, fifty one (51) in the Video-based flipped group and fifty two (52) in the control group.

3.3.1 Criteria Used for the Selection of Concepts for the Study

The Biology concepts selected for this study are Animal Nutrition, Food classes and Food test. The sub topics include definition of food, classes of food, tests for carbohydrates (simple reducing sugar, complex sugar and starch) tests for protein (millon's test, biuret test), test for lipid (sudan III test, translucent paper mark test) and test for water (cobalt chloride paper mark, anhydrous copper sulphate). Food and test for food are main topics in the Biology Pre-degree level; they are selected because they involve more of practical work, and so require more time to teach for good understanding. It could be very difficult to present the concepts within the conventional period of teaching. The peculiar colour change that characterised each food test cannot be obtained in a conventional theoretical class. Thus, the need to use an animation based flipped instructional strategy, pre-recorded video based flipped instructional strategy and then to be followed by a face-to face collaborative classroom sessions. The concepts selected were taught within a semester. The selected concepts taught are well suited for University students at pre-degree level based on their curriculum.

3.4 Research Instruments

Four (4) response research instruments and three (3) stimuli research instruments were used for the study: viz

I. Biology Practical Achievement Test (BPAT)

II. Biology Practical Skill Rating Scale (BPSRS)

III. Students Attitude to Biology Questionnaire (SABQ)

IV. Computer Self Efficacy Questionnaire (CSEQ)

The Teachers/Instructors Instructional Package (T/IIP) comprised of

I. Animation-Based Instructional package (ABIP)

II. Video-Based Instructional package (VBIP)

III. Conventional Lecture Instructional Guide (CLIG)

3.4.1 Instrument for Obtaining Data(Response Instruments)

3.4.1.1 Biology Practical Achievement Test (BPAT)

This is a multiple choice test items developed by the researcher. It comprises of two sections: section A is demographic- it sought information on personal data of the students/respondents. Section B contains thirty-five multiple choice (objective) questions with options A-D from which students were expected to pick the correct option. Section B was used to collect data on the level of students' achievement in the selected concepts in Biology, namely: Animal nutrition (food definition), classes of food, food test, (test for carbohydrate, test for protein, test for fat and oil and test for water) that students were taught.

Development and Validity of BPAT

A test blue-print was formulated to reflect the different levels of Bloom's taxonomy of the cognitive domains on one axis and content areas on the other. At the start, sixty multiple choice questions were drawn from the selected concepts. The draft instrument was shown to two lecturers in the Department of Science Education, Adekunle Ajasin University, Akungba-Akoko, and two lecturers in the unit of Measurement and Evaluation in Adekunle Ajasin University and two lecturers in the Biological Sciences Department, Faculty of Science, Adekunle Ajasin University, to determine their suitability for target population in terms of forms, contents, reading level and behavioural objectives of the items.

The discrimination power of the test and the difficulty indices of the items were computed after administering the test on 50 Biology pre-degree students (2014/2015set) that were not part of the study from Adekunle Ajasin University. The discriminating power was calculated and items with low discriminatory powers and very high discriminatory power were dropped. Items with difficulty indices between 40-60% were considered for the final test. The final draft of the test have items distributed as shown in the test blue print in Table 3.2 (Bloom, 1956)

Table 3.2 Table of Specification for BPAT

Content Area **Main Contents**	**Categories in Cognitive Domain**						
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total item across Concepts
Food	**(1)**27	**(1)** 1	**(2)**2,3	**(1)** 5	-	-	**5**
Classes of Food	**(4)**4,6,8,26	**(4)**10,28,29,32	**(1)**9	-	-	-	**9**
Food Test : Carbohydrate	**(1)**11	**(3)**12,14,31	-	**(3)**13,15, 30	**(1)** 24	-	**8**
Test for protein	**(4)**16,17,18, 20	**(1)** 34	-	**(1)** 33	-	-	**6**
Test for Fat and Oil	**(2)** 21,22	**(1)** 19	**(1)**23	-	-	-	**4**
Test for water	**(1)**25	-	**(1)**7	**(1)**35	-	-	**3**
Total/Percentage	**13** (37.1%)	**10** (28.6%)	**5**(14.3%)	**6**(16.7%)	**1**(2.9%)	0(0%)	**35**

The questions were based on the concepts of Animal nutrition, Food classes and Food test, and were checked with five levels of cognition according to Blooms (Knowledge, Comprehension, Application, Analysis, and Synthesis). These five levels of cognition are considered appropriate because the respondents (pre-degree students) should be involved in part of higher cognition such as application, analysis, and synthesis.

Questions generated on the Biology concept- Food were five(5), nine (9) questions were generated for Food classes, eight(8) questions were generated on Test for carbohydrates, six (6) questions on Test for protein, four (4) on test for Fat and Oil and three (3) questions on test for water.

A correct answer/ response was given one (1point) while a wrong response attracted zero (0) as its value.

Reliability of BPAT

Copies of the thirty five item BPAT were administered to 50 Biology pre-degree students from Ekiti State University, Ifaki- Ekiti campus; their scores were subjected to internal consistency using the Kuder- Richardson 20 formula. The values yielded 0.82 which shows that the instrument is reliable enough to be used for the study.

3.4.1.2 Biology Practical Skill Rating Scale (BPSRS)

Fifteen questions centred on Biology practical skills were generated based on the selected concept for the study. Students were made to perform or carry out the activity/ skill. A correct skill/practice was given one (1) while a wrong skill/practice attracted zero (0) as its value.

Development and Validity of BPSRS

A test blue-print was formulated to reflect the different levels of Bloom's taxonomy of the cognitive domains on one axis and content areas on the other. At the start, thirty practical questions were drawn from the selected concepts. The draft instrument was shown to two lecturers in the Department of Science Education, Adekunle Ajasin University, Akungba-Akoko, and two lecturers in the Biological Sciences Department, Faculty of Science, Adekunle Ajasin University, to determine their suitability for target population in terms of forms, practicality, and availability of resources to use for the questions. The discrimination power of the test and the difficulty indices of the items were computed after administering the test on 50 Biology pre-degree students(2014/2015set) that were not part of the study from Adekunle Ajasin University. The discriminating power was calculated and questions with low discriminatory powers and very high discriminatory power were dropped. Items with difficulty indices between 40-60% were considered for the final test. The final draft of the skill scale has 15 items distributed as shown in the test blue print in Table 3.3(Bloom, 1956)

Table 3.3 Table of Specification for BPSRS

Content Area **Main Contents**	**Categories in Cognitive Domain**						
	knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total item across Concepts
Food	-	-	-	-	-	-	**0**
Classes of Food	-	-	-	**(1)** 1	-	-	**1**
Food Test : Carbohydrate	-	-	**(2)** 2,4	-	**(2)** 3, 6	**(3)**5,13, 14	**7**
Test for protein	-	-	-	-	**(1)** 9	**(1)**10	**2**
Test for Fat and Oil	-	-	-	-	**(1)** 7	**(1)** 11	**2**
Test for water	-	-	-	-	**(2)** 8, 15	**(1)** 12	**3**
Total/Percentage	-	-	**2**(13.3%)	**1**(6.7%)	**6**(40.0%)	**6**(40.0%)	**15**

Reliability of BPSRS

The fifteen item BPSRS were administered on 50 Biology pre-degree students from Ekiti State University, Ifaki- Ekiti campus; their scores were subjected to internal consistency using Kuder-Richardson 20 formula. The values yielded 0.81 which shows that the instrument is reliable enough to be used for the study.

BPAT and BPSRS were used for pretest and posttest measures (Appendix I & II)

3.4.1.3 Students Attitude to Biology Questionnaire (SABQ)

Development and Validity of SABQ

This instrument was also developed by the researcher. It was divided into two sections. Section A is demographic; it sought information on institution of the participants, level, sex, institution's location and State. Section B aimed at assessing students' attitude to Biology. Section B has 25 close-ended items. Each item is placed on a four point Likert type ordinal scale, viz: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The scorings were from 4, 3, 2 and 1 for its thirteen positively worded items and 1, 2, 3 and 4 for its twelve negatively worded questions (see appendix III). The face and content validity of the instrument was ensured through the involvement of experts in the field of Biology Education from the Science Education Department, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria. The instrument was also examined and scrutinised by the researcher's supervisor in order to determine whether the items could measure the intended variable. The valuable contributions and suggestions from the experts and the researcher's supervisor informed the final production of SABQ.

Reliability of SABQ

Cronbach alpha formula procedure was used to determine the internal consistency of SABQ after it was administered to twenty five (25) pre-degree students from Ekiti State University Ifaki- Ekiti campus. The value yielded 0.73 which shows that the instrument is reliable enough to be used for the study.

3.4.1.4 Computer Self Efficacy Questionnaire (CSEQ)

This instrument was adapted from Murphy scale (1989) on Computer self efficacy assessment. Murphy scale centres on measuring individuals' self-perceptions of accomplishments surrounding particular computer-related knowledge and skills. This instrument helped to obtain information on the computer self efficacy level of the participants. It is a fact finding questionnaire adapted to two sections. The main modification done was on section A which sought respondent's basic biographic information while the modification done on section B was to personalise the items. So, section A sought information on personal data of the participants while section B elicited information on the levels of computer self efficacy of the students at three levels: beginner, intermediate and high. See (Appendix III)

Responses to CSEQ were classified as:

i. whose Computer self efficacy is lower than 40 as low
ii. whose Computer self efficacy is between 41 and 70 as moderate
iii. whose Computer self efficacy is higher than 70 as high

Reliability of CSEQ

Cronbach alpha formula procedure was used to find the level of reliability to ensure the internal consistency of the adapted CSEQ instrument locally, by administering it to twenty five (25) Biology pre-degree students from Ekiti State University, Ifaki- Ekiti campus. The value yielded 0.88 which shows that the instrument is reliable enough to be used for the study.

3.4.2 Teachers/Instructors Instructional Package (T/IIP)

This refers to the treatment implementation packages. There were three implementation packages, the first for the animation-based flipped instruction group, second for the video-based flipped instruction group and the third for the conventional lecture group.

3.4.2.1 Animation-Based Instructional Package (ABIP)

This package comprises of an instructional guide designed for the research assistants that participated in the study to regulate their activity while dealing with the flipped group using Animation instruction. It also contained a virtual animated based instruction on VCD where instruction (on the concepts selected) has been prepared, to be viewed/studied at home before the contact class sessions (see Appendix V), the user manual, Instructor's Evaluation sheet and a series of activities that were done during the contact class sessions.

Validity of the Animation-Based Instructional Package

The validity of the animation- based Instructional package was ensured using face and content validity, through expert reviews by lecturers in the Educational Technology Unit, Teacher Education department, University of Ibadan and Adekunle Ajasin University Akungba-Akoko. An evaluation rubric was equally completed by each of these experts after they have seen the animation instruction.

Their areas of review were curriculum content, ease of use, quality of sound and images, clarity of animation character, documentation and support, ability levels, engagement/ interactivity, technical quality, fun, adaptability, accessibility, and speed. Their valuable comments and suggestions informed the final production of the virtual animation instruction. Experts in Biology Education from Science Education Department of Adekunle Ajasin University also checked the package for content validity.

3.4.2.2 Video-Based Instructional Package (VBIP)

This package comprised of an instructional guide designed for the research assistants that participated in the study to regulate their activity while dealing with the flipped group using video instruction. It also contained a Video Compact Disc (VCD)(mp4) where instruction (on the concept selected) had been pre recorded, which was viewed/studied at home before the contact class sessions (see Appendix VI), the user manual, Instructor's Evaluation sheet and a series of activities that were done during the contact class sessions.

Validity of the Video-Based Instructional Package

The validity of the Video-based Instructional package was ensured using face and content validity, through expert reviews by one lecturer each in the Educational Technology Units of University of Ibadan and Adekunle Ajasin University, Akungba-Akoko. An evaluation rubric was also completed by each of these experts after they have watched the Video. Their areas of review were curriculum content, clarity of video, ease of use, documentation and support (sub title), ability levels, engagement/ interactivity, technical quality, adaptability, accessibility, and speed. Their valuable comments and suggestions informed the final production of the instructional video. Experts in Biology Education from Science Education Department of Adekunle Ajasin University also checked the package for content validity.

The animation and video packages followed the stages and phases of creating and developing digital materials for educational purposes. The design and development of the packages adopted the five stages of Instructional System Design (ISD) described by Seels & Richey (1994) i.e.:

1. Analyzing: process of defining what is to be learned and the context in which it is to be learned.
2. Designing: process of specifying how it is to be learned
3. Developing: process of authoring and producing the instructional material
4. Implementing: actually using the materials and strategies in context, and
5. Evaluating: process of determining the adequacy of the instruction.

The content of the packages were in congruence with the integrated pre-degree curricula from selected Universities

3.4.2.3 The Conventional Lecture Instructional Guide (CLIG)

The conventional lecture guide is a stimulus instrument that was used for the control group. It directed the research assistants in creating learning experiences. The participants were allowed some measure of interaction with materials such as students' notes and text books rather than using the animated or video packages. The guide contained series of activities and works done as home work. (See Appendix VII)

Validity of Conventional Lecture Guide

The validity of the guide was ensured by two Biology Education lecturers in the Department of Science Education, Adekunle Ajasin Univeristy, Akungba-Akoko. Their observations, criticisms and suggestions were taken into consideration to improve the quality of the instrument.

Validity of all the Instructional Packages

The instructional packages passed through four stages of validation. First, Dick and Carrie Model for video and animation development was used to ascertain the suitability, appropriateness, clarity of ideas, class level and scope of the packages after which two lecturers from Science Education (Biology) Department Adekunle Ajasin University checked for face and content validity. Two lecturers in Educational Technology from Adekunle Ajasin University also scrutinised and amended the packages using the developed evaluation rubrics. The supervisor of this study equally made necessary corrections to the packages.

Table 3.4: Guideline for Animation Based Instructional Package (ABIP) Validity

Content	**4**	**3**	**2**	**1**	**0**
Documentation and support Clarity of the Animation characters Quality of the sound Quality of the images Contents Ease of use Engagement and interactivity Technical quality Fun Adaptability					
Total					

Table 3.5: Guideline for Video Based Instructional Package (VBIP) Validity

Content	**4**	**3**	**2**	**1**	**0**
Content Ease of use Clarity of video Documentation and support Ability level Engagement and interactivity Attractive Technical quality and adaptability Accessibility and speed					
Total					

3.5 Research Procedure

Work Schedule

The study lasted for twelve weeks in a semester; activities during the period are contained in Table 3.6

Table 3.6: Activities of Work Schedule

WEEK	ACTIVITY	TOPIC/Sub topics
1	Selection of research assistants	-
2	i. Selection of institutions ii. Categorisation of institutions into treatment and control groups iii. Purposive selection of participants iv. Training of research assistants	-
3	Administration of Pretest for the experimental and control groups	-
4- 11	The Experiment: the main treatment (use of animation-based flipped instructional strategy and video-based flipped instructional strategy in the experimental groups and the use of conventional instructional strategy, using print media in the control group)	Food, food classes, food test: tests for carbohydrates, tests for proteins, tests for Fat and Oil and tests for Water.
12	Administration of Posttest for the experimental and control groups	-

3.5.1 Pre- Experimental Activities

The researcher obtained letter of introduction issued by the Head of Teacher Education Department, University of Ibadan and presented the letter to all the Directors/Co-ordinators of pre-degrees centres in the Universities that were involved in the study. This made it easy to get the support of the needed research assistants. Three (3) Universities were purposively selected from the eight state owned universities in the South-west geo-political zone of Nigeria. These Universities were purposively assigned to the treatments and control groups based on the criteria of availability of hostel accommodations where electricity is always available for students' use at night as well as institutions with Science Education laboratory available for students' use. This was followed by training of the research assistants.

3.5.2 Training of Participating Research Assistants

The first two weeks of this study was used for selection and training of the participating research assistants. This was to ensure the research assistants competencies in their randomly assigned groups; the training took place in their respective institutions and the training had the following segments

Segment 1: The general set up of the study and the specific nature of each instructional strategy was explained to the research assistants especially as it concerns them. The advantage of the respective guide/package that was assigned to each research assistant was explained to them. This was to ensure that each of them would have the feeling that the guide/package assigned to them could achieve the best result if properly used.

Segment 2: Research assistants were assigned to each instructional group (1 per group). The general guideline to follow in conducting a flipped classroom was explained to the participating research assistants. They were not supposed to do the teaching per se in the contact class; instead, they were supposed to lead discussion sessions, guide students' contribution and their attempts to complete assignments. Each contact lesson activities for the eight weeks were carried out thoroughly by the participating research assistants. They avoided skiving, rate fixing and the use of negative reinforcement with the students; instead, they positively motivated the students and created a lively learning environment.

3.5.3 Administration of the Pretest

After the training of the research assistants, the participants for the study (pre-degree students) were pre tested by the research assistants, using these instruments in the following order:

i. Students' Attitude to Biology Questionnaire (SABQ)
ii. Biology Practical Achievement Test (BPAT)
iii. Biology Practical Skill Rating Scale (BPSRS)
iv. Computer Self Efficacy Questionnaire (CSEQ)

The Students' Attitude to Biology Questionnaire (SAQ) was the first to be administered, in order to obtain their pre-entry attitude; this was followed by the BPAT, BPSRS and CSEQ. This order is important because participant's contact with BPAT, BPSRS and CSEQ may influence their attitude and response to the SABQ

3.5.4 The Treatment

The Guidelines for activities in the treatment groups using animation, video and the control group are presented in Tables on Appendices XIV- XVI

Treatment Stage

The participating research assistants carried out the coordination of the experimental groups and the teaching in the control group for one hour per week and it lasted for eight weeks in the 2015/2016 set of students. The researcher went round to ensure that the research assistants followed the guideline given to them.

1. Experimental Group I (Flipped Instructional Strategy using Animation, Guide)

Step 1 The research assistant introduced the lesson and the strategy the instruction was going to follow.

