EFFECTS OF THREE MODES OF FLIPPED CLASSROOM COLLABORATIVE STRATEGIES ON LEARNING OUTCOMES OF SECONDARY SCHOOL PHYSICS STUDENTS IN MINNA, NIGERIA

BY

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ABSTRACT

This study investigated the effects of three modes of flipped classroom collaborative learning strategies on learning outcomes of secondary school Physics students in Minna, Nigeria. The study employed quasi-experimental design which included a pretest, posttest and retention test using 4x3x2 factorial matrix design. One hundred and forty six (146) students from intact Physics classes from four secondary schools in Minna were used as the sample of the study. This consists of sixty seven (67) male and seventy nine (79) female students from four senior secondary schools in Minna. Each of these schools was used as experimental group I, group II, group III and the fourth for the control group respectively. Eleven (11) specific objectives, eleven (11) research questions and eleven (11) null hypotheses were used in the study. The research instruments used for the study are: Flipped-classroom Instructional Package (FIP), Physics Achievement Test (PAT), Students' Attitude towards Physics Questionnaire (SATPQ) and Students' Attitude towards Flipped Classroom Questionnaire (SATFCQ). These instruments were validated by experts from Federal University of Technology, Minna, Test and Measurement Department of National Examination Council (NECO) and Physics teachers from senior secondary schools in Minna. Pilot test and field trial test were carried out. A reliability coefficient of 0.84, 0.73 and 0.81 were obtained from the pilot testing of the PAT, SATPQ and SATFCQ respectively. The reliability results were considered reliable as they were all above the recommended edge of 0.6 alpha levels. The data collected from the pretest, posttest and retention test were analyzed. Descriptive statistics of Mean and Standard Deviation were used to answer the eleven (11) research questions while the inferential statistics of ANCOVA and ANOVA were used to test the Hypotheses at 0.05 Alpha levels. The result of the study revealed that the flipped classroom collaborative learning settings (Think-Pair-Share (TPS), Reciprocal Teaching (RT), Think-Aloud Pair Problem Solving (TAPPS)) had significant effect on the students' achievement and retention in the posttest and retention scores with p-value of 0.01. The study similarly shows that there is significant difference in the mean attitude of student taught using flipped in collaborative learning setting of Think-Pair-Share (TPS), Reciprocal Teaching (RT), Think-Aloud Pair Problem Solving (TAPPS); and those in individualized learning setting (IL) with a p-value of 0.18. Moreover, the study shows that gender is not a vital factor in the mean achievement scores of students taught Physics using flipped classroom in collaborative learning (0.606). There is also no significant difference on retention and on attitude of students based on gender with p-value of 0.893 and 0.118 respectively. It was recommended that, flipped classroom collaborative learning strategies as one of the innovative teaching methods should be used to reinforce classroom instructions in the teaching of Physics in senior secondary schools in Nigeria so as to assist students learn at their own pace, time and anywhere that is convenience for them. Also, educational policy makers should conduct seminars and workshops on blended learning for teachers on the use of modern innovative methods of teaching and learning.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The impact of technology has spread to almost every aspect of life today including education and has affected teaching methods. Teaching with technology engages students with different kinds of incentives involved in activity based learning. Technology makes material more interesting. It makes students and teachers more media literate. Technology is a means to justify the end of composition outcomes and has become a unified extension of the curriculum in the classroom (Naga and Iyappan, 2018). In medieval times where books were inadequate, only a few elites had access to educational opportunities. Individuals had to travel to centers of learning to get education. Today, massive amount of information from books, audio, images, videos among others are available at fingertips through the Internet. Also, opportunities for formal learning are now available online through the Khan Academy, Massive Open Online Courses (MOOCs), podcasts, traditional online degree programmes among others. This has absolutely changed how teachers teach and how students learn. Teachers are learning how to teach with emerging technologies such as tablets, iPads, Smart Boards, digital cameras, computers and many more, while students are using advanced technology to shape learning in the classroom (Cormier and Siemens, 2010).

By embracing and integrating technology into the classroom, students are being prepared for successful life outside the school as this helps to build collaboration, interaction and teamwork. Students of today have been referred to as digital natives or millennial students in that they grow up using technology at early stage than other students in previous generations. These students learn differently than those before them because the technology they use has become a way of life for them (Roehl *et al.,* 2013). They have information at hand through the internet and they can ultimately connect with others around the world.