Step 2 The research assistant distributed the virtual animation CD for the first lesson to the participants and instructed them to go through it when they got home, and that their questions, comments and assignment would be taken in the contact class next week.

Step 3 In the contact- class, the research assistant welcomed the participants, asked them if there was any problem encountered in playing the Virtual animation CD, he then coordinated the questioning, assignment and collaboration session.

Step 4 The participants discussed what they have learnt from their flipped materials (Virtual animation CD) in the contact class. They also shared their jottings and exchanged materials.

Step 5 The research assistant coordinated the discussion of the participants, Corrected their misconceptions gave the task for each day and inspected/guided the student's collaboration in solving the day's task and ended the class by distributing the Virtual animation CD for the next lesson to the students. He instructed them to watch the Virtual animation CD before the next contact class.

2. Experimental Group II (Flipped Instructional Strategy using Video, Guide)

Step 1 The research assistant introduced the lesson and the strategy the instruction was going to follow.

Step 2 The research assistant distributed the Video CD to students with laptop and shared the mp4 video with students that had smart phones or other smart mobile devices, for the first lesson, he instructed them to go through it when they got home and that their questions, comments and assignment would be taken in the contact class next week.

Step 3 In the contact- class, the research assistant welcomed the participants, asked them if there was any problem encountered in playing the video, he then coordinated the questioning, assignment and collaboration session.

Step 4 The participants discussed what they have learnt from their flipped materials (Video) now in the contact class. They shared their jottings and exchanged materials.

Step 5 The research assistant coordinated the discussion of the students, corrected their possible misconception, gave the task for the day and inspected/guided the students' collaboration in solving the day's task. Then he ended the class by distributing/sharing the Video CD/mp4 for the next lesson to the students. He also instructed them to watch the Video before the next contact class.

3. Control Group (Conventional Lecture Method Guide)

Step 1 The research assistant introduced the lesson to the participants by asking related questions from them especially based on their O' Level Biology. All questions were to determine students' previous knowledge.

Step 2 The research assistant taught and explained the topic for the day

Step 3 The research assistant ensured that he followed the sequential order of teacher's note of lesson

Step 4 The research assistant asked questions from students to test how far they understood the topic being taught.

Step 5 The research assistant gave note to participants by dictating key points of the topic.

Step 6 The participants wrote the note being dictated by the research assistants in their notebook.

Step 7 The research assistant gave assignment to the students to answer from home.

Step 8 The research assistant summarised the lesson by asking few questions again from the participants and made necessary corrections based on the topic taught.

3.5.5 Administration of the Posttest

The treatment lasted for eight weeks after which the posttest was administered by the research assistants on the three groups (two experimental and one control) using the same instruments: Students Attitude to Biology Questionnaire (SABQ), Biology Practical Achievement Test (BPAT) and Biology Practical Skill Rating Scale (BPSRS) as for the pretest.

3.6 Method of Data Analysis

Data collected were analyzed in two stages with the use of descriptive statistics such as means and standard deviation and with the use of inferential statistics such as Analysis of Covariance (ANCOVA) to determine the significant main effects and interaction effects of independent and moderator variables on dependent variables. Estimated Marginal Mean (EMM) was used to determine the magnitude of the mean score across the groups. Where significant main differences were observed, Scheffe Post-Hoc analysis was used to determine the direction of significance and to estimate the amount of variation due to the independent variables. Tables, graphs, charts, and figures were also used to interpret relevant interaction effects.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the findings of this study. The results are presented according to the sequence of the hypotheses which were tested. The Analysis of Covariance (ANCOVA) was computed for the variables in both the experimental and control groups. This adjusted for the initial differences that existed in the various groups before the treatment. Estimated Marginal Mean (EMM) was also done to find out how each of the groups performed, especially where there is a significant difference among the groups. Scheffe Post-Hoc analysis was used to find out the source of significance among the three groups. All hypotheses were tested at $p < 0.05$ level of significance. The discussion of the result is also presented.

4.1 RESULTS

4.2 Testing of Null Hypotheses

Hypothesis 1a: There is no significant main effect of treatment (instructional strategy) on students' achievement in Practical Biology

Table 4.1: Analysis of Covariance (ANCOVA) of Post-Biology Practical Achievement Test scores by Treatment, Gender and Computer Self Efficacy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1915.423[a]	18	106.412	4.330	.000	.335
Intercept	4848.298	1	4848.298	197.277	.000	.560
PreBPAT	.000	1	.000	.000	.998	.000
Treatment	200.615	2	100.307	4.082	.019*	.050
Gender	114.113	1	114.113	4.643	.033*	.029
CSEQ	59.405	2	29.703	1.209	.301	.015
Treatment * Gender	91.094	2	45.547	1.853	.160	.023
Treatment * CSEQ	67.928	4	16.982	.691	.599	.018
Gender * CSEQ	22.195	2	11.098	.452	.637	.006
Treatment * Gender * CSEQ	225.683	4	56.421	2.296	.062	.056
Error	3809.295	155	24.576			
Total	90249.000	174				
Corrected Total	5724.718	173				

a. R Squared = .335 (Adjusted R Squared = .257)* Denote significant difference at 0.05 level of significance

Table 4.1 shows that there is significant main effect of treatment on students' Biology Practical Achievement Test scores in ($F_{(2,155)}$ =4.082; P< 0.05, partial η^2 = 0.050). The effect size is 5.0% this means that there was a significant difference in the post-BPAT means scores of students across the groups. Thus, hypothesis 1a was rejected. Therefore, there is significant main effect of treatment on students' achievement in practical Biology. In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was calculated and the result was presented in Table 4.2

Table 4.2: Estimated Marginal Means for Post-BPAT Scores by Treatment and Control group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped(Animation) (FAS)	23.48[a]	1.096	21.315	25.647
Flipped (Video)(FVS)	21.05[a]	1.208	18.667	23.441
Conventional Strategy(CS)	19.11[a]	1.074	16.988	21.231

(a=Adjusted post BCAT mean Score)

Table 4.2 revealed that the students in Flipped animation strategy (FAS) group had the highest adjusted post- Biology Practical Achievement Test mean score(23.48) followed by Flipped video strategy group (FVS) whose mean was (21.05) while the conventional strategy (CS) group had the least adjusted post- Biology Practical Achievement Test mean scores (19.11).

Table 4.3: Scheffe Post-hoc Analysis of Post-BPAT Scores by Treatment and Control Groups

Treatment	Mean	FAS	FVS	CS
FAS	23.48		*	*
FVS	21.05	*		*
CS	19.11	*	*	

* = Pairs of significantly different at p<.05

This order can be represented as FAS> FVS> CS.

Table 4.3 revealed that students exposed to Flipped Animation Strategy (FAS) were significantly different in their achievement from their counterparts that were exposed to Flipped Video Strategy (FVS) and Conventional Strategy (CS) in their post- Biology Practical

Achievement Test scores. Furthermore, the students exposed to flipped video strategy were significantly different in their achievement from those exposed to conventional strategy.

Hypothesis 1b: There is no significant main effect of treatment (instructional strategy) on students' practical skill in Biology

Table 4.4: Analysis of Covariance (ANCOVA) of Post-Biology Practical Skills Rating Scores by Treatment, Gender and Computer Self Efficacy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	847.434[a]	18	47.080	9.119	.000	.514
Intercept	1368.088	1	1368.088	265.001	.000	.631
PreBPSRS	64.558	1	64.558	12.505	.001	.075
Treatment	246.794	2	123.397	23.902	.000*	.236
Gender	9.642	1	9.642	1.868	.174	.012
CSEQ	6.339	2	3.169	.614	.543	.008
Treatment * Gender	42.364	2	21.182	4.103	.018*	.050
Treatment * CSEQ	27.901	4	6.975	1.351	.254	.034
Gender * CSEQ	.405	2	.203	.039	.962	.001
Treatment * Gender * CSEQ	13.460	4	3.365	.652	.626	.017
Error	800.198	155	5.163			
Total	18888.000	174				
Corrected Total	1647.632	173				

Squared = .514 (Adjusted R Squared = .458) * Denote significant difference at 0.05 level of significance

Table 4.4 shows that there is a significant main effect of treatment on students' Biology Practical Skill Scores ($F_{(2,155)} = 23.902$; $P < 0.05$; partial $\eta^2 = 0.236$). The effect size is 23.6%. Hence, hypothesis 1b was rejected. Therefore there is significant main effect of treatment on students' practical skill in Biology. In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was carried out and the result was presented in Table 4.5.

Table 4.5: Estimated Marginal Mean for post- Biology Practical Skill Rating Scores by Treatment and Control Group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Animation (FAS)	12.02[a]	.500	11.030	13.005
Flipped Video (FVS)	10.29[a]	.541	9.225	11.362
Conventional Strategy (CS)	7.01[a]	.517	5.992	8.034

a=adjusted post practical skill mean score

Table 4.5 shows that students in the Flipped Animation Strategy (FAS) treatment group had the highest adjusted post- Biology Practical Skill mean score (12.02) followed by the Flipped Video Strategy (FVS) treatment group (10.29) while students in the Conventional Strategy (CS) group had the least adjusted post- Biology Practical Skill mean score (7.01).

Table 4.6: Scheffe Post-hoc Analysis of Post- Biology Practical Skill Rating Scores by Treatment and Control Group

Treatment	Mean	FAS	FVS	CS
FAS	12.02		*	*
FVS	10.29	*		*
CS	7.01	*	*	

* = Pairs of significantly different at p<.05
This order can be represented as FAS> FVS > CS.

Table 4.6 revealed that students exposed to flipped animation strategy were significantly different from their counterparts exposed to flipped video strategy and conventional strategy in their post-biology practical skill scores. Furthermore, the students exposed to flipped video strategy were significantly different from those exposed to conventional strategy. This implies that both flipped animation and flipped video strategies are the main source of significant differences in treatment.

Hypothesis 1c: There is no significant main effect of treatment (instructional strategy) on students' attitude to Biology

Table 4.7: Analysis of Covariance (ANCOVA) of Post-Student Attitude to Biology Questionnaire Scores by Treatment, Gender and Computer Self Efficacy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1473.486[a]	18	81.860	1.244	.233	.126
Intercept	9657.435	1	9657.435	146.740	.000	.486
PreSABQ	2.962	1	2.962	.045	.832	.000
Treatment	386.154	2	193.077	2.934	.041*	.036
Gender	7.799	1	7.799	.119	.731	.001
CSEQ	126.231	2	63.116	.959	.386	.012
Treatment * Gender	24.695	2	12.348	.188	.829	.002
Treatment * CSEQ	436.699	4	109.175	1.659	.162	.041
Gender * CSEQ	224.717	2	112.358	1.707	.185	.022
Treatment * Gender * CSEQ	455.382	4	113.846	1.730	.146	.043
Error	10201.043	155	65.813			
Total	771732.000	174				
Corrected Total	11674.529	173				

a. R Squared = .126 (Adjusted R Squared = .025) * Denote significant difference at 0.05 level of significance

The results on Table 4.7 indicate that there is significant main effect of treatment on students' attitude scores ($F_{(2,155)}$ = 2.934; $P< 0.05$, partial η^2 = 0.036). The effect size is 3.6%; this implies that 3.6% of the variance observed in the attitude mean score is due to the treatment. It means that there was a significant difference in the post-attitude mean scores of students. Thus, hypothesis 1c was rejected. In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was carried out and the result was presented in Table 4.8.

Table 4.8: Estimated Marginal Mean Post-Attitude by Treatment and Control Group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Animation (FAS)	68.02[a]	1.784	64.493	71.540
Flipped Video (FVS)	66.08[a]	1.904	62.322	69.845
Conventional Strategy(CS)	61.85[a]	1.820	58.257	65.448

a=adjusted post-attitude mean score

Table 4.8 shows that students in the flipped animation strategy group had the highest adjusted post-attitude mean score (68.02) followed by the flipped video strategy group

(66.08) while students in the conventional strategy control group had the least adjusted post-attitude mean score (61.85).

Table 4.9: Scheffe Post-hoc Analysis of Post-Attitude by Treatment and Control Group

Treatment	Mean	FAS	FVS	CS
FAS	68.02		*	*
FVS	66.08	*		*
CS	61.85	*	*	

* = Pairs of significantly different at p<.05
This order can be represented as FAS> FVS > CS.

Table 4.9 revealed that students exposed to flipped animation strategy are significantly different from their counterparts exposed to flipped video strategy and conventional strategy in their post-attitude scores. Furthermore, the students exposed to flipped video strategy are significantly different from those exposed to conventional strategy. This implies that both flipped animation and flipped video strategies are the main source of significant differences in treatment.

Hypothesis 2a: There is no significant main effect of gender (male and female) on students' achievement in practical Biology

Table 4.1 shows that there is significant main effect of gender on students' Biology Practical Achievement Test Scores ($F_{(1,155)}$ = 4.643, P<.05, partial η^2 = .029). The effect size is 2.9%, this means that there was a significant difference in the mean post-Biology Practical Achievement Test scores of students according to gender. Thus, hypothesis 2a was rejected. Therefore, there is significant main effect of gender on students' achievement in practical Biology. In order to determine the magnitude of the significant main effect across gender, the estimated marginal means of students' gender was carried out and the result was presented in Table 4.10.

Table 4.10: Estimated Marginal Means for Post-BPAT Scores by Gender

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	19.83[a]	.898	18.053	21.599
Female	22.60[a]	.921	20.784	24.424

a=adjusted post-BPAT mean score

Table 4.10 revealed that the female students had the higher adjusted post-Biology Practical Achievement Test mean score (22.60) followed by their male counterparts (19.83). The difference in their mean scores is statistically significant.

Hypothesis 2b: There is no significant main effect of gender (male and female) on students' practical skill in Biology

Table 4.4 shows that there was no significant main effect of gender on students' practical skill in Biology ($F_{(1,155)}$ = 1.868, P>.05, partial η^2 = .012). Therefore, hypothesis 2b was not rejected.

Hypothesis 2c: There is no significant main effect of gender (male and female) on students' attitude to Biology

The results in Table 4.7 shows that gender had no significant main effect on students' attitude to Biology ($F_{(1,155)}$ = 0.119; P>0.05, partial η^2 =.001). Hence the null hypothesis 2c was not rejected.

Hypothesis 3a: There is no significant main effect of level of computer self efficacy on students' achievement in Practical Biology

The results in Table 4.1 showed that there was no significant main effect of computer self efficacy on students' Biology Practical Achievement Test Scores ($F_{(2,155)}$ = 1.209, P>.05, partial η^2 = .015). Thus, the null hypothesis 3a was not rejected. Therefore, there is no significant main effect of level of computer self efficacy on students' practical skill in Biology.

Hypothesis 3b: There is no significant main effect of level of computer self efficacy on students' practical skill in Biology

The results in Table 4.4 showed that there was no significant main effect of computer self efficacy on students' practical skill in Biology ($F(_{2,155})$ = .614, P>.05, partial η^2 =

.008). Thus, the null hypothesis 3b was not rejected. Therefore, there is no significant main effect of level of computer self efficacy on students' practical skill in Biology.

Hypothesis 3c: There is no significant main effect of level of computer self efficacy on students' attitude to Biology

The results in Table 4.7 showed that there is no significant main effect of computer self efficacy on students'attitude to Biology ($F_{(2,155)}$ = .959, P>.05, partial η^2 = .012). Therefore, the null hypothesis 3c was not rejected.

Hypothesis 4a: There is no significant interaction effect of treatment (instructional strategy) and gender on students' achievement in practical Biology

The results in table 4.1 showed that there was no significant two-way interaction effect of treatment and gender on students Biology Practical Achievement Test Scores ($F_{(2,155)}$ = 1.853, P>.05, partial η^2 = .023). The null hypothesis 4a was not rejected. Therefore, there is no significant interaction effect of treatment and gender on students' achievement in practical Biology

Hypothesis 4b: There is no significant interaction effect of treatment (instructional strategy) and gender on students' practical skill in Biology

Table 4.4 shows that there was significant two-way interaction effect of treatment and gender on students' Biology practical skill scores ($F_{(2,155)}$ = 4.103, P<.05, partial η^2 = .050). The effect size of 5.0% was fair. Thus, the null hypothesis 4b was rejected. This depicts that gender (male and female) and treatment has effect on students' practical skill when taken together. In order to determine the magnitude of the significant main effect across gender, the estimated marginal means of students' gender was carried out and the result was presented in Table 4.11.

Table 4.11: Estimated Marginal Means for post- Biology Practical Skill Rating Scores (BPSRS) by Treatment and Gender

Treatment	Gender	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Flipped Animation Strategy	Male	22.57[a]	1.889	18.844	26.306
	Female	24.39[a]	1.095	22.224	26.550
Flipped Video Strategy	Male	20.87[a]	1.511	17.881	23.850
	Female	21.24[a]	1.844	17.599	24.885
Control	Male	16.04[a]	1.204	13.658	18.416
	Female	22.18[a]	1.779	18.668	25.696

a=adjusted post-BPSRS mean score

Table 4.11 revealed that the female students in flipped animation strategy group had the highest adjusted post-Biology Practical Skill mean score (24.39) followed by the male students in flipped animation strategy group (22.57) followed by the female students in the control group (22.18) followed by the female students in flipped video strategy group (21.24) followed by the male students in the flipped video strategy group (20.87) while the male students in the control group had the lowest adjusted post- Biology Practical Skill mean score (16.04).The interaction is ordinal.

In order to disentangle the interaction effect, figure 4.1 presents the interaction in line graph.

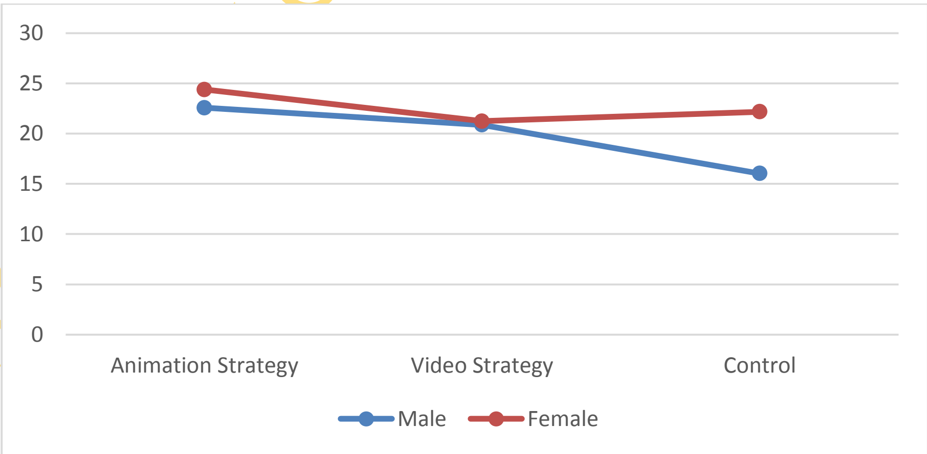


Fig. 4.1: Line Graph Showing the Interaction Effect of treatment and gender on Students' Biology Practical Skill

Fig.4.1 revealed that the interaction is ordinal; this implies that the female group performed better in the treatment and control groups. The implication of this is that the treatment favours the female more than their male counterparts

Hypothesis 4c: There is no significant interaction effect of treatment (instructional strategy) and gender on students' attitude to Biology

The results in Table 4.7 revealed that there is no significant interaction effects of treatment and gender on students' attitude to Biology ($F_{(2,155)}$ = .188, P>.05, partial η^2 = 0.002). Therefore, the null hypothesis 4c was not rejected.

Hypothesis 5a: There is no significant interaction effects of treatment (Instructional strategy) and level of computer self efficacy on students' achievement in Practical Biology.

Analysis of covariance on Table 4.1 revealed that there was no significant two-way interaction effects of treatment and computer self efficacy on students' BPAT Scores ($F_{(4,155)}$ = .691; P>.05; partial η^2 = .018. Thus, the null hypothesis 5a was not rejected. Therefore, there is no significant interaction effects of treatment and level of computer self efficacy on students' achievement in Practical Biology.

Hypothesis 5b: There is no significant interaction effects of treatment (Instructional strategy) and level of computer self efficacy on students' practical skill in Biology

The results in Table 4.4 revealed that there was significant interaction effect of treatment and computer self efficacy on students' practical skill in Biology ($F_{(4,155)}$ = 1.351, P>.05, partial η^2 = .034). The null hypothesis 5b was not rejected. Therefore, there is no significant interaction effects of treatment and level of computer self efficacy on students' practical skill in Biology

Hypothesis 5c: There is no significant interaction effects of treatment (Instructional strategy) and level of computer self efficacy on students' attitude to Biology

The results in Table 4.7 revealed that there was no significant interaction effects of treatment and computer self efficacy on students' attitude to biology ($F_{(4,155)}$ = 1.659, P>.05, partial η^2 = .041). The null hypothesis 5c was not rejected. Therefore, there is no significant interaction effects of treatment (Instructional strategy) and level of computer self efficacy on students' attitude to Biology

Hypothesis 6a: There is no significant interaction effects of gender and level of computer self efficacy on students' achievement in Practical Biology

Table 4.1 revealed that the interaction effects of gender and computer self efficacy on students' Biology Practical Achievement Test Scores was not significant ($F_{(2,155)}$ = .452, P>.05, partial η^2 = 0.006). Thus, the null hypothesis 6a was not rejected. Therefore, there is no significant interaction effects of gender and level of computer self efficacy on students' achievement in Practical Biology

Hypothesis 6b: There is no significant interaction effects of gender and level of computer self efficacy on students' practical skill in Biology.

The covariance analysis of students' post- Biology Practical Skill Scores in Table 4.4 revealed that the two-way interaction effects of gender and computer self efficacy on students' practical skill in Biology was not significant ($F_{(2,155)}$ = .039, P>.05, partial η^2 = .001). Therefore, the null hypothesis 6b was not rejected. Therefore, there is no significant interaction effects of gender and level of computer self efficacy on students' practical skill in Biology

Hypothesis 6c: There is no significant interaction effects of gender and level of computer self efficacy on students' attitude to Biology

The covariance analysis of students' attitude in Table 4.7 revealed that the interaction effects of gender and computer self efficacy on students' attitude to Biology is not significant ($F_{(2,155)}$ = 1.707, P>.05, partial η^2 = .022). Therefore, the null hypothesis 6c was not rejected.

Hypothesis 7a: There is no significant interaction effects of treatment (instructional strategy), gender and level of computer self efficacy on students' achievement in Practical Biology

Table 4.1 shows that the three-way interaction effects of treatment, gender and computer self efficacy on students' Biology Practical Achievement Test Scores was not significant ($F_{(4,155)}$ = 2.296, P>.05, partial η^2 = .056). The null hypothesis 7a was therefore not rejected. Therefore, there is no significant interaction effects of treatment, gender and level of computer self efficacy on students' achievement in Practical Biology

Hypothesis 7b: There is no significant interaction effects of treatment (instructional strategy), gender and level of computer self efficacy on students' practical skill in Biology

From Table 4.4 the three-way interaction effects of treatment, gender and computer self efficacy on students' Biology Practical Skill Scores was not significant $F_{(4,155)}$ =.652; P>.05; partial η^2 = 0.017). Hence the null hypothesis 7b was not rejected. Therefore, there is no significant interaction effects of treatment, gender and level of computer self efficacy on students' practical skill in Biology

Hypothesis 7c: There is no significant interaction effects of treatment (instructional strategy), gender and level of computer self efficacy on students' attitude to Biology.

From Table 4.7 the three-way interaction effects of treatment, gender and computer self efficacy on students' attitude to Biology is not significant $F_{(4,155)}$ = 1.730; P>.05; partial η^2 = 0.043). Hence the null hypothesis 7c was not rejected.

4.3 DISCUSSION

4.3.1 Effects of Treatment on Students' Achievement in Practical Biology

The findings of the study revealed significant differences in the achievement scores of students in selected Biology Practical concepts across the two levels of experimental and control groups. Students exposed to the animation-based and video based strategies had higher achievement scores than their counterparts in the control group. The findings showed that the experimental strategies (using animation and video platforms) are more effective than the conventional method in improving students' achievement in practical Biology. The result is in support of findings by Aremu *et.al.*

(2010), Stone (2012), Aremu *et.al.* (2014), Gladys (2015) and Adedoja (2016). The findings of the study revealed that there is significant progress made by students in the process of learning practical Biology using the flipped strategy and this is in accordance with the findings of Jason (2012) where he found that students progressed through materials faster, understood topics in greater depth, and covered additional content without sacrificing the quality of the course as a whole. The significant effect of treatment on students' achievement would also have been caused by the fact that flipped classroom strategy enhances retention. Sadaghiani (2012) said that multi modal learning of flipped classroom (as obtained in this study) would enhance retention. Dale (1967) in his cone of experience showed that people generally remember 90% of what they do, unlike 20% of what they hear and 10% of what they read. Flipped classroom instructional strategy is based on the learning theory of making students participate in their learning and whenever students are involved in higher level of cognition they were able to analyse, create, design and evaluate properly.

The result also lends credence to the claims of Aremu *et al.* (2010) when computer Animation package was used to test the achievement of senior secondary school students in Biology, which is similar to this present study; there was significant main effect of treatment on students achievement in Biology. The study recommended animation package as a means of teaching Biology at all levels of study. This present study therefore takes it a little further to determine the effect of animation-based flipped strategy on biology practical and the result is similar to the findings of Aremu *et.al.* (2010). One fact that is common to these studies is that the use of animation for instruction in Biology is interactive that is, it often involves the students in making progress as they learn. Animation packages are often designed in such a way that the user would have to be active with the use of the package by clicking, dragging or typing using the mouse or keyboard in order to advance in the use of the animation package. Similarly, the video package is also recorded with the learners in mind. The step by step arrangement of the video may help learners to use the video as guide while in the laboratory carrying out the experiments. The result agrees with the finding of Ojo (2009) where Video CD and audio Cassette instruction were used to determine the learning outcomes of students in environmental education concept in Biology.

The involvement of students in this study while using the package is in line with the constructivist theory of learning as stipulated by Kolb in his theory of experiential learning as well as by Vygotsky developmental theory. This theory's basic assumption is that the use of active learning (which is obtainable in animation used in this study) where learners play active roles can engage and motivate learning more effectively than activities where learners are passive i.e. relying more on their hearing faculties than their limbs. Furthermore, the flipped strategy whereby the classroom element of instruction and the home element of instruction are inverted has made the learner to be the director of his learning. In the conventional method of learning according to Okoye (2010) and Smith (2013) many learners simply attend class without thinking or planning what the day's work would be, this way, they are termed passive, and that is what is responsible for many students sleeping while lesson is going on. The flipped classroom has reversed the role of the student from being just the receiver to becoming active player in the course of sending the message. Though the act of encoding the content of the lesson still largely remains the role of the teacher but students are now more important stake holders in their learning process. From the findings of this study, it may therefore be concluded that the use of instructional strategies that are centred on constructivist learning theory which actively involve the learners in their learning process would go a long way in enhancing their comprehension and retention of the content thereby leading to appreciable and significant achievement after evaluation is done.

4.3.2 Effects of Treatment on Students' Practical Skills in Biology

The findings of the study revealed that there is a significant main effect of treatment on students' practical skills in Biology: students in Animation-based flipped experimental group had the highest adjusted post mean scores, followed by students in the Video-based flipped experimental group. Students in the control group had the lowest adjusted post mean scores in BPRSS**.** Possible reason for this may be because of the active involvement of the students in their learning process, which is the basic assumption of the constructivist learning theory on which flipped classroom strategy is based. Flipped classroom is particularly helpful in the practical aspect of Biology; it helps to serve as an alternative means of carrying out practical activities even when there are not enough facilities to go round all the students on roll. Jegede *et al.* (2013) advocated for practical focused approaches in the instruction of Biology. Animation-based flipped strategy as used in this study had the highest positive effect on students' practical skill. Students in the animation-based group improved in their practical skills more than other groups most likely because they were more engaged in the learning process by clicking to proceed in the learning process unlike their counterpart in the video and control groups where they merely watched and listened to the teacher. The flipped classroom groups did better than the conventional lecture group probably because they had to prepare for the contact section of the flipped classroom: they had to take notes; there were questions that led to class discussion. Furthermore, some characteristics of the animation package such as its sound and colourful images as well as the ability to view an area of interest over and over again may have been responsible for the significant improvement of their practical skills. The motivation that learners got using the animation package is unprecedented. There was a lot of excitement displayed by the users about the animation package.

The high level of teacher-to-student and student-to-student interaction in a Biology practical flipped classroom is another possible reason for the significant improvement in the practical skills acquired by students in this study. The contact class was not teacher dominated as it was in the conventional method, questions generated in the flipped lesson were tackled collaboratively in the contact class, this gave a whole lot of peer interaction, and the teacher was able to guide by the side paying attention to students with weak contribution with the aim of guiding and correcting them. Moore *et .al.* (2014) emphasised that their experience in flipped classroom facilitated a one-on-one contact with every student during every class period which in turn enhanced students performance in practical work. Thus, not only do students use the flipped video or animation to be a guide in the face-to-face class, it also interests them because of the simulation that the flipped material contains (Khan 2012). Aremu *et al*. (2012) used tools similar to animation (games and toys) to enhance psychomotor skill in students, animation package which is similar to game has the ample uniqueness of sharpening psychomotor skills which is used in practical. Biology practical is centred more on the psychomotor domain than cognitive domain of Bloom's taxonomy, therefore strategy that involves learners participation would help to improve mastery of such skills. It is not surprising therefore to see that animation group had the highest adjusted post test mean score. The result also lends credence to the claims of Sams (2010), Nguyen *et al.* (2012), Jason (2012), Brame (2013) and Miles (2015). These researchers have established that whenever there is peer tutoring or peer collaboration, students always enjoy support from their peers which is not always available whenever the lesson is teacher dominated. So, when there is peer assistance and support in a practical lesson, mastery of skills are likely to be more than when it is teacher mediated. Flipped classroom therefore is what has necessitated the significant result in this study. From the findings of this study, it may therefore be reasonable to conclude that flipped strategy particularly has the tendency to improve students' mastery of practical skills since they have the support of their peers while in class.

4.3.3 Effect of Treatment on Students' Attitude to Biology

Findings from this study revealed that there is a significant main effect of animation and video-based flipped instructional strategy on students' attitude to Biology: students in the animation-based flipped group particularly had the highest adjusted post-attitude mean score, followed by the video-based flipped group, while students in the control group had the least adjusted post-attitude mean score. This result is in line with the findings of Adedoja *et al.* (2013), Aremu *et al.* (2013), Nsofor *et al.* (2015) and Adedoja (2016) Students are likely to have developed a positive attitude towards flipped classroom strategy because it frees them from the boredom often associated with the conventional method of teaching biology. Observation from this study revealed that students' interest and participation in Biology have increased as a result of the flipped strategy used. Students in the treatment groups commented that they never knew that Biology lectures could be this lively and benefiting. They specifically reported that they enjoyed the collaboration segments of the study. These reports are in conformity with what Jason (2012) experienced where he reported that 75% of students in flipped classroom frequently or always help other students in class.

It appears that any strategy that is ICT based always receives more attention and acceptance from students, especially those in higher level of studies. Several scholars have established this: Adedoja *et al.* (2010), Aremu *et al.* (2010), Tom (2012), Bergmann *et.al.* (2012), Mike (2012), Aremu *et al.* (2013), Adedoja *et al.* (2013), Efuwape *et al.* (2013), Akingbemisilu (2014), Aremu *et al.* (2014), Gladys *et al.* (2015). The rate of acceptance and usability of ICT based strategy by students in higher institutions has been confirmed high. It is therefore appropriate to infer that ICT based instructional strategy such as flipped classroom always influence the attitude of students to the subject it is used to facilitate. In this study, the flipped strategy using animation and video platforms were able to significantly influence the attitude of students towards Biology positively.

4.3.4 Effect of Gender on Students' Achievement in Biology

Findings from this study showed that there is a significant main effect of gender on students' achievement in practical Biology, the female students outperformed their male counterparts however, and there is no significant main effect of gender on students' practical skill in Biology as well as in their attitude to Biology. Various authors such as Abiona (2008), Ojo (2009) and Efuwape (2013), have come up with different report/results on the issue of gender and practical skills, this study however has confirmed that female students tends to be more interested in flipped strategy than their male counterpart. The result of this study agrees with the findings of Okeke (2001), Ogunleye(2002), Olatundun (2008), Olagunju *et al*. (2008), Aremu and Fasan (2011), Efuwape (2013), but contrary to the studies of Bilesanmi-Awoderu (2002), Abiona (2008), Ojo (2009) and Ganiyu *et al*. (2014). It appears that the effect of gender on students' achievement over the years has not been consistent, though this study shows that female achieved better in practical Biology test but this was not consolidated in their practical skills and attitude to Biology, it therefore means that several other factors may influence the rate of students' achievement as far as gender is concerned. This implies that findings on gender remain an unsolved puzzle; further studies may have to look closely to this important intervening variable. From the findings of this study, it may therefore be reasonable to conclude that females perform better than their male counterparts in achievement test but not in practical skills.

4.3.5 Interaction Effects

The 2-way interaction effect of treatment and gender on Students' practical skill was significant in this study: the female students in the animation-based flipped group had the highest adjusted post-Biology Practical Skill mean score followed by the male students in the animation-based flipped group followed by the female students in the control group, followed by the female students in the video-based flipped group, followed by the male students in the video-based flipped group while the male students in the control group had the lowest adjusted post- Biology Practical Skill mean score. The interaction is ordinal. Possible reason for this ordinal interaction in favour of the female could have been the roles that the females performed during the study; the girls outnumbered the boys, and this was responsible for the girls always taking more active roles during the study. Such roles include the coordination of the groups and the collaborative practical sessions. It is possible that because the female were more than their male counterparts they are able to influence the work done in each of the groups thereby enhancing their performance. The results that tinted more to the female's side could also have been because of the nature of the packaging of the animation and video media. The colour use in the animation package and the video as well may have attracted the females than it did for the males, thereby making the treatment and gender to have a positive impact on the skills students are to acquire during the practical.

The result therefore shows that treatment and gender contributed more to the significant differences in students' practical skills. This finding is in line with the findings of Olatundun (2008), where the treatment was significant for the female. The treatment had more positive impact on the female than their male counterpart as far as practical skill acquisition is concerned, this probably is so because the female were more attracted to the package. However, the 2-way interaction effects of treatment and gender on achievement in Biology, as well as the 2-way interaction effects of treatment and gender on attitude to Biology are not significant. The interaction effects of treatment and computer self efficacy as well as gender and computer self efficacy were not significant. This means that treatment and computer self efficacy as well as gender and computer self efficacy has little or no effect on students' achievement in practical Biology as well as in their practical skill and attitude. The three-way interactions of the variables also produced no significant effect on students' achievement in practical Biology, practical skill in Biology and attitude to Biology.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of findings of the study, the conclusion and recommendations.

5.1 SUMMARY

The results of the study are summarised below

1. There is a significant main effect of treatment on students' achievement in practical Biology. Students in Animation-based flipped experimental group had the highest achievement scores, followed by students in the Video-based flipped experimental group. Students in the control group had the lowest achievement scores. On practical skills in Biology, there is also a significant main effect of treatment on students' practical skills in Biology: students in Animation-based flipped experimental group had the highest adjusted post mean scores in Biology Practical Skill, followed by students in the Video-based flipped experimental group. Students in the control group had the lowest adjusted post mean scores in Biology Practical Skill. Furthermore, on attitude to Biology, there is a significant main effect of treatment on students' attitude to Biology: students in the animation-based flipped group had the highest adjusted post-attitude mean score, followed by the video-based flipped group, while students in the control group had the least adjusted post-attitude mean score
2. There is a significant main effect of gender on students' achievement in practical Biology, the female students had a higher adjusted post-Biology practical Achievement Test mean score than their male counterparts. However, there is no significant main effect of gender on students' practical skill in Biology as well as in their attitude to Biology.
3. There is no significant main effect of level of computer self efficacy on students' achievement in practical Biology, practical skill in Biology as well as their attitude to Biology.
4. There is no significant interaction effect of treatment and gender on students' achievement in practical Biology as well as in their attitude to Biology. However,

the 2-way interaction effect of treatment and gender on Students practical skill was significant: the female students in animation-based flipped group had the highest adjusted post- Biology Practical Skill Rating Scale mean score followed by the male students in animation-based flipped group followed by the female students in the control group, followed by the female students in video – based flipped group, followed by the male students in the video-based flipped group while the male students in the control group had the lowest adjusted post- Biology Practical Skill Rating Scale mean score. The interaction is ordinal.