Presently, there is growth in the adaptation and integration of technology into everyday life, the same thing ought to affect the way students are taught with technological tools in today's classrooms. Nigeria recognized the importance of technology and this was emphasized in National Policy on Education that a greater proportion of educational expenditure will be devoted to science and technology (Federal Republic of Nigeria, FRN, 2013). There is direct proportional relationship between the level of development of a society and level of technological advancement. In fact, developed countries are societies with high level of technology advancement (Jegede and Adebayo, 2013).

The application of technology in instructional process cut across various disciplines including science. Science teaching in Nigerian secondary schools started when the grammar schools were established in 1859. Physics is one of the science subjects taught at the secondary school level in Nigeria. Physics is the study of matter, energy and their interaction, Physics plays a key role in the progress of mankind (Omebe, 2009). Physics education is a major factor in the enhancement of development. The Nigerian education scheme designed for Secondary School Physics in 1985 has it that, the objective of studying Physics include, among others, to provide basic literacy in Physics for functional living in the society and to acquire essential scientific skills and attitudes as a preparation for the technological application of Physics (Jegede and Adebayo, 2013).

Hence, for national development in technology, basic concepts and principles of Physics are indispensable. Gambari and Yusuf (2017) explained that Physics education is aimed at training students to acquire appropriate scientific skills and attitudes as a prerequisite for future scientific activities. To achieve this objective, active participation and collaborative learning activities become imperative and there is need for functional instructional media to make Physics instruction effective. The teaching of Physics in secondary school is aimed at producing young scientists who would be able to design the technological devices that would make everyday activities easier and life more comfortable (Ajayi, 2008). Since Physics is one of the pivotal subjects in technology and national development, the teaching and learning of Physics require serious attention in order to enhance a sustainable technological development in Nigeria and Niger State in particular. In fact, companies, hospitals, maintenance outfits, oil and gas industries, and many others, employ artisans, attendants and technicians that have at least a pass in Physics. Even on grounds of direct personal benefits, a basic knowledge of Physics enables one to rectify minor faults in home appliances, personal computers, and private cars, among others (Mbamara and Eya, 2015). In general, the level of development of a country like Nigeria is dependent on the extent of its acquisition and utilization of innovations. This is unattainable if a working knowledge of Physics does not exist.

Appliances and equipment such as light bulbs, digital cameras, cars, cell phones, airplanes, solar panels, fiber optics, DVD players, computers, MP3 players grocery, laser scanners, space rockets, flat screen television and many others will not be in existence without Physics. Thus Mulvey and Pold (2015) reported that Physics helps people to develop critical thinking and problem-solving skills. All these are success of Physics towards improving the wellbeing of mankind. As a result of these numerous benefits of this subject, more attention needs to be given to the teaching of Physics especially at the secondary school level. Presently, research findings revealed that students' performance in the subject has been very low in both internal and external examinations in Nigeria (Aiyelabegan, 2003; Akanbi, 2003; Kola, 2007; Bello, 2012).

Also, Akanbi (2010) observed that the trend in the performance of secondary school students in science subjects, especially Physics assumed threatening and frightening dimension. One of the factors responsible for poor performance in Physics is the abstract nature of the subject (Adeyemo, 2010). This implies that the mastery of Physics concepts might not be fully achieved without the use of instructional media or innovative teaching strategies. The teaching of Physics without instructional materials or appropriate teaching strategies may certainly result in poor academic achievement (Onasanya and Omosewo, 2011). The authors also stressed that, no matter how well trained a professionally qualified science teacher may be, he/she would not be able to put in ideas into practice if the school lacks equipment and instructional resources to translate his/her competence into reality. Furthermore, Okoronka and Wada (2014) identified poor teaching strategies and methods among which traditional approach is a major factor contributing to poor performance in Physics.

Also, another factor which low academic performance has been attributed to is gender bias in Physics and Mathematics (Nzewi, 2003). The author posited that some courses like physical sciences and technical courses which are dominated by male students were regarded as difficult for female students while Biological sciences, Home Economics and Secretarial Studies which were dominated by female students were regarded as simple courses. This traditional way of classifying students had also affected their learning and performance the same way traditional method of teaching had done. In the traditional teaching method (teacher-centered), students attend class, take notes and prepare for exams; they do not have personal input in their learning.