5. There is no significant interaction effect of treatment and level of computer self efficacy on students' achievement in practical Biology, students' practical skill in Biology as well as their attitude to Biology.
6. There is no significant interaction effect of gender and level of computer self efficacy on students' achievement in practical Biology, practical skill in Biology as well as in students' attitude to Biology.
7. There is no 3-way interaction effect of treatment (instructional strategies), gender and level of computer self efficacy on students' achievement in practical Biology, practical skill in Biology as well as in their attitude to Biology

5.2 CONCLUSION

The results of the study have shown that both animation and video-based flipped instructional strategies are more effective in enhancing students' level of achievement, practical skill in and attitude to Biology than the conventional method. The two modes of flipped strategies produced better achievement, better practical skill and more positive attitude to Biology than the conventional method. This means that the usual inability to cover the voluminous Biology topics/contents in the stipulated time and the usual poor biology practical skill resulting from insufficient practical resources which often lead to poor performance in Biology courses could be effectively tackled through the application of animation and video-based flipped instructional strategies. The study equally shows that animation and video-based flipped instructional strategies could also be used to enhance students' attitude to Biology which in turn can lead to improved academic achievement. The study also shows that learning carried out with students largely in charge of their learning (as obtained in flipped classroom) will lead to greater academic practical achievement.

5.2.1 Implication of Findings

Several pedagogical implications may be drawn from this study. To begin with, the study was informed by the persistent failure of students in Biology practical based courses, as well as lack of sufficient resources and facilities for practical work in Biology which often lead to poor Biology practical skill of students in sampled universities in Nigeria. The study has clearly shown that flipped strategies (using animation and video) are effective means of enhancing students' achievement and practical skills in Biology. Therefore, science lecturers must strive always to actively involve their students in the learning process by making use of the mobile devices now available to many undergraduates in facilitating their learning.

The finding that students in the treatment groups performed significantly better than their counterparts in the control group may encourage Biology lecturers to flip their lesson with animated learning resources available online, irrespective of their level of computer self efficacy. Also, insufficient time to complete the expected course work as well as insufficient practical resources that are usually the challenge for Biology courses, especially when the enrolment is high can be eliminated with the adoption of a strategy like the flipped classroom which would not only help to cover the large course content in record time but would also inculcate the expected practical skills in the student even when the resources are not always available.

Another implication of the study has to do with the most effective type of learners' paced inclusive learning strategy that science lecturers can adopt. Although there is slight difference in the achievement of students exposed to the animation based flipped strategy and the video based flipped strategy, results showed that the animation based strategy is more effective than the video based flipped strategy. The animation based flipped strategy is capable of helping students develop excellent practical skill because while students use the animation package they are indirectly performing the practical in a simulated form, this is very helpful in sharpening their practical skill rather than being passive recipients of instruction during practical lectures. This strategy increases students' participation in the teaching/learning process thereby making learning more personal and more permanent.

The low mean achievement scores of students in the control group also requires that government and university management take practical steps to discourage the constant use of talk and chalk method for Science courses.

5.2.2 Contribution of the Study to Knowledge

This study has been able to give an empirical basis for the adoption of animated and video-based flipped classroom strategy for instruction in Biology practical courses. It has established that the mobile devices carried around by the university students can be used to engage them positively in line with their studies rather than the mere use of these devices for social, entertainment and communication purposes. The designed Biology instruction packaged in animation and video platform that were used for this study are also of great contribution to knowledge if adopted for use in the instruction of students taking the selected concepts, because it enhances retention of practical knowledge.

5.3 RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made:

1. Lecturers taking biology practical in universities should adopt these strategies in teaching their courses
2. To achieve no. 1 above, seminars and workshops should be organised by the university management to train such lecturers on the use of these strategies. As flipped strategy is not mere giving students materials to read/study at home, but it has systemic approach, therefore it should be learnt.
3. Curriculum planners and developers in biology courses for Nigeria Colleges of Education and Faculties of Education and Science should emphasize on the need to continuously use innovative strategies such as flipped classroom to enhance biology practical based instruction.
4. University students should be encouraged to cooperate with their lecturers whenever this strategy is used, by doing the home aspect of the learning

without any supervision. And also to be active while the collaboration process in contact class is ongoing.

5. Educational technology and Biology units in various higher institutions of learning should incorporate flipped classroom strategies into their curricula.
6. Instruction designers should develop instructions that are participatory for students when ever lecture content is being packaged on video or animation platform especially if such instruction is to be used for flipped classroom.

5.4 Limitation to the Study

Nonchalant attitude of some university students and irregular school attendance by few of the students who participated in the study constituted the main constraint of the study. As a result of this some of the students that took part in the pretest but not in posttest were later excluded from the study. Instrument for attitude may need amendment if it is to be adopted for further research. Nevertheless, these limitations did not affect the outcome of the study.

5.5 Suggestions for Further Studies

Based on the findings and limitation of the study, the following suggestions are made for further studies

1. The study should be replicated using private university students because private university students may have more sophisticated ICT tools.
2. The study should be carried out on a longitudinal scale, to check if the strategy would continue to significantly improve student performance and practical skill
3. The study could also be replicated using standard private secondary schools where students have and are allowed to use ICT gadgets in their hostels to ascertain if students at secondary school level would be able to improve significantly after using the strategy.
4. There could also be a comparative study of flipped strategy on Biology, Chemistry and Physics courses to determine which one flipped classroom would work best for since they all have practical components for which flipped classroom is well suited.

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APPENDIX I

University of Ibadan, Ibadan

Department of Teacher Education

Biology Practical Achievement Test (BPAT)

Instruction: Kindly complete the information required in section A and tick the correct answer in section B from options A-D.

Section A

Sex of respondents: ____________________

Institution: ___________________________________

Section B

1. Autotrophic nutrition may be defined in terms of food obtained ___ (a) From other organisms in exchange for some product (b) by the breakdown of complex substances (c) by an organism utilising its own store of energy (d) by synthesising simple substances using energy from an external source.
2. Which of the following is an autotrophic mode of nutrition? (a)Chemosynthesis (b) Saprophytism (c) Parasitism (d) Symbiosis
3. Which of these food substances is best stored using the refrigeration/freezing means? (a)fish (b) Yam (c) beans (d) oil
4. Which of these food substances in known as body building? (a) Carbohydrate (b) Fats and Oil (c) Protein (d) Mineral
5. The substance that provide nourishment when taken by man or animals is called (a) Diet (b) Food (c) Fruit (d) Vitamin
6. Which of these classes of food plays an important role in blood clotting? (a) Vitamin (b) fats and oils (c)water (d) protein
7. The class of food that is called universal solvent is (a) Carbohydrate (b) Protein (c) Mineral (d) Water
8. The deficiency of Vitamin D leads to __ (a) Scurvy (b) Pellagra (c) Rickets (d) non clotting
9. Which of these substances is likely to be deficient in the diet of a person having goitre? (a) Calcium (b) Iron (c) Iodine (d) Vitamin C

10. Spongy gums, loosening of the teeth and bleeding into the skin and mucous membranes are symptoms of which Vitamin deficiency? (a) Vitamin C (b) Vitamin K (c) Vitamin B (d) Vitamin A
11. Which of the following reagents is used for the test for starch? (a) Millon's reagent (b) Fehling's solution (c) Sudan III solution (d) Iodine solution
12. The colour that confirms the presence of a simple reducing sugar during Benedict's test is ___ (a) brick red (b) light green (c) deep black (d) ocean blue
13. A reddish precipitate formed during Fehling's test indicate the presence of (a) saturated fat (b) Protein (c) reducing sugar (d) water
14. The colour change associated with iodine solution during test for starch is (a)brick-yellow (b) brick-red (c) Brown-grey (d) blue-black
15. Why is sucrose first boiled in dil. HCl during test for Sucrose? (a) To hydrolyse (b) To evaporate (c) To oxidise (d) To dehydrate
16. When a proteinous substance is mixed with Millon's reagent a white precipitate turns _____ while heating (a)yellow (b) red (b) blue (d) violet
17. Which of these is the correct arrangement of reagents used in Biuret test of protein? (a) Sodium hydroxide and 2% copper hydroxide solution (b) Sodium sulphate and 1% copper sulphate solution (c) Sodium hydroxide and 1% copper sulphate solution (d) Sodium benzoate and 2% copper hydroxide solution
18. Which colour indicates the presence of protein in a biuret test? (a) red or black (b) purple or violet (c) yellow or orange (d) pink or violet
19. Which of these substances would take the colour of sudan III during sudan III test? (a) vegetable oil (b) water (c)the vegetable oil and water (d)none of the above
20. Which of these proteinous substances is best suitable for test for protein? (a) cooked beans (b) boiled egg (c)uncooked egg albumen (d) uncooked egg yolk
21. Which of the following food substances turns bright red when warmed with Sudan III Solution? (a) Starch (b) reducing sugar (c) protein (d)fat
22. Ethanol mixed with any fatty material during test for Fat and oil is called ___ (a) Sudan III test (b) Emulsion test (c) Translucent paper mark test (d) Ethanoid test
23. A drop of oil on a piece of paper will leave the spot (a) burnt (b) blurred (c) translucent (d) darkened

24. Sucrose does not react with Benedict solution because (a)Benedict solution is a strong acid (b) sucrose does not reduce copper sulphate (c) both are immix able (d)Benedict solution is an alkaline
25. Which of these is used to test for the presence of water? (a) Cobalt chloride paper (b) litmus paper (c) white paper (d) mess paper
26. The food class generally referred to as energy giving food is __ (a) Carbohydrate (b) lipid (c) Protein (d) Vitamin
27. Materials that provide living things with nutrient they need for energy and growth is called _ (a) drug (b) water (c) food (d) glucose
28. Vitamin is generally called (a) Body building food (b) energy giving food (c) digestive food (d) body protective food
29. The class of food that is generally termed body building is called __ (a) protein (b) Carbohydrate (c) fat and oil (d) Mineral
30. Glucose belongs to which of the following class of Carbohydrate? (a) polysaccharide (b) monosaccharide (c)disaccharide (d) starch
31. The kind of disaccharide found in sugar cane is (a) sucrose (b) maltose (c) lactose (d)galactose
32. A meal that contains the correct proportion of food substances and nutrient for normal body growth and maintenance of good health is called (a) ideal diet (b) normal diet (c) quick diet (d) balanced diet
33. The correct procedure of Benedict test is (a) 2cm3 each of 2% glucose+ Benedict+ heat (b) 2cm3 of Benedict solution+ 2% glucose+ heat (c) 2cm3 of each of Benedict solution+ glucose+ heat (d) heat+ Benedict solution
34. Which of these is a test for protein? (a) emulsion test (b) biuret test (c) fehlings test (d)iodine test
35. Anhydrous copper sulphate is different from hydrate copper sulphate because it is (a) without water (b) without weight (c) with water (d) with very little water

The correct answers to the questions are

1 D

2 A

3 A

4 C

5 B

6 A

7 D

8 C

9 C

10 A

11 D

12 A

13 C

14 D

15 A

16 B

17 C

18 B

19 A

20 C

21 D

22 B

23 C

24 B

25 A

26 A

27 C

28 D

29 A

30 B

31 A

32 D

33 A

34 B

35 A

APPENDIX II

University of Ibadan, Ibadan

Department of Teacher Education
Biology Practical Skill Rating Scale (BPSRS)

Questions on practical skills

Instruction: Perform the activities in Questions 1-15 before your examiner

	Questions on Practical skills	**For official use only**	
		Correct ( )	Incorrect( )
1	Identify by picking up, a test tube among a mix of many glass wares		
2.	Using a measuring cylinder, measure 10cm3 of dilute HCl into a beaker		
3	Using a dropper collect Benedict solution and add five drops to $5cm^3$ of 2% glucose solution in a test tube		
4	Light up a Bunsen burner and place a Pyrex beaker on it for heating		
5	Heat the solution you have in question 4		
6	Test for starch in a slice of bread using iodine solution		
7	Form an unstable emulsion from vegetable oil and water		
8	Use cobalt chloride paper to test for water		
9	Break an egg and collect the egg albumen in a conical flask or beaker		
10	Pour few portion of the egg albumen in a test tube and add 3cm3 of millon's reagent		
11	Show that vegetable oil can cause a white paper translucent		
12	Turn an anhydrous copper sulphate to deep blue		
13	Hydrolyse a cane sugar extract in a test tube using Dil. HCl		
14	Neutralise the excess acid in the mixture in Que. 13 using NaOH		
15	Identify by picking a cobalt chloride paper in a mixture of litmus, filter and cobalt chloride papers		

APPENDIX III

University of Ibadan, Ibadan

Department of Teacher Education

Students Attitude to Biology Questionnaire (SABQ)

Dear Respondent,

This questionnaire is necessary to obtain data from undergraduates on their Attitude to Biology; your cooperation is therefore required to assist the researcher in achieving success in this study. Kindly complete this questionnaire with every sense of honesty

All information provided will be kept confidentially.

Thank you.

Section A

(Kindly complete section A as appropriate)

Name of institution and location: ____
Sex: _____________ Level of respondent: _________ Department: ________________

Course of study____

Section B

Kindly tick (✓) which is applicable to you. Please note that SA= Strongly Agree, A= Agree, D=Disagree and SD= Strongly Disagree

	ITEM				
	RESPONSES TO BIOLOGY LESSON				
	I am always eager to attend Biology lectures				
	I am not always active and I do not usually participate in Biology lectures				
	Biology lectures can never be boring to me				
	I offer biology lectures because I have no choice				
	My response to biology is high because it deals with the study of life				
	INTEREST IN BIOLOGY LESSON				
	My interest in Biology began from my secondary school days				
	I am not interested in biology because of its many practical				

	works				
	My interest is high in Biology because it deals with what we can see and not abstract				
	My interest is low in Biology because it involves too much writing and reading				
	It is not easy to forget biology concepts				
	I like biology because it is easy to read and pass with little or no teaching				
	I developed interest in biology because it is a prestigious course				
PERFORMANCES IN BIOLOGY					
	I have never failed any biology course before				
	My scores in Biology courses are usually above average				
	I perform best in Biology and that's why it's my best subject				
LEVEL OF COMPREHENSION OF BIOLOGY CONCEPTS					
	I always have a good mastery of my biology courses				
	I don't usually forget whatever i am taught in Biology easily				
	I have a very high rate of comprehension of Biological courses				
	I cannot teach my juniors students many of the biology courses that I have taken before				
	I don't always comprehend biology courses because they are voluminous				
INTEREST IN AND INFLUENCE OF BIOLOGY TEACHER					
	I did not develop interest in Biology because of the methods my lecturers do use to teach biology courses				
	My choice of Biology as a course was based on the influence of my Biology teacher at secondary school level				
	The interest I developed in Biology was because my teacher always make us do practical works				
IMPACT OF GENDER ON LEARNING BIOLOGY					
	My gender has influenced my interest in Biology learning				
	Biology is not appropriate for people of my gender				

APPENDIX IV

University of Ibadan, Ibadan

Department of Teacher Education

Educational Technology Unit

Adapted Murphy (1989) Computer Self Efficacy Questionnaire (CSEQ)

Instruction: Kindly complete this questionnaire by writing your particulars in section A and by ticking the corresponding option that applies to you in Section B.

Section A

Name of Institution: ___________________________ Level: ________________________

Sex_________________

Section B

SA= Strongly agree, A= Agree, D= Disagree and SD= Strongly Disagree

Level of computer skills	**Item**	**SA**	**A**	**D**	**SD**
Low/ beginner	I am confident: working on a personal computer (microcomputer) getting the software up and running entering and saving data (numbers or words) into a file escaping/exiting from a program or software confident choosing a data file to view on a monitor screen handling a floppy disk correctly making selections from an onscreen menu using a printer to make a "hard copy" of my work copying a disk coping an individual file adding and deleting information to and from a data file moving the cursor around the monitor screen using the computer to write a letter or essay storing software correctly getting rid of files when they are no longer needed organizing and managing files				
2 Moderate	I am confident: using the user's guide when help is needed understanding terms/words relating to computer hardware understanding terms/words relating to computer software learning to use a variety of programs (software) learning advanced skills within a specific program (software)				

	using the computer to analyze number data writing simple programs for the computer describing the function of computer hardware (keyboard, monitor, disk drives, processing unit) understanding the three stages of data processing: input, processing, output getting help for problems in the computer system explaining why a program (software) will or will not run on using the computer to organize information troubleshooting computer problems				
3.High/ Advanced	I am confident: logging onto a mainframe computer system working on a mainframe computer logging off the mainframe computer system				

APPENDIX V

University of Ibadan, Ibadan

Department of Teacher Education

Animation Based Instructional Package (attached in a Compact Disk)

APPENDIX VI

University of Ibadan, Ibadan

Department of Teacher Education

Video Based Instructional Package (attached in a Compact Disk)

APPENDIX VII

University of Ibadan, Ibadan
Department of Teacher Education

Conventional Lecture Instructional Guide (CLIG)

Week 1

Topic: The concept Food

Objectives: By the end of the lesson, students should be able to:

i. Define food

ii. State 4 uses of food

iii. Explain what a balance diet is.

Duration: 1 hour

Topic	**Steps**	**Teacher's activities**	**Student's activities**	**Material**
Definition of food	1	The teacher defines the concept food to the students. He gives addition information by explaining the concept. He also cites examples of food.	The students listen to teacher's definition. They ask questions on any area not clear to them.	The chalkboard and print text
Uses of food	2	The teacher states at least four uses of food to animals(man). He explains each of the uses stated	The students listen to the teacher and also mention some uses of food that they know	The chalkboard and print text
Balanced diet	3	The teacher explains what a balanced diet is to the students. He highlights the constituent of a balanced diet.	The students listen to teacher's explanation. They ask questions on any area not clear to them.	The chalkboard and print text

Summarized content:

i. Food: A food is defined as any materials used by an organism for growth, maintenance of the body cells, for tissue respiration or for replacement/repair of body damaged parts. A balance diet is one which contains the correct proportion of all the different food requirement of an organism. it usually include water, carbohydrate, protein, lipids, mineral salt and vitamins

ii. Teacher explains four Uses of food as follows:

(a) For tissue respiration (b) For maintenance of body cell (c) For growth (d) For replacement and repair of body damaged parts

Evaluation: Teacher asks students the following questions

i. What is food?

ii. State 3 uses of food to an animal

iii. Define a balanced diet.

Week 2

Topic: Classes of food

Objectives: By the end of the lesson, students should be able to:

i. State 3 classes of food
ii. Describe the constituent of carbohydrate
iii. Mention examples of food with protein and its constituent
iv. State the functions of vitamin to an animal and its constituent

Duration: 1 hour

Topic	**Steps**	**Teacher's activities**	**Student's activities**	**Material**
Classes of food	1	The teacher states 3 classes of food to be considered in the lesson(carbohydrates, protein and vitamins) He ask students to mention examples of each.	The students listen to the teacher, they answer questions and they ask questions on any area not clear to them.	The chalkboard and print text
Carbohydrate	2	The teacher explains the constituents of carbohydrate. Mentioning the three forms of carbohydrates	The students listen to the teacher and they ask questions on any area not clear to them.	The chalkboard and print text
Protein	3	The teacher ask the students to mention examples of food with protein, he also explains the constituents of protein to them.	The students listen to teacher's explanation. , they answer questions posed by the teacher and they ask questions on any area not clear to them.	The chalkboard and print text

Vitamins	4	The teacher state the major functions of vitamins in the diet of animals	The students listen to the teacher, they answer questions and they ask questions on any area not clear to them.	The chalkboard and print text

Summarized content:

Carbohydrate, protein, and vitamins,

(a) Carbohydrate(CHO): These are compound made of carbon, oxygen and hydrogen, in which the molecule always contain twice as many hydrogen atoms as there are of oxygen. This group include simple sugar, complex sugar, starches, cellulose and animal starch or glycogen.

Simple sugars (monosaccharide) : These group of CHO have the formula $C_6H_{12}O_6$ and are glucose(grape sugar), fructose(fruit sugar) and galactose. They are found in dried raisins as hard brown grains. It is also found mixed with fructose in the juice of nearly all sweet fruits, in the roots and leaves of many plants and in honey. In animals which have blood, CHO is carried in the blood in the form of glucose. These simple sugars taste sweet, but not as sweet as cane sugar. They are form in which CHO is used for tissue respiration.

(b) Proteins: These are complex compounds made from many amino acid molecules linked together. Proteins contain carbon, hydrogen, oxygen, nitrogen and in some cases sulphur. Proteins forms an important component of cell protoplasm. Most proteins are insoluble in water, but soluble in dilute acids and alkalis. Insoluble proteins form part of the body structure i.e body building materials. e.g. keratin of hair, horn, nails and feathers, collagen fibre in bones tendons and skin. Examples of protein foods include meat, fish, beans, milk and cheese.

(c) Vitamins: These are chemical compounds required in small amount for the healthy growth of animals. They are required in minute quantities to promote vital chemical reactions in the body. Vitamins act as biocatalysts. If they are lacking, deficiency diseases may develop which are curable only when the vitamin is supplied. There are about fifteen vitamins and they are designated by the letter A-K. The more important vitamins however are vitamins A,B, C, D, and E. Vitamin A,D,E and K are fat-soluble while vitamins B group and C are water soluble.

Evaluation: Teacher asks three students to discuss carbohydrates, protein and vitamins each. Stating examples of each class

Week 3

Topic: Classes of food

Objectives: By the end of the lesson, students should be able to:

i. State 3 classes of food
ii. Describe the constituent of Fats and Oil(Lipids)
iii. Mention examples of food with minerals salt
iv. State the functions of water to an animal and its sources

Duration: 1 hour

Topic	**Steps**	**Teacher's activities**	**Student's activities**	**Material**
Classes of food	1	The teacher states 3 classes of food to be considered in the lesson(Lipids, mineral salts and water) He ask students to mention examples of each.	The students listen to the teacher, they answer questions and they ask questions on any area not clear to them.	The chalkboard and print text
Fats and Oil(Lipids)	2	The teacher explains the constituents of lipids and he states the functions of lipids to the diet of an animal	The students listen to the teacher and they ask questions on any area not clear to them.	The chalkboard and print text
Mineral salts	3	The teacher ask the students to mention examples of food mineral salts, he also explains the constituents of mineral salt to them.	The students listen to teacher's explanation. , they answer questions posed by the teacher and they ask questions on any area not clear to them.	The chalkboard and print text
Water	4	The teacher state the major sources of water and also explains the functions of water to the diet of animals	The students listen to the teacher, they answer questions and they ask questions on any area not clear to them.	The chalkboard and print text

Summarized content:

Fats and Oil(lipids), minerals salt and water

(a) Fats and Oil(Lipids): These contain the elements carbon, hydrogen and oxygen. They have a higher proportion of hydrogen and little oxygen compared with carbohydrates. They are made up of fatty acids that are linked with glycerol in various combinations. Oils are liquid at room temperature and contain a high proportion of unsaturated fatty acids while fats consist of saturated fatty acid and tend to be solid at room temperature. Fats and oils are soluble in alcohol but are insoluble in water. They are solvent for fat-soluble vitamins and hormones. Sources of fats and oils include butter, palm oil, groundnuts, margarine etc

(b) Mineral salt: These are inorganic salts required by animals because they provide most of the elements needed for growth, protection and the regulation of metabolic processes. Humans require about fifteen (15) different minerals in their diet which are supplied by meat, eggs, milk, fruits and green vegetable. Though minerals have no energy value, they play an important role in body functions. Some minerals that are needed in minute amount in the body are called trace elements and they include copper, zinc, iodine, manganese, fluorine, chromium and cobalt

(c) Water: water makes up a large part of the protoplasm. It serves as a solvent for many substances conveyed to various parts of the body, it is a medium of transportation. All body secretions need a water medium to work. It is essential in the regulation of body temperature and maintenance of osmotic balance in the body. All food taken in their natural form contains water. Deficiency is rare. Body dehydration leads to quick death, especially in children.

Evaluation: Teacher asks three students to discuss lipids, mineral salts and water each. Stating two examples of each class

Week 4

Topic: Test for Carbohydrates(simple reducing sugar- Benedict and Fehling's test)

Objectives: By the end of the lesson, students should be able to:

i. Report the procedure of testing for simple reducing sugar
ii. Describe the Benedict Test
iii. Describe the Fehling's test

Duration: 1 hour

Topic	**Steps**	**Teacher's activities**	**Student's activities**	**Material**
Test for simple sugar (glucose) using Benedict test	1	The teacher explains the procedures involved in the test for simple reducing sugar (glucose) using Benedict test. He shows the students the reagents needed	The students listen to the teacher, they answer questions and they ask questions on any area not clear to them.	The chalkboard, reagents and laboratory
Test for simple sugar (glucose) using Fehling's test)	2	The teacher explains the procedures involved in the test for simple reducing sugar (glucose) using Fehling's test. He shows the students the reagents needed	The students listen to the teacher and they ask questions on any area not clear to them.	chalkboard, reagents, print text and laboratory

Summarized content:

Exp 1. To test for simple sugar (glucose, fructose, maltose, and lactose) using

A. Benedict's Test

Procedure: Place 2cm^3 each of 2% glucose solution or any reducing sugar and Benedict's solution in a test tube.(Benedict's solution is a reagent that contain 1.7g of copper sulphate, 17.3g of Sodium citrate,10.0g of anhydrous Sodium carbonate and 100.0g of Distilled water) Heat the mixture gently

Observation: A pale/sky blue ppt will turn to brick -red gradually on heating the mixture

Conclusion: Brick- red colour confirms the presence of a simple reducing sugar(glucose)

Exp 2. To test for simple sugar (glucose, fructose, maltose, and lactose) using

B. Fehling's Test

Procedure: Add 2cm^3 of Fehling's solution A to 2cm^3 of Fehling's B in a test tube. Add an equal volume of 2% glucose solution and heat gently (you could also boil) for about 3minutes

Observation: A reddish ppt will be formed

Conclusion: A red colour ppt confirms the presence of a simple reducing sugar

Evaluation: teacher ask students to state the end colour formed at the end of Benedict and Fehling's tests

Week 5

Topic: Test for Carbohydrates (complex sugar and starch)

Objectives: By the end of the lesson, students should be able to:

i. Report the procedure of testing for complex sugar

ii. Describe test for starch

Duration: 1 hour

Topic	Steps	Teacher's activities	Student's activities	Material
Test for complex sugar (sucrose)	1	The teacher explains the procedures involved in the test for complex sugar (sucrose) He shows the students the reagents needed	The students listen to the teacher, they ask questions on any area not clear to them.	The chalkboard, reagents and laboratory
Test for starch using bread and iodine solution	2	The teacher explains the procedures involved in the test for starch in a piece of bread using iodine solution He shows the students the reagents needed	The students listen to the teacher and they ask questions on any area not clear to them.	chalkboard, reagents, print text and laboratory

Summarized content:

Complex Sugar: Complex sugars have the formula $C_{12}H_{22}O_{11}$ and included in this group are sucrose (cane sugar), maltose (malt sugar) and lactose (milk sugar). The complex sugars are colourless crystalline substances which are about three times more soluble in water than the simple sugars. They also diffuse more slowly than the simple sugar. They are easily converted (hydrolysed) to simple sugar by traces of acid or by enzymes

Exp. 3: Test for complex sugar (sucrose)

Procedure: Sucrose does not react with Benedict's solution because it does not reduce copper sulphate, so it is necessary to first boil it in Dil. HCl so as break the sucrose into simple sugar (hydrolysis) $C_{12}H_{22}O_{11} + H_2O \xrightarrow{} $ hydrolysis by HCl $C_6H_{12}O_6 + C_6H_{12}O_6$

So boil a cane sugar extract with some portion of Dil. HCl then, add few drops of Sodium hydroxide to neutralise excess acid. Now, perform Benedict's test as done in simple sugar experiment.

Observation: A pale/sky blue ppt will turn to brick -red gradually on heating the mixture

Conclusion: Brick-red colouration confirms the presence of a simple reducing sugar(glucose) from a complex sugar (sucrose)

Exp. 4: Test for Starch (Polysaccharide)

Procedure: Take a slice of bread, and add a few drops of Iodine solution on the white part of the slice bread

Observation: A blue-black colouration appears

Conclusion: Blue-black colouration confirms the presence of starch

Evaluation: students are asked to name two other foods that can be used for test for starch apart from bread. They are also asked to list three reagents used in the test for complex sugar

Week 6

Topic: Test for Protein (Biuret and Millon's tests)

Objectives: By the end of the lesson, students should be able to:

i. Report the procedure of testing for protein using the Biuret test

ii. Report the procedure of testing for protein using the Millon's test

Duration: 1 hour

Topic	**Steps**	**Teacher's activities**	**Student's activities**	**Material**
Test for Protein using the biuret test	1	The teacher explains the procedures involved in the test for protein using the biuret test. He shows the students the reagents needed	The students listen to the teacher, they ask questions on any area not clear to them.	The chalkboard, reagents and laboratory
Test for Protein using the Millon's test	2	He explains the procedures involved in the test for protein using the Millon's test. He shows the students the reagents needed	The students listen to the teacher and they ask questions on any area not clear to them.	chalkboard, reagents, print text and laboratory

Summarized content:

***Exp. 5:* Biuret Test**

Procedure: Mix some portion of protein e.g. milk, egg albumen or meat extract with sodium hydroxide solution and then add some drops of 1% copper sulphate solution

Observation: A purple or violet colour appears

Conclusion: Purple or Violet colour confirms the presence of protein.

***Exp. 6:* Millon's Test**

Procedure: Mix some portion of any proteinous substance with few drops of Millon's reagent and heat gently

Observation: A white ppt will turn red when heat is introduced.

Conclusion: Red colour confirms the presence of protein

Evaluation: students are asked to state two differences between biuret and millons tests

Week 7

Topic: Test for Fats and Oil (Translucent paper test and Sudan III tests)

Objectives: By the end of the lesson, students should be able to:

i. Report the procedure of testing for Fats and Oil using Translucent paper test
ii. Report the procedure of testing for Fats and Oil using the Sudan III tests

Duration: 1 hour

Topic	Steps	Teacher's activities	Student's activities	Material
Test for Fats and Oil using Translucent paper test	1	The teacher explains the procedures involved in the test for Fats and Oil using Translucent paper test. He shows the students the reagents needed	The students listen to the teacher; they ask questions on any area not clear to them.	The chalkboard, reagents and laboratory
Test for Fats and Oil using the Sudan III tests	2	He explains the procedures involved in the test for Fats and Oil using the Sudan III tests. He shows the students the reagents needed	The students listen to the teacher and they ask questions on any area not clear to them.	chalkboard, reagents, print text and laboratory

Summarized content:

***Exp. 7:* Translucent paper mark test**

Procedure: Put a drop of vegetable oil onto a piece of paper, allow for some two minutes and hold the paper against the light.

Observation: The spot thus formed will remain permanent, allowing transmission of light being translucent.

Conclusion: translucent paper confirms the presence of Oil.

***Exp. 8:* Sudan III Test**

Procedure: Put in a test tube 10 cm3 of water mixed with twelve drops of groundnut or olive oil. Shake the mixture very well. An unstable emulsion is formed. Then, add 10 drops of Sudan III to the emulsion and shake the mixture again.

Allow the test tube to stand in a test tube rack for about 10minutes

Observation: The oil turns red having taken the colour of the Sudan III

Conclusion: The red colour confirms the presence of fat or oil.

Evaluation: teacher asks the students to state the colour change that Sudan III will result to while testing for fat and oil

Week 8

Topic: Water

Objectives: By the end of the lesson, students should be able to:

i. Define water and state its components
ii. State three uses of water to animals
iii. Report the procedure of testing for water using Cobalt chloride paper test
iv. Report the procedure of testing for water using Anhydrous copper sulphate test

Duration: 1 hour

Topic	Steps	Teacher's activities	Student's activities	Material
Water	1	The teacher defines water to the students and also mention the components that make up water	The students listen to the teacher, they take notes and they ask questions on any area not clear to them.	The chalkboard and print materials
Uses of water	2	The teacher states three uses of water especially in the nutrition of animals. He gives room for students to make comments	The students listen to the teacher, they take notes; they ask questions on any area not clear to them.	The chalkboard and print materials
Test for water using Cobalt chloride paper test	3	He explains the procedures involved in the test for water using Cobalt chloride paper test. He shows the students the reagents needed	The students listen to the teacher and they ask questions on any area not clear to them.	chalkboard, reagents, print text and laboratory
Test for water water using Anhydrous copper sulphate test	4	The teacher explains the procedures involved in the test for water using Anhydrous copper sulphate test. He shows the students the reagents needed	The students listen to the teacher, they take notes; they ask questions on any area not clear to them.	chalkboard, reagents, print text and laboratory

Summarized content:

Water: Generally referred to as the universal solvent, necessary for both plants and animals. The general use of water includes (i) water keeps the colloidal protoplasm fluid (ii) it forms the natural surrounding for many organism (iii) Motile male gametes swim in it to effect fertilisation

In plants water is used in photosynthesis and protein synthesis, it is also used to disperse some fruits, seeds and spores of some plants. Water is equally needed as a solvent in: germinating seed, mineral salts in soil and transport of minerals/food in plant.

In animals, mammals especially the skin is kept cool during hot weather by the evaporation of water from sweat. Animals use water as a solvent during food digestion, for secretion of various chemical/hormones, for the transport of various substances around the body and for the excretion of waste substances from the body.

***Exp. 9:* Cobalt chloride paper test**

Procedure: Dip a dry blue, cobalt chloride paper in a water suspected liquid

Observation: The colour of the paper changes from blue to pink

Conclusion: The liquid is confirmed as water, since its only water that can turn blue cobalt chloride paper pink.

Evaluation: the teacher asks the students to itemise the procedure involved in the cobalt chloride paper test for water.

***Exp.10:* Anhydrous copper sulphate test**

Procedure: Put a spoonful copper sulphate (blue) in an evaporating dish and heat to constant either in an oven or on a Bunsen burner. When the weight is constant, it means it is then in anhydrous state (white). Then add a little drop of a liquid suspected to be water to the anhydrous copper sulphate.

Observation: The anhydrous copper sulphate turns blue from the white state it was

Conclusion: The suspected liquid is confirmed water. Since it's only water that can turn anhydrous copper sulphate blue.

Evaluation: Teacher asks two students discuss colbalt chloride test and anhydrous copper sulphate tests each.