The traditional methods of teaching have primarily revolved around a teacher-centered approach where instructors focus on conveying information, assigning work, and leaving it to the students to master the material. This type of instruction forces students to be merely receptors of information rather than participants in their own learning processes through active learning. To overcome these problems, there is need for a paradigm shift from traditional methods of teaching to innovative teaching strategies using modern technological devices. Fortunately, technology has increasingly grown and infiltrated the classrooms, especially in developed countries; new learning models have emerged that move away from the teacher-centered approach to a more collaborative (student-centered) learning environment. These include: mobile learning, collaborative learning, web-based learning, flipped classroom, among others (UNESCO, 2014).

Flipped classroom is an instructional strategy and a type of blended learning that reverses or inverses the traditional learning environment by delivering instructional content outside the classroom. It moves activities, including those that may have traditionally been considered homework into the classroom. In a flipped classroom, students watch online or offline lectures, collaborate in online discussions, or carry out research at home and engage in concepts in the classroom with the guidance of a mentor. Also, content delivery in a flipped classroom may take a variety of forms. Often, video lessons prepared by the teacher or third parties are used to deliver content (Abeysekera *et al.,* 2015).

Flipped classroom instruction is a pedagogical approach in which direct instruction moves from the group learning to the individual learning, and the group learning is subsequently transformed into a dynamic, interactive, learning environment (Flipped Learning Network, FLN, 2014). The role of teacher is to guide students as they apply concepts and engage creatively in the subject matter. In practice, activities can take many forms, but generally involve students preparing for class by watching a pre-recorded lecture or undertaking assigned reading and activities, followed by the ‘lecture’ time being used for interactive discussion, problem-solving and other activities with the teacher. As such, the role of the teacher shifts from being the ‘sage on the stage’ to the ‘guide on the side’ (FLN, 2014).

The main goal of a flipped classroom is to enhance student learning and achievement by reversing the traditional model of a classroom, focusing class time on student understanding rather than on lecture (Wilson, 2013). To accomplish this, teachers post short video lectures online for students to view at home prior to the next class session. This allows class time to be devoted to expanding on and mastering the material through collaborative learning exercises, projects, and discussions. The benefits of this approach include: an increase in interaction between students and teachers, a shift in the responsibility for learning on to students and opportunity for students to prepare at a time that suits them. It also provide an archive of teaching resources; an increase in student engagement and a shift from passive listening to active learning collaborative working between students (Bergman *et al.*, 2011).

Collaborative Learning (CL) strategy is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product (Roberts, 2009). Collaborative learning is an umbrella term for a variety of approaches in education that involve joint intellectual effort by students or students and teachers. It can also be defined as a strategy and learning environment in which learners engage in a common task in which each individual depends on and is accountable to each other. It involves the use of small groups so that all students can maximize their learning and that of their peers. It is a process of shared creation: two or more individuals interacting to create a shared understanding of a concept, discipline or area of practice that none had previously possessed or could have come to on their own (Nkwodimah, 2003). The author also held that Collaborative learning activities can include: collaborative writing, group projects, and other activities. Examples of Collaborative Learning Strategies include: Think-Pair-Share (TPS), Reciprocal Teaching (RT) also known as Reciprocal peer tutoring, Think-Aloud Pair Problem Solving (TAPPS), Group Writing Assignment (GWA), and Group Grid (GG) (Bill, 2010).

In Think-Pair-Share (TPS), the learning activity involves a student explaining ideas to another student. The instructor poses a question to the class; students write a response and then share it with a student nearby. Students clarify their positions and discuss points of agreement and disagreement. The instructor can use several answers to illustrate important points or facilitate a whole class discussion. This technique is used to keep students engaged in large classes. In order for meaningful learning to occur, students must interpret, relate, and incorporate new information with students' existing knowledge and experiences (Cortright *et al.,* 2005).

In Reciprocal Teaching (RT), the learning activity involves students teaching one another in a group. Students jointly read a text or work on a task. Students take turns being the teacher for a segment of the text or task. Students lead the discussion, summarizes material, ask questions, and clarify material. This method is useful to improve students' ability to do specific intellectual activities such as reading primary sources, interpreting graphs, analyzing artwork and exposes students to other ways to interpret the material **(**Bill, 2010). Peer tutoring is an instructional strategy that consists of student partnerships, linking high achieving students with lower achieving students or those with comparable achievement, for structured reading and mathematics study sessions. Rohrbeck *et al.*, (2003) identify peer tutoring as a systematic, peer-mediated teaching strategies.

In Think-Aloud Pair Problem Solving (TAPPS), the learning process involves solving problems. Students work in pairs and alternate roles. For each problem one is the solver while the other is the listener. The solver thinks aloud-narrating his/her reasoning process - while solving the problem. The listener prompts the solver to keep talking and asks for clarification but does not intervene to help. This process is useful because; it emphasizes process rather than product, students can practice formulating ideas, rehearse routine skills, attend to sequence, identify gaps and errors in understanding, and instructors can observe students' reasoning process (Barkley *et al.,* 2014).

In Group Grid, the learning activity involves analyzing, classifying, and organizing subject matter. The instructor creates a grid or matrix based on several categories or criteria. Students use the grid to classify course concepts. After groups complete their grids the instructor shows the correct version. Students compare their work, ask questions and revise their ideas. The technique is useful to help students process and re-organize information and useful when students are trying to absorb a lot of new information **(**Bill, 2010).

In the Group Writing Assignments (GWA), Bill (2010) inscribes the learning activity involves collaborative work that culminates in a group-authored document. Assign groups to write (and submit) entries on course-related topics or create study guides for the course. The method is useful in writing-to-learn to help students develop and revise ideas. It helps students to have opportunities to see how other students view the same topic with an authentic purpose which can increase students' interest, commitment and academic achievement (Bill, 2010)**.**

Academic achievement is a significant part of the education process and informs educators of student ability and progress toward educational goals. One of the most important factors that generally influence better achievement of students in science is the teacher and the teaching methods adopted (Olorundare, 2013). This implies that teachers could use their occupational skills to manipulate all other factors and gear the skills towards improving students' interest, retention and achievement in the sciences irrespective of gender.

Gender is one of the factors that have considerable effects on students' academic achievement especially in science subjects. Gender is the range of physical, biological, mental and behavioural characteristics pertaining to and differentiating between the feminine and masculine (female and male) population (Adigun *et al.*, 2015). Many researchers reported gender issues in science education as inconclusive (Bilesanmi-Awoderu, 2002; Erinosho, 2005). Adebule and Aborishade (2014) reported that both male and female students have almost the same attitude towards science. However, David *et al.*, (2013) reported that male students developed more positive attitudes than their female counterparts. Another research concluded that there is no disparity in the attitudes of students towards science based on gender (Sakariyau, *et al.*, 2016).

Attitude is the predisposition to classify objects and events, to react to them with evaluative consistency. Attitudes are formed by people as a result of some kinds of learning experience. If the experience is favourable a positive attitude is found and vice versa (Orunaboka, 2011). Some attitudes are based on people's experience, knowledge and skills and some are gained from other sources. However, attitude is not stagnant /static. It changes in a couple of time and gradually (Olasheinde and Olatoye, 2014). Fasakin (2012) recognized attitude as a major factor in a subject choice. Development of positive attitudes towards science, scientists, and learning of science, which has always been a constituent of science education, is increasingly a subject of concern (Trumper, 2006).

Research has shown that students' attitude towards science subjects may be influenced by the quality of exposure, the learning environment, and teaching methods (Craker, 2006). If students have negative attitude towards science subjects, this may affect their interest to the courses and the teachers. Based on this premise, numerous studies have been conducted to determine the factors that affect students' attitudes towards science subjects. For instance, Students' attitude towards science is more likely to influence achievement in science courses than achievement influencing attitude (O'Connel, 2000). Similar results were stated by Craker (2006), who found that students need to have a positive attitude towards problem-solving to be successful, and this problem-solving requires students' knowledge and problem solving skills to overcome risks. Edermir (2009) affirmed that attitude, whether positive or negative, affect learning in science.

However, a negative attitude towards a certain subject makes learning and retention difficult. Retention which is the ability to reproduce the learnt concept when the need arises has been examined by many researchers. It is necessary for better achievement because it stretches the ability to remember things learned by individuals at later time. It takes place when learning is coded into memory (Anchor *et al.,* 2013). Students' interests and retention could be aroused and retained through the use of an appropriate instructional media like e-learning (Osemmwinyen, 2009).