APPENDIX VIII

Biology Instructional Animation Evaluation Rubric

Date: ____

Name of Evaluator: ____________________________________

Institution / Position: __________________________________

Instructional Animation title: ____________________________

Subject Area: ____

S/N	ITEM	1 SD	2 D	3 A	4 SA	NA
A	**Documentation and Support**					
1	The instructor manual is clear and thorough					
2	The instruction prompter in easily observable					
3	There are alternative ways of using the animation package					
4	Additional resources such as relevant web links and bibliographies are suggested					
5	Content summary and objectives are clearly stated					
6	Activity or procedural steps are clearly stated					
7	Help within the animation package is easily accessible and understandable					
8	Information are available textually to support the graphical illustration					
9	Colours are used to enhance the illustrations					
10	The emphasis signals enables user to know the next step to take					
B	**Clarity of animation characters**					
11	The images and equipment does not confuse the learners					
12	Characters though animated still convey the required information					
13	Images are very clear and distinct					
14	Movement of animation character are not confusing					
15	Images are of digital clarity					
16	Modules and lessons presentation are very clear to pick from					
17	Colour changes in the animation are very observable and clear					
18	Users participation prompt icons are not hidden					
19	The screen is not cumbersome					
20	Transition from stage to stage is very observable					
C	**Quality of the Sound**					
21	The quality of the sound is very good and optimize learning					
22	The voice in the animation is free of ethnic accent					
23	The background music is complementary					
24	The user has control over the pitch/sound level					

25	The animation is free of underground unwanted noise					
D	**Quality of the Image**					
26	The quality of the images are high and optimizes learning					
27	The text and images are gender fair, i.e. they appeal to both sexes					
28	Image, text, graphics and background are complimentary					
29	Images used are digitally clear					
30	The size of images used are too small					
E	**Content**					
31	The content is accurate and factual					
32	The content is educationally appropriate					
33	The content is free of error in grammar, spellings and punctuation					
34	Screen content contains nothing that would confuse the learner					
35	The content is age appropriate					
36	Content is bias free, or illustrates a sense of moral and ethical issues					
37	Animation expression is an accurate depiction of the real practice					
38	The content is free of stereotypes and cultural bias					
39	The content meets the Nigerian educational standard					
40	The content is level appropriate					
F	**Ease of Use**					
41	Prompts and directions are clear					
42	User can use animation immediately on the first try					
43	Instructions of use can be seen on the screen					
44	Learner/ user has control over settings					
45	User can restart the animation where they stopped.					
G	**Engagement/Interactivity**					
46	Learners are actively engaged and receive timely feedback					
47	Users are motivated to continue learning and to master concepts					
48	Lay out is logical, intuitive and consistent					
49	Screen direction are easy to follow					
50	Pace is controllable with options for stop/ pause/ exit					
H	**Technical Quality**					
51	Animation and graphics are used well					
52	Graphics , audio, video and music are of high quality and optimize learning					
53	The text and images are gender fair and free of racial, ethnic and cultural biases or stereotype					
54	Audio (voice input/output) is well used.					
55	The animation permit reversal and branching					
I	**Fun**					
56	Captivates a range of learning styles					
57	Makes learning fun, meaningful and interesting					
58	The involvement of user makes the package usage fun					
J	**Adaptability**					
59	Animation package is compatible with other installed programs					

	on the computer					
60	Animation package works on various operating system					
61	Animation package incorporate features that support assistive technology					

APPENDIX IX

Biology Instructional Video Evaluation Rubric

Date: ____

Name of Evaluator: ____

Institution / Position: ____

Instructional Video title: ____

Subject Area: ____

Check the rating for each item

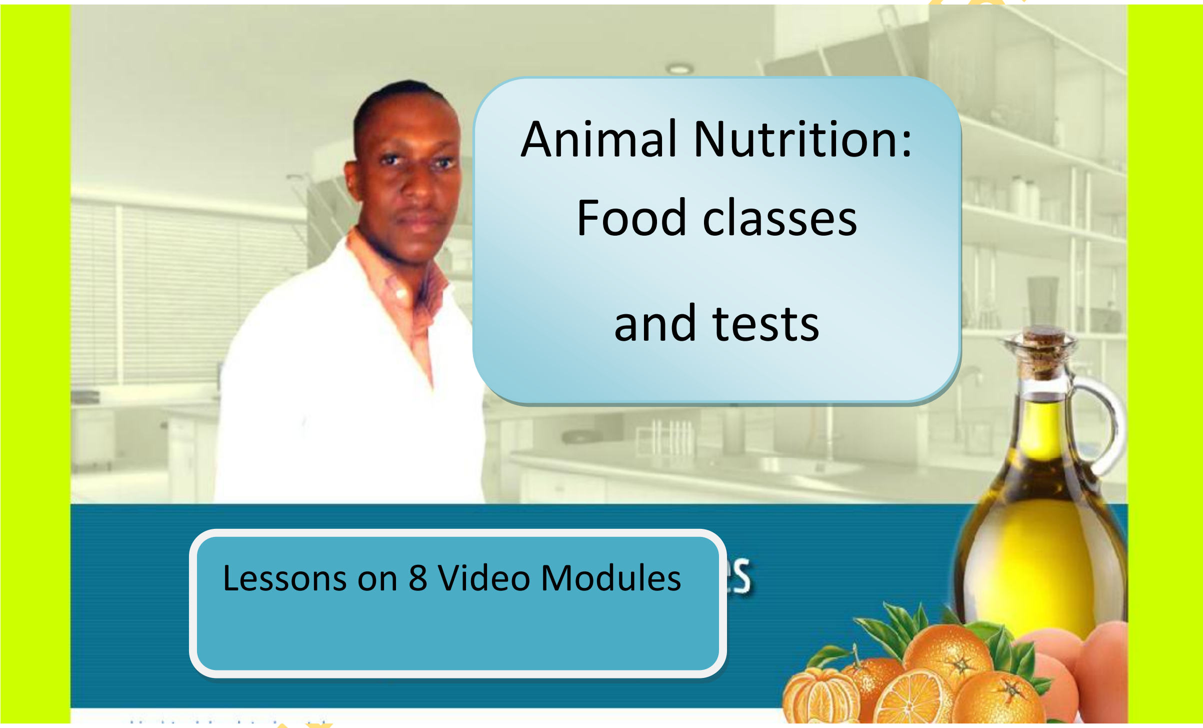
S/N	ITEM	1 SD	2 D	3 A	4 SA	NA
A	**Content**					
1	The content is accurate and factual					
2	The content is educationally appropriate					
3	The content is free of error in grammar, spellings and punctuation					
4	Screen content contains nothing that would confuse the learner					
5	The content is age appropriate					
6	Content is bias free, or illustrates a sense of moral and ethical issues					
7	Video is an accurate depiction of the real practice					
8	The content is free of stereotypes and cultural bias					
9	The content meets the Nigerian educational standard					
10	The content is level appropriate					
B	**Ease of use**					
11	Easy to play on the PC or Mobile device					
12	Directions are clear and not cumbersome					
13	User can exit the video at any time					
14	User can use/play the video independently on the first try					
15	Keys , menus and Icons are accessible and intuitive					
16	User has control over the volume					
17	User can fast forward or rewind/playback the video					
18	Easy to play, forward, rewind or stop					
19	The video is reliable and free of disruption by system error					
20	Instructions can be seen on screen					
C	**Clarity of Video**					
21	Videos are high quality and optimises learning					
22	Audio or voicing is clear					
23	Sound effects are well used					
24	Sub titles are timely and correct					
25	Video colouring are distinct					
26	Background and text are compatible and easy to read					
27	Video can open in any smart phone or mobile devices					

28	Video shows all the required steps in the lesson					
29	Video has rewind and forward options					
30	Video sections are brief and straight to the point					
31	The speed of the video is adequate					
D	**Documentation and Support**					
32	Words pronounced are been complimented with text, that show on the screen					
33	Emphasis are made by the use of arrows, colours or flash signals in the video					
34	Instruction for play and operation are easy to follow					
35	Subtitle is available					
E	**Ability level**					
36	The video covers a variety of ability levels					
37	Appropriate teaching strategy, experience and readability for age level					
38	Language of instruction is adequate for the level of learner					
39	Instruction does not lead to boredom or frustration					
40	The video instruction could be used for any level of student in tertiary institution					
F	**Engagement /Interactivity**					
41	User are motivated to continue learning and to master concept					
42	Instructional video is logical, intuitive and consistent					
43	Easy to manipulate through the video					
44	The video pace is controllable with options for stop/pause/exit					
45	Screen navigation is easy to follow, drag or click					
G	**Attractive**					
46	The quality of video graphics make it attractive					
47	Colour display during lesson can facilitate learning					
48	Laboratory and teacher appearance are fascinating					
49	Graphic labels are not difficult to read					
50	Transition and animation of words are attractive					
H	**Technical Quality and Adaptability**					
51	Video opening and closing has good biological graphical design					
52	The video incorporates features that support assistive technology					
53	Learner has the ability to use their mobile devices to play the video as well as on DVD or PC					
I	**Accessibility and Speed**					
54	The video could be easily accessed on the PC					
55	The speed of the video recording is adequate					
56	Each video lesson can be accessed and played independently					
57	The duration of each lesson is adequate and appropriate					

APPENDIX X

Instructional Manual for Video package

Video Instructional Guide



By

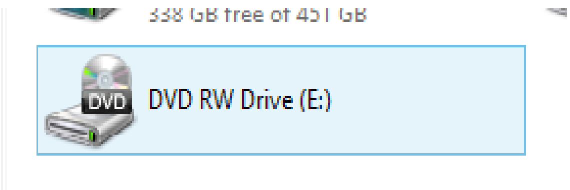
Abiola AKINGBEMISILU

Table of Contents

1. How to play the lesson Videos

Step 1: Insert the VCD into the Computer DVD drive and left click "This PC" Icon

Step 2: Double click on the "DVD" Icon



to open/ play video

As this 

Repeat these steps each time you wish to play any of the videos

2. How to rewind or fast forward the lesson videos

Step 1: While the video is in play mood move the mouse into the middle of the screen, the control bar would appear like this

Step 2: Click and hold the forward arrow to fast forward

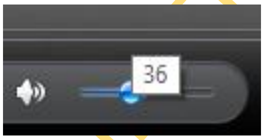
Step 3: Click and hold the backward arrow to rewind

Repeat these steps each time you wish to fast forward or rewind any part of the videos

3. **How to decrease/ increase the volume of the lesson video**

Step 1: While the video is in play mood move the mouse into the middle of the screen, the control bar would appear like this

Step 2: Click and drag the volume navigator to the right (to increase volume) or to the left (to decrease volume)



4. **How to pause the video: should you want to stop temporarily and take note while watching the video, follow the following steps**

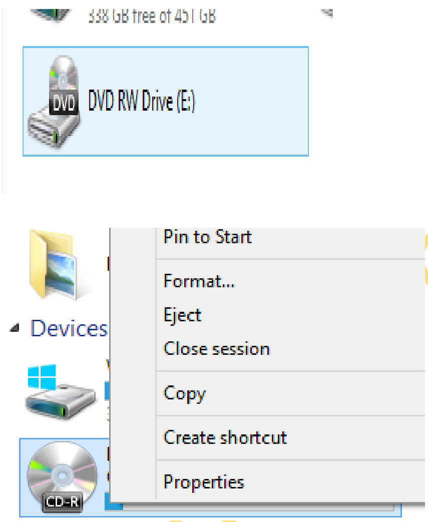
Step 1: To pause a video in a playing mode, move the mouse into the middle of the screen, the control bar would appear like this

Step 2: Left click on the pause icon and the video would pause

NB: you may also simply tap the space bar key to pause and also to resume play again.

5. How to eject or remove the Video CD

Step 1: Stop the video and right click on the DVD icon



Then select or left click on eject, and the CD drive will be open for you to remove the CD.

APPENDIX XI

Instructional Guide

For

By

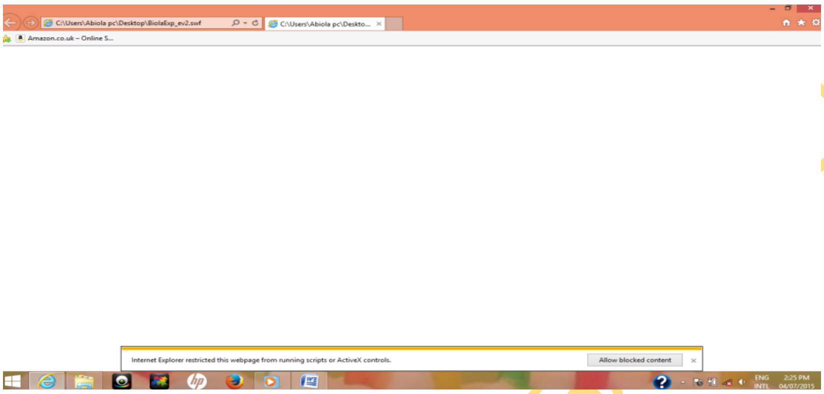
Abiola AKINGBEMISILU

TABLE OF CONTENTS

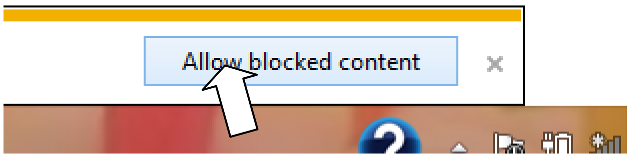
HOW TO ENTER LAB.

Launch the application from the DVD enclosed in the package on your PC Use the internet explorer or any browser to open the application.

A page appears like this



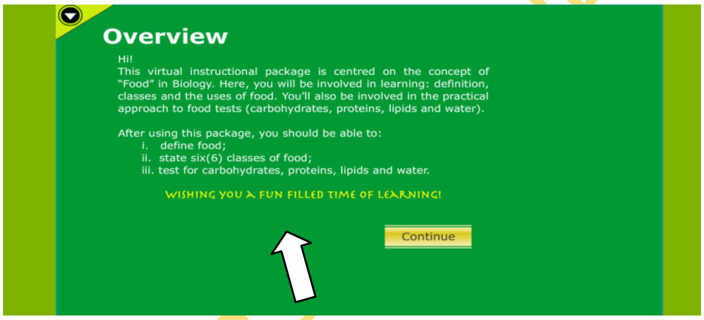
Click Allow blocked content,



Then a front page appears like this

Enter the Lab. By clicking on Enter Lab Icon 

An overview page appears like this,

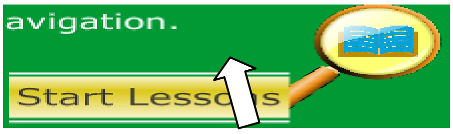


Carefully read the Overview page before proceeding to the lessons. Click

to proceed

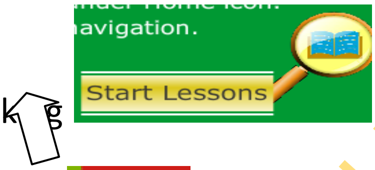
The Guide page appears like this 

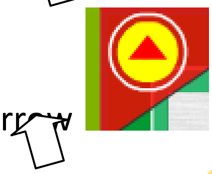
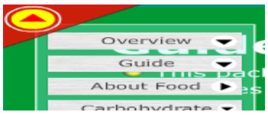
Read the guide page carefully for help on how to navigate within the Laboratory.

Then, begin lesson by clicking 

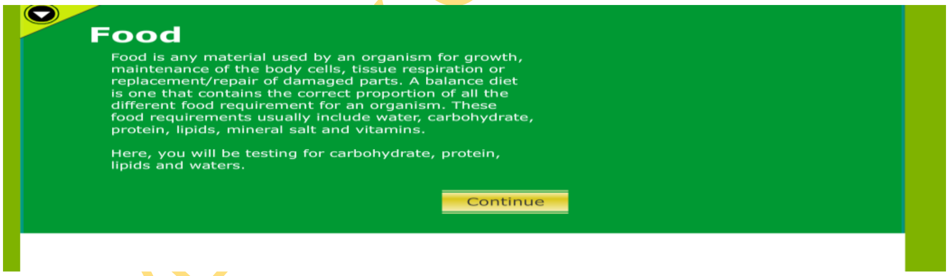
Icon on the guide page.