Empirical studies on students' retention and influence of gender on students' achievement in Physics have been conflicting and inconclusive. Studies on flipped classroom in Physics especially in secondary schools in Nigeria educational context are uncommon. In addition, researches on the use of flipped classroom with collaborative learning strategies are novel in developing nations. Hence, the need for this research on the effects of three modes of flipped classroom collaborative learning strategies on secondary school students' learning outcomes in Physics in Minna, Nigeria.

1.2 Statement of the Research Problem

Studies have shown that methods of teaching in which learners are not accountable for their learning but are teacher-centred have affected achievement and retention, especially in science subjects where evaluating, analyzing, applying and creating of ideas are highly in use. The effectiveness of blended learning like the flipped classroom over the conventional teacher-centered method had also been established through many researches. However, studies on the different types of flipped classroom collaborative strategies which promote a significant upsurge in student achievement and retention are scanty especially in Nigeria.

Based on these facts, there is need for a study whose objective is to reach (through comparison of the different types of flipped classroom collaborative strategies) the most effective flipped collaborative strategy to teach different subjects in secondary school especially Physics. Physics as one of the core science subjects in secondary school has been termed difficult as revealed by numerous researches (Aiyelabegan, 2003; Akanbi, 2003; Kola, 2007; Bello, 2012). Thus, there is need to investigate which of these innovative learning strategies will help the teaching and learning of Physics to produce increase in achievement and retention, and also improve students' attitude towards Physics in the classroom.

Similarly, investigations likewise revealed that much of the work on flipped classroom collaborative (group-based flipped classroom) strategy were carried out in tertiary institutions of learning not much work on flipped classroom collaborative (group-based flipped classroom) strategy had been carried out in secondary schools generally across the globe. Hence the reason for this research to determine the effect of three modes of flipped classroom collaborative strategies on secondary school Physics students' learning outcome in Minna, Nigeria.

1.3 Aim and Objectives of the Study

The aim of this research is to examine the effects of three modes of flipped classroom collaborative learning strategies on secondary school Physics students' learning outcomes in Minna, Nigeria. The objectives of the study are to:

i. Determine the difference in the mean achievement scores of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS) and those taught using individualized learning (IL) setting.

ii. Determine the difference in the mean retention scores of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think aloud paired problem solving (TAPPS) and think pair share (TPS) and those taught using individualized learning (IL) setting.

iii. Examine the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Pair Share (TPS) collaborative learning settings.

iv. Determine the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving (TAPPS) collaborative learning settings.

v. Examine the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching (RT) collaborative learning settings.

vi. Determine the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Individualized learning (IL) settings.

vii. Determine the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Pair Share (TPS) collaborative learning settings.

viii. Examine the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving (TAPPS) collaborative learning settings.

ix. Examine the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching (RT) collaborative learning settings.

x. Determine the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Individualized learning (IL) settings.

xi. Determine the difference in the mean attitude rating of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –

aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning (IL) setting.

1.4 Research Questions

The study answered the following questions:

i. What is the difference in the mean achievement scores of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS) and those taught using individualized learning (IL) setting?

ii. What is the difference in the mean retention scores of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think aloud paired problem solving (TAPPS) and think pair share (TPS) and those taught using individualized learning (IL) setting?

iii. What is the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Pair Share (TPS) collaborative learning settings?

iv. What is the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving (TAPPS) collaborative learning settings?

v. What is the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching (RT) collaborative learning settings?

vi. What is the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Individualized learning (IL) settings?

vii. What is the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative (TPS) learning settings?

viii. What is the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving (TAPPS) collaborative learning settings?

ix. What is the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching (RT) collaborative learning settings.

x. What is the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Individualized learning (IL) settings?

xi. What is the difference in the mean attitude rating of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think – aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning (IL) setting?

1.5 Research Hypotheses

The following null hypotheses were formulated and were tested at 0.05 level of significance in the study:

HO_1: There is no significant difference in the mean achievement scores of students exposed to flipped classroom in Think pair share collaborative learning settings ((TPS), reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and those taught using individualized learning (IL) setting.

HO_2: There is no significant difference in the mean retention scores of students exposed to flipped classroom in collaborative learning settings (Think pair share (TPS), reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and those taught using individualized learning (IL) setting.

HO_3: There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Pair Share (TPS) collaborative learning settings.

HO_4: There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving (TAPPS) collaborative learning settings.

HO_5: There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching (RT) collaborative learning settings.

HO_6: There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Individualized learning (IL) settings.

HO_7: There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Pair Share (TPS) collaborative learning settings.

HO_8: There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving (TAPPS) collaborative learning settings.

HO_9: There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching (RT) collaborative learning settings.

HO_{10}**:** There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Individualized learning (IL) settings.

HO_{11}**:** There is no significant difference in the mean attitude rating of students exposed to flipped classroom in collaborative learning settings (reciprocal teaching (RT), think - aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning setting.

1.6 Scope of the Study

This study investigated the effects of three modes of flipped classroom collaborative strategies on secondary school Physics students' learning outcomes in Minna, Nigeria. The study was carried out in four co-educational schools in Minna, Nigeria namely: Police Secondary School, Minna, Brighter School, Minna, Hilltop Model School, Maitumbi, and Fema School Tudun-Fulani, Minna.

The concept was limited to the content of light waves in Physics which include the following topics Introduction to light waves, reflection of light waves and refraction of light waves in lenses with dispersion of light through a prism. These contents were selected because they were identified to be among the difficult concepts in the senior secondary school two (SSII) syllabus (Erinosho, 2005). The variable under the study include four levels of independent variables, Reciprocal Teaching (RT), Think Aloud Paired Problem Solving (TAPPS), Think Pair Share (TPS) and Individualized Learning (IL) strategy which is the control group); three levels of dependent variables (Achievement, Attitude and Retention), and two levels of moderating variable of gender (male and female). The instrument is limited to flipped-classroom instructional package (FIP), Students' Attitude to Physics (SATPQ), Students Attitude to Flipped Classroom Questionnaire (SATFQ) and Physics Achievement Test (PAT). These were used for data collection. The field work lasted for ten weeks.

1.7 Significance of the Study

It is expected that the findings of this research would be significant to students, teachers, researchers, curriculum planners, examination bodies, parents, publishers, educational associations, non-governmental organizations and policy makers. Precisely: This learning strategy will help the students to analyze the topic in depth as they read at their pace, reverse, pause or rewind, make clarification and discuss with their teachers and peers in class after the flipping. It also allows students who need more time to understand certain concepts to take their time reviewing the material and receives immediate assistance from teachers and classmates. This encourages collaboration with other students; to teach and learn concepts from each other with the guidance of their teachers hence teamwork ability is built.

It would stimulate Physics subject teachers and their counterparts in other subjects matter to be creative and encourage them to employ the use of technology to enhance teaching and learning process. By the use of flipped classroom as the primary way of delivering lessons, the teachers could benefit from this positive approach to the problem of lack of concentration and understating during classes.

It will also stand as a stepping stone for future researchers and academicians as the information provided would be useful in further research in this area or related areas. This study can also provide empirical evidences for further researches on flipped classroom collaborative strategies on Physics. It will contribute to literature and add to the existing knowledge since there are few studies available regarding this strategy.

It is hoped that the findings of this study will help the curriculum planners to design curriculums that will encourage student-centered learning approach and improve performance of students in Physics at senior secondary school level. The findings of this study would open another direction for policy makers in education to redirect their educational policies to the use of strategies that will encourage active learning. The outcome of this study will help the Physics publishers to structure the Physics textbooks based on strategy that pose more activities on students to be creative and take charge of their learning.

1.8 Operational Definition of Terms

Attitude: The communication of indulgence or disapproval towards the use of flipped classroom collaborative strategy in teaching Physics content in the schools.

Collaborative Learning: This involves two or more students grouped together to solve Physics problem, complete a task, or create a product. Examples are: Reciprocal Teaching (RT), Think-Aloud Pair Problem Solving (TAPPS) and think pair share (TPS).

Flipped classroom: This is a learning strategy in which teacher prepares the Physics content in video and students watch and listen to it outside the classroom and during the class period, the teacher facilitate the lesson by creating tasks and activities to reflect the content they watch in the video.

Individualized learning: This is a learning strategy in which Physics video lesson is available to each learner to access his/her convenience without the assistance of his peers and teachers. Students can learn at his/her own pace, watch the video several times, fast forward, pause and reverse the video.