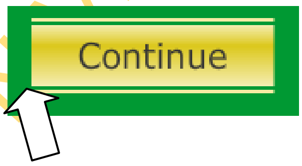
LESSON ON FOOD:

Take lesson on food by clicking 

on guide page or by clicking on the home arrow  for drop down menu, select about food 

and click the home arrow  again for dropped menu to disappear. Then, take lesson on food

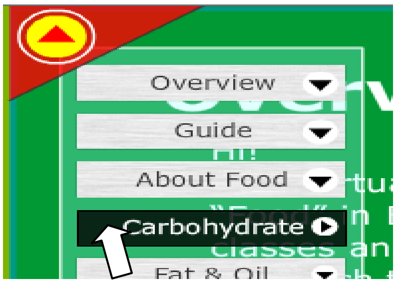


Click 

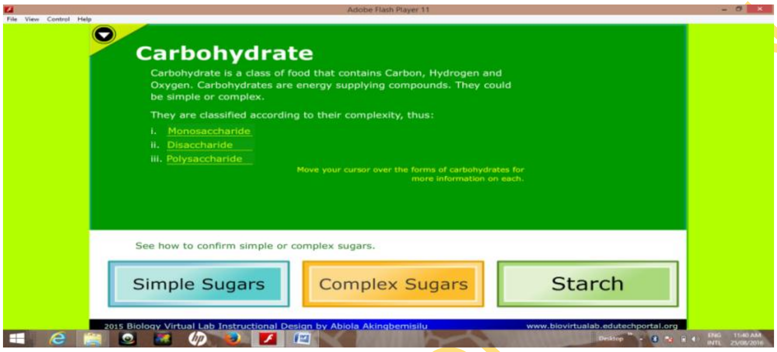
to proceed

LESSON ON CARBOHYDRATE:

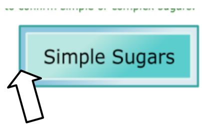
Clicking on the home arrow  for a drop menu, click carbohydrate to take lesson on carbohydrate



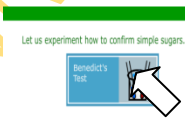
Click the home arrow  again for dropped menu to disappear. Then, take lesson on carbohydrate



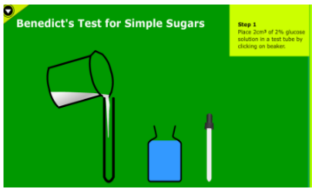
Simple sugar

To do experiments on simple sugar click 

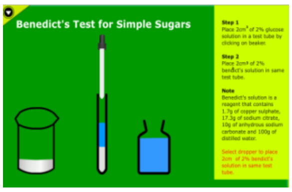
To perform the Benedict test:

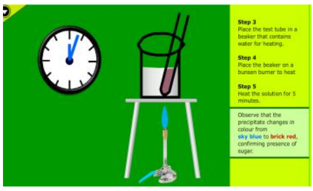
i. Click 

ii. Click Start to perform experiment 

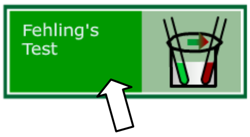


iii. Follow the steps to perform experiment



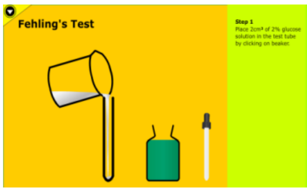


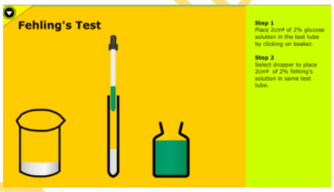
To perform the fehling's test:

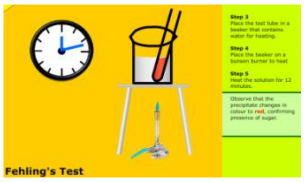
i. Click 

ii. Click Start to perform experiment

iii. Follow the steps to perform experiment







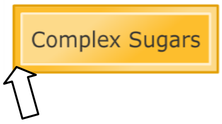
Starch

To perform test for starch

i. Click on the Icon Starch 

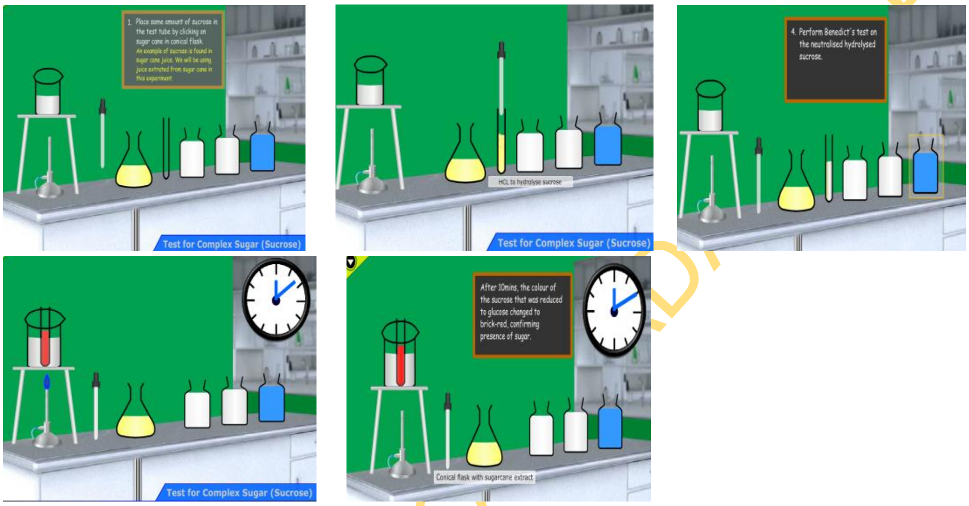
ii. A page appears like this 

iii. Click start to begin the experiment 

To do experiment on *complex sugars* click 

Click test for Complex sugar to begin experiment

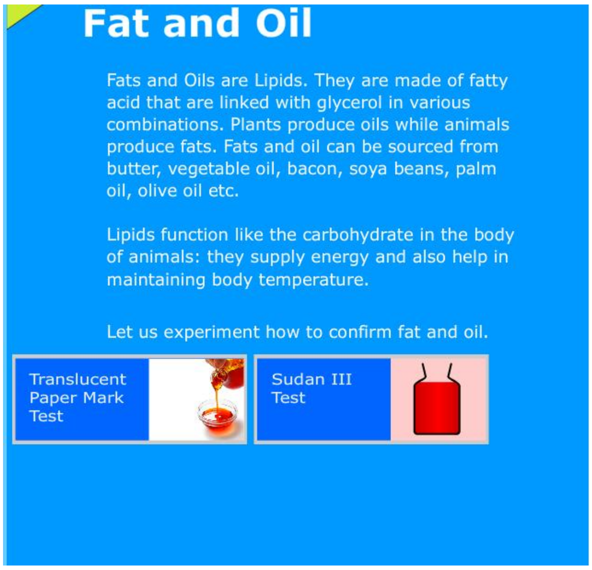
Follow the steps to perform experiment



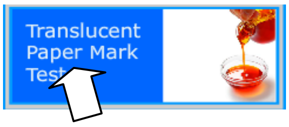
LESSON ON FAT AND OIL

Clicking on the home arrow  for a drop menu, click Fats and Oil to take lesson on Fats and Oil 

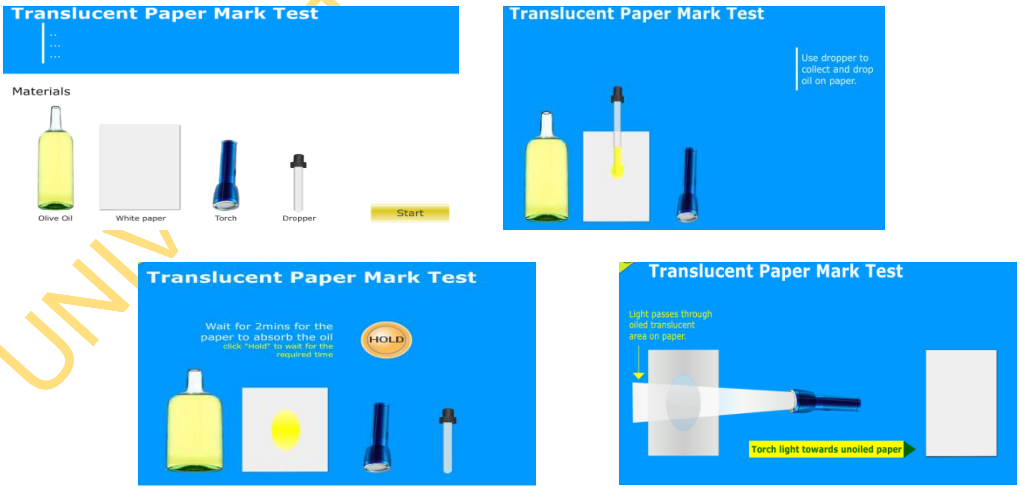
Click the home arrow  again for dropped menu to disappear. Then, take lesson on fats and Oil

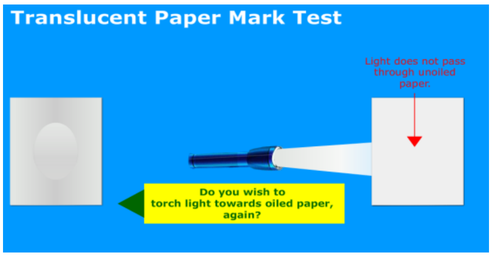


To carry out experiment on *Translucent Paper mark test* click



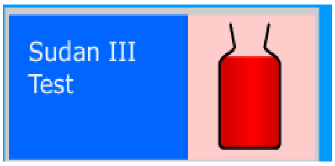
Follow the steps to perform the experiment

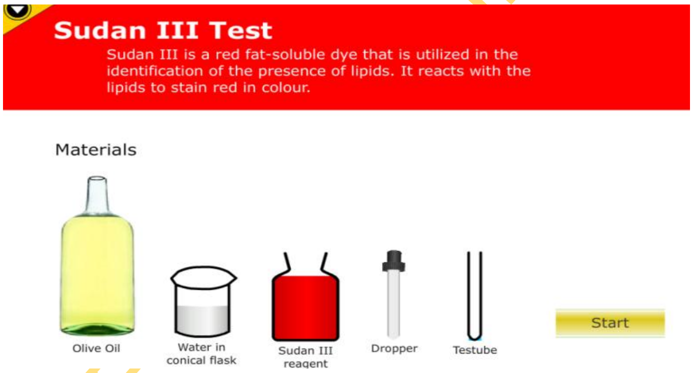




To carry out experiment on Sudan III test

i. Click sudan III icon

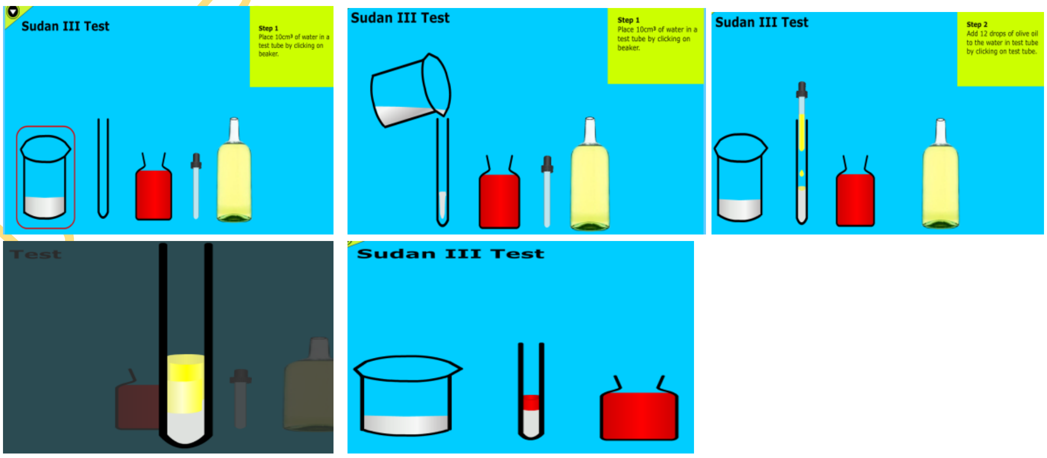




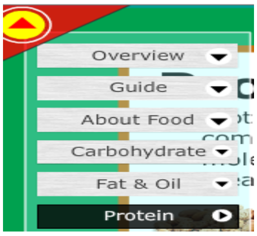
a page like this appears

ii. Click the start icon

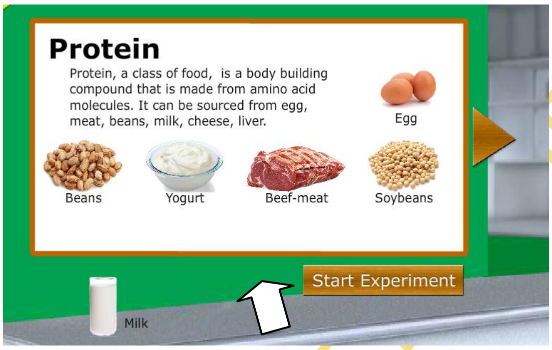
iii. Follow the steps to perform the experiment

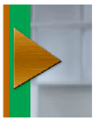


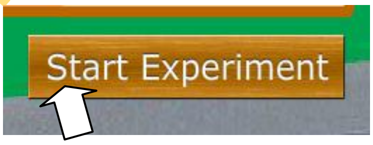
LESSON ON PROTEIN

Clicking on the home arrow  for a drop menu, click protein to take lesson on protein 

Click the home arrow  again for dropped menu to disappear. Then, take lesson on protein

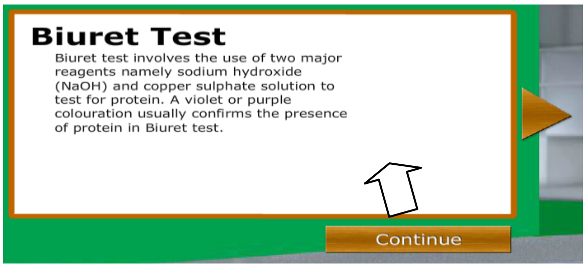


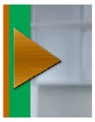
Click the brown arrow  to take lessons on protein. Click the brown arrow  to return.

Click the 

to carry out experiment on Protein

Biuret test

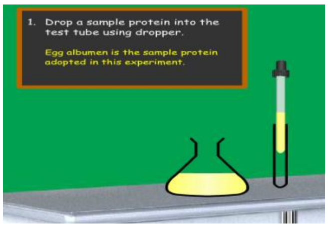


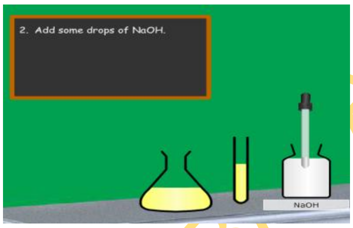
Click the  to read more on Biuret test. And click  to return.

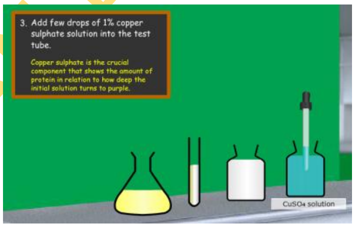
Click 

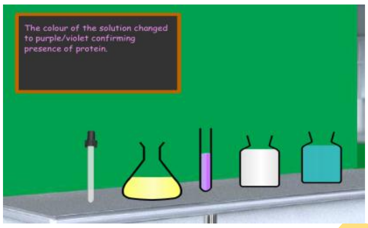
to proceed with experiment

Follow the steps to perform the Biuret Test



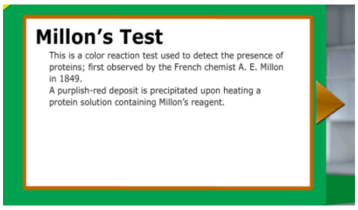




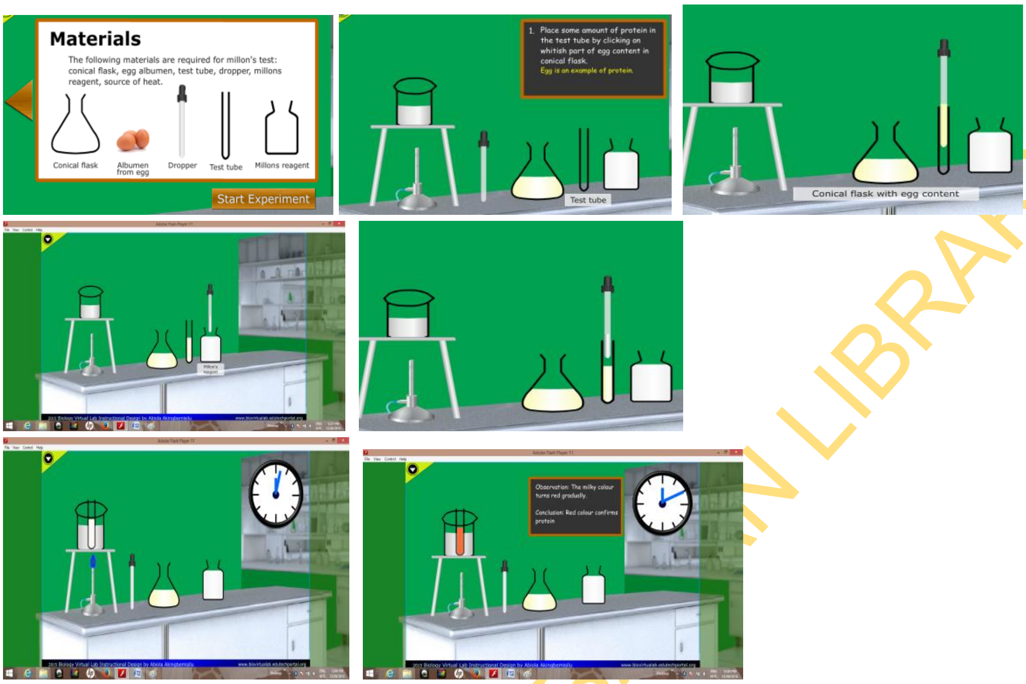


To carry out Millon's test

i. Click the icon 



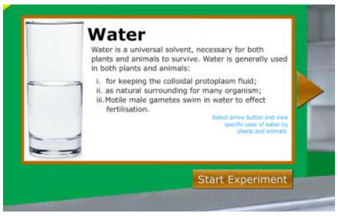
ii. Follow the steps to take the lesson and experiment

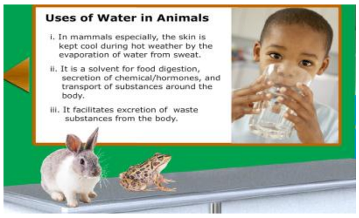


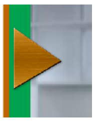
LESSON ON WATER

Clicking on the home arrow  for a drop menu, click water to take lesson on water

Click the home arrow  again for dropped menu to disappear. Then, take lesson on water



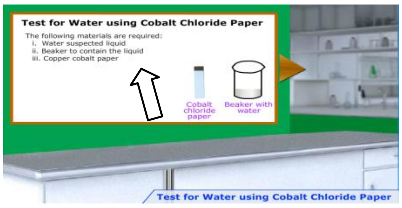


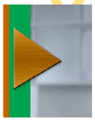
Click the  to read more on water. And click  to return.

Click the Cobalt Chloride Paper test Icon 

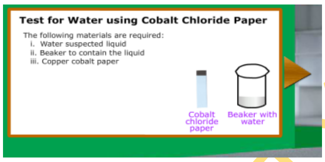
to do experiment  water.

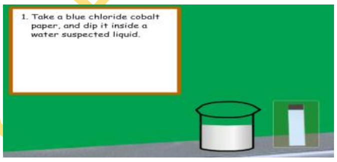
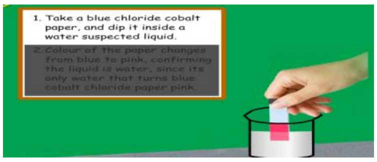
Cobalt Chloride Paper test

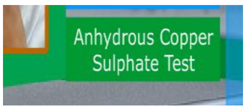


Click the  to begin the experiment

Follow the steps to perform the experiment

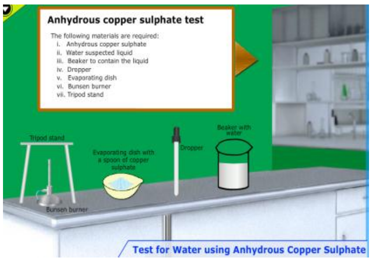


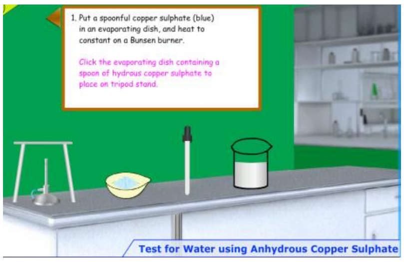



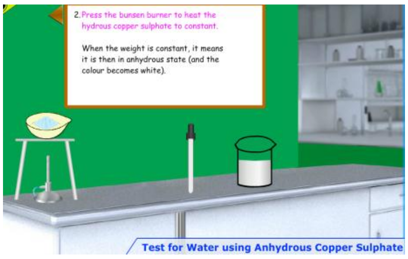
Click the Anhydrous Copper Sulphate test Icon 

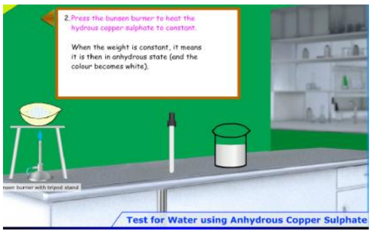
to do experiment on water.

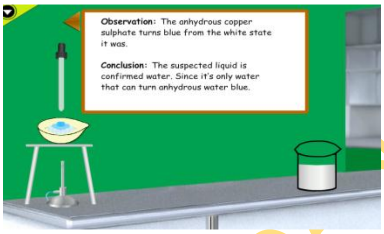
Follow the steps to carry out the experiments

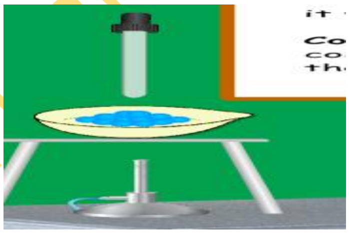








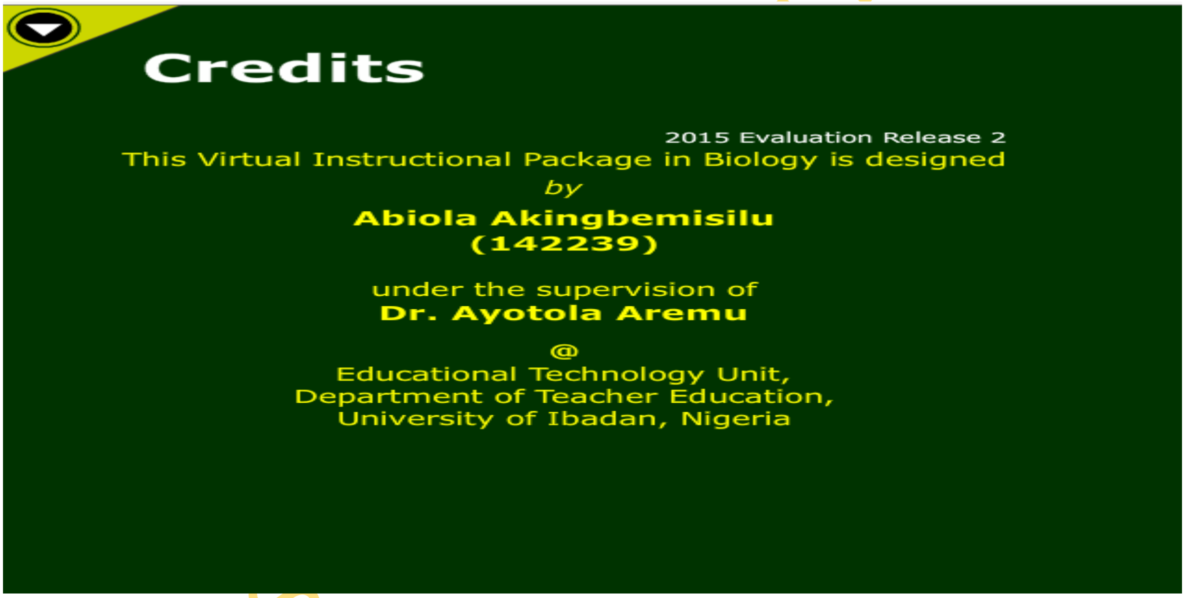




CREDITS

Clicking on the home arrow  for a drop menu, click credits to view credits


Overview
Guide
About Food
Carbohydrate
Fat & Oil
Protein
Water
Credits


Credits
2015 Evaluation Release 2
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APPENDIX XII

The procedure for the adoption of the Dick and Carey Model 2005 for validating the Animation and Video Packages

Phase One: Identify Instructional goals and objectives
The first step in the Dick and Carey Model is to clarify your goals and objectives. The learner must be aware of what they will be able to do when they complete the animation and video based courses, including the skills they will develop and the knowledge they will acquire. Make sure that you tie it to real world applications so that they know how the eLearning course can benefit them outside the virtual learning space.

Phase Two: Conduct Complete instructional analysis
The next step is determining what your learners already know so that you can figure out how to fill the learning gap. This can be done through assessments, surveys, and interviews that focus on their current skill sets and knowledge base. For example, if the assessment reveals that a learner is unable to perform a specific on-the-job task, then you integrate the skills and information they need to master the task.

Phase Three: Determine entry behaviours and learner characteristics
Conduct audience research to determine your learner's behaviours, traits, personal preferences, and motivation factors, such as what has prompted them to enrol. Focus on characteristics that pertain directly to the goals and objectives for your course. This helps you to narrow down the specific content that is vital for your animation and video course, rather than covering information that they have already acquired. You can identify all of the ideas and concepts that you should include to provide a comprehensive and personalized experience.

Phase Four: Write performance objectives
In addition to the learning goals, you must also develop performance objectives that clearly describe the task or process that must be mastered, as well as criteria that you are going to gauge learner progress. The performance objectives must also include the

specific conditions in which the task or skill will be carried out, such as observing your audience on-the-job or in a particular real-world setting.

Phase Five: Develop assessment of instrument

This involves finding the ideal assessment type for your learners, such as the multiple-choice questions or interactive scenarios, as well as the grading rubric and criteria. Though formative and/or summative assessment, you can also determine if the instructional strategy, itself, is effective and reveal the weaknesses and strengths of the activities and exercises of the animation and video course.

Phase Six: Develop Instructional strategy

Now that you've done all of the research and developed your objectives and goals, it is time to create a sound instructional strategy for your audience. You should take into consideration the learning theories that are best suited for your subject matter and learner needs, based on which you will develop the animation and video activities that properly convey the desired information to your learners.

Phase Seven: Develop and select instructional material

Select each of the learning materials, tools, and exercises that serve the learning goals and objectives. This also involves content creation, such as online tutorials, branching scenarios, and text and multimedia-based instructional aides. You should also consider the preferences of your learners when choosing your online materials, and include a wide range of activities to appeal to a wider audience.

Phase Eight: Design and conduct formative evaluation of instruction

This takes place even before you unveil your animation and video course to the students. It often involves focus groups or the release of beta versions that help to iron out any issues prior to eLearning course deployment. If you find any weak areas in the eLearning course, now is the time to fix them and ensure that every element is as effective as possible. This may require a major rewrite of your content or even revamping your activities, if necessary. Keep in mind that it's better to remedy the problems now, rather than risking your brand image with a flawed course later on.

Phase Nine: Revise instruction

Based on the formative evaluation of the instruction, there would be the need to revise or amend certain parts of the content, and method of instruction to reflect the deficiencies of the learners

Phase Ten: **Carry out summative evaluation.** The last step is assessing whether your animation and video course actually achieves the desired outcome. This can only truly be determined through learner post-assessments, such as tests at the end of the lesson, and performance-based online exams, like observing a learner on-the-job or examining business statistics. An example of this would be to check customer satisfaction scores to discover if a customer service eLearning course had the desired effect.

APPENDIX XIII

Names of Universities that Participated in the Study

For the Baseline information

University A= Ekiti State University, Ado Ekiti, Ekiti State(EKSU)

University B= Adekunle Ajasin University, Akungba-Akoko, Ondo State (AAUA)

University C= Olabisi Onabanjo University, Ago-Iwoye, Ogun State

For Treatments(Experiments)

For the Animation-based Flipped Group= Adekunle Ajasin University, Akungba-Akoko, Ondo State.

For the Video-based Flipped Group= Tai Solarin University of Education. Ososa Campus, Ogun State.

For Control

For the control group= Osun State University, Ejigbo Campus, Osun State.

APPENDIX XIV

Guidelines for Flipped Groups Instruction

Procedure	Flip by Animation		Flip by Video	
	Teacher's Activities	**Student's Activities**	**Teacher's Activities**	**Student's Activities**
Step 1	The research assistant distributes the virtual animation CD to the participants and instructs them to go through it when they get home.	Students collect the animation CD and plays it when they get home taking note on it.	The research assistant distributes/shares the Video CD/mp4 to/with the participants and instructs them to go through it when they get home.	Students collect the video and play it when they get home. They also took notes based on the lesson.
Step 2	In the contact class, the research assistant leads each day's activities and also welcomes questions from the students based on the lesson taken home, and then he gives the task for the day and inspects/guides the student's collaboration in solving the day's task. He encourages a brainstorming and collaborative effort in tackling the task.	Students in the contact class receive the task for the day from the research assistant. They are involved in a collaboration session, where they will do a lot of brainstorming	In the contact class, the research assistant leads each day's activities and also welcome questions from the students, based on the lesson taken home, and then he gives the task for the day and inspects/guides the student's collaboration in solving the day's task. He encouraged a brainstorming and collaborative effort in tackling the task	Students in the contact class receive the task for the day from the research assistant. They are involved in a collaboration session, where they will do a lot of brainstorming
Step 3	The research assistant coordinates the student's findings and guides them to solve their assignments.	Students shows their findings/ results to the research assistants	The research assistant coordinates the student's findings and guides them to solve their assignments.	Students shows their findings/ results to the research assistants
Step 4	The research assistant distributes the virtual Animation CD for the next week to the participants after the end of the current contact class.	Students collects the animation CD and plays it when they get home taking note on it.	The research assistant distributes the Video CD for the next week to the participants after the end of the current contact class.	Students collect the video and play it when they get home. They are to also take notes based on the lesson.

APPENDIX XV

Guidelines for Activities in the Animation- Based Flipped Class and its Contact Class Sessions

WEEK	ACTIVITY		TOPIC/SUB-TOPICS
	ANIMATION-BASED FLIPPED CLASS	**CONTACT CLASS**	
1.	Animation-based lesson on Definition of food and four uses of food to living things are to be **viewed** and **studied** at home by the students	Discussion in contact class is based on **identifying** real examples of food and **answering** questions on the uses of food, based on the responses to the questions, further discussions on the uses of food, will be done by students with the guidance of the research assistant	Definition of food and uses of food
2.	Animation-based lesson on Classes of food: Carbohydrate, proteins and vitamins with relevant examples are to be **viewed and studied** at home by the students	Students are made to **arrange** different types of food into the classes carbohydrate, protein and vitamins. **Discussions** among students will also take place on importance of each class of food to an animal.	Classes of food: Carbohydrate, proteins and vitamins with relevant examples
3.	Animation-based lesson on Classes of food: fats and Oil, minerals and water with relevant examples are to be **viewed and studied** at home by the students	Students are made to **arrange** different types of food into the classes fats, and Oil, minerals and water. **Discussion** among students will also take place on importance of each class of food to an animal.	Classes of food: fats and Oil, minerals and water
4.	Animation-based lesson on Test for Carbohydrate: Benedict's and Fehling's tests are to be **viewed and studied** at home by the students	Students are made to **carry out practical** on test for Carbohydrate in the laboratory using the animation package as a guide	Test for Carbohydrate: Benedict's and Fehling's tests
5.	Animation-based lesson on Test for complex sugar and Test for Starch are to be **viewed and studied** at home by the students.	Students are made to **perform pra0ctical** on test for complex sugar and Test for Starch in the laboratory using the animation package as a guide	Test for complex sugar and Test for Starch
6.	Animation-based lesson on Test for protein: Biuret and Millon's test are to	Students are made to **carry out practical** on test for protein: Biuret and Millon's test in the laboratory	Test for protein: Biuret and Millon's test

	be **viewed and studied** at home by the students.	using the animation package as a guide	
7.	Animation-based lesson on Test for Fats and Oil: Translucent paper mark test and Sudan III test are to be **viewed and studied** at home by the students.	Students are made to **perform practical** on Test for Fats and Oil: Translucent paper mark test and Sudan III test in the laboratory using the animation package as a guide	Test for Fats and Oil: Translucent paper mark test and Sudan III test
8.	Animation-based lesson on Water: uses and Test for Water: cobalt chloride paper test and anhydrous copper sulphate test are to be **viewed and studied** at home by the students.	Students are made to **carry out practical** on Water: uses and Test for Water: cobalt chloride paper test and anhydrous copper sulphate test in the laboratory using the animation package as a guide	Water: uses and Test for Water: cobalt chloride paper test and anhydrous copper sulphate test

APPENDIX XVI

Guidelines for Activities in the Video- Based Flipped Class and its Contact Class Sessions

WEEK	ACTIVITY		TOPIC/SUB-TOPICS
	VIDEO BASED FLIPPED CLASS	**CONTACT CLASS**	
1.	Video based lesson on Definition of food and four uses of food to living things are to be **viewed** and **studied** at home by the students.	Discussion in contact class are to be based on **identifying** real examples of food and **answering** questions on the uses of food, based on the responses to the questions, further discussions on the uses of food, are done by students with the guidance of the research assistant	Definition of food and uses of food
2.	Video based lesson on Classes of food: Carbohydrate, proteins and vitamins with relevant examples are to be **viewed and studied** at home by the students.	Students will be made to **arrange** different types of food into the classes' carbohydrate, protein and vitamins. **Discussion**s among students take place on importance of each class of food to an animal.	Classes of food: Carbohydrate, proteins and vitamins with relevant examples
3.	Video based lesson on Classes of food: fats and Oil, minerals and water with relevant examples are to be **viewed and studied** at home by the students.	Students are made to **arrange** different types of food into the classes' fats, and Oil, minerals and water. **Discussion**s among students also take place on importance of each class of food to an animal.	Classes of food: fats and Oil, minerals and water
4.	Video based lesson on Test for Carbohydrate: Benedict's and fehlings tests are to be **viewed and studied** at home by the students.	Students are made to **carry out practical** on test for Carbohydrate in the laboratory using the Video package as a guide	Test for Carbohydrate: Benedict's and Fehling's tests
5.	Video based lesson on Test for complex sugar and Test for Starch are to be **viewed and studied** at home by the students.	Students are made to **carry out practical** on test for complex sugar and Test for Starch in the laboratory using the Video package as a guide	Test for complex sugar and Test for Starch
6.	Video based lesson on Test for protein: Biuret and Millon's test are to be **viewed and studied** at home by the students.	Students are made to **carry out practical** on test for protein: Biuret and Millon's test in the laboratory using the Video package as a guide	Test for protein: Biuret and Millon's test

7.	Video based lesson on Test for Fats and Oil: Translucent paper mark test and Sudan III test are to be **viewed and studied** at home by the students.	Students are made to **carry out practical** on Test for Fats and Oil: Translucent paper mark test and Sudan III test in the laboratory using the Video package as a guide	Test for Fats and Oil: Translucent paper mark test and Sudan III test
8.	Video based lesson on Water: uses and Test for Water: cobalt chloride paper test and anhydrous copper sulphate test are to be **viewed and studied** at home by the students.	Students are made to **carry out practical** on Water: uses and Test for Water: cobalt chloride paper test and anhydrous copper sulphate test in the laboratory using the Video package as a guide	Water: uses and Test for Water: cobalt chloride paper test and anhydrous copper sulphate test

APPENDIX XVII

Guidelines for Activities in the Conventional Class and its Homework Activities

WEEK	ACTIVITY		TOPIC/SUB-TOPICS
	CONTACT CLASS	HOME WORK	
1.	The research assistant does the teaching on definition of food and stated four uses of food.	Students are given the assignment to mention 2 types of food they know and to mention other 2 uses of food apart from what was taught in the class	Definition of food and uses of food
2.	The research assistant states and explains three classes of food: carbohydrate, proteins and vitamins with relevant examples	The research assistant instructs the students to read more on other examples of the discussed classes of food and to read on the other classes of food not yet taught	Classes of food: Carbohydrate, proteins and vitamins with relevant examples
3.	The research assistant states and explaines three classes of food: Fats and Oil, Minerals and Water with relevant examples	The students are given the assignment to identify 2 other examples of the classes of food discussed in the class.	Classes of food: fats and Oil, minerals and water
4.	The research assistants explaines the procedure involved in the process of Benedict's test to the students using a tabular format of Test, Observation and Inference	The research assistant instructes the students to find out how to perform the Fehling's test.	Test for Carbohydrate: Benedict's and Fehling's tests
5.	The research assistant marks students' assignment on Fehling's test and corrects them where they make mistakes, then, he explains the procedures involved in the tests for complex sugar and starch.	The research assistant instructs the students to read more on test for protein	Test for complex sugar and Test for Starch
6.	The research assistant explains the procedures involved in the test for protein: Biuret and Millon's test	The students are instructed to answer questions based on test for starch and test for proteins	Test for protein: Biuret and Millon's test
7.	The research assistant marks students' assignment on tests for starch and protein. Then, he explains the	Students are to perform the translucent paper mark test when they get home and bring the paper to the next class. They were also to read on the test for	Test for Fats and Oil: Translucent paper mark test and Sudan III test

	procedures involved in the test for fats and oil(paper mark test and Sudan III test)	water	
8.	The research assistant explains water and its uses and also explains the procedures involved in the tests for water	The students are instructed to read more on the tests for water	Water: uses and Test for Water: cobalt chloride paper test and anhydrous copper sulphate test