Reciprocal Teaching (RT): This is a collaborative learning activity that involves two or more students that watch Physics lesson video and take turn to teach the aspect of the Physics concept to another student in a group.

Retention: This refers to the ability of students taught Physics using the flipped classroom collaborative strategy to hold information or store learned material or experience that makes recall or recognition possible whenever it is needed.

Think Pair Share (TPS): This is a collaborative learning strategy which involves two students paired to write a response then share their ideas with each other and clarify their positions and discuss points of agreement and disagreement whenever teachers give them a task after watching Physics lesson video.

Think-Aloud Pair Problem Solving (TAPPS): This is a learning process involves solving Physics problems where students work in pairs and alternate roles. For each problem, one is the solver while the other is the listener.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Framework

This conceptual framework pilots the whole research activity. In this study, the flipped classroom collaborative strategies of reciprocal teaching (RT), think aloud paired problem solving (TAPPS), think pair share (TPS) and individualized learning (IL) setting are the independent variables, while achievement, retention and attitude are the dependent variables. However, the study also incorporated a moderating variable of gender in the drawn framework. Cause-effect relationships frequently include several independent variables that affect the dependent variables. This is summarised in Figure 2.1.

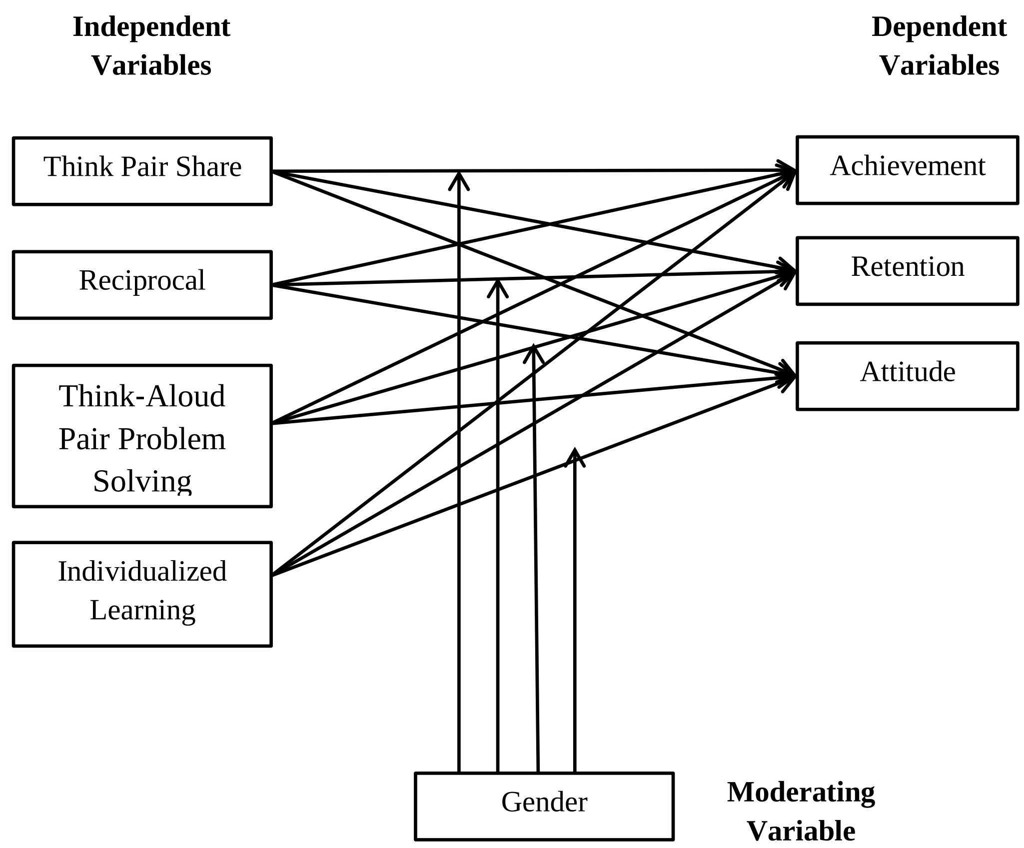


Figure 2.1: The Conceptual Framework for the study

2.1.1 The Concept of Information Communication Technology (ICT) in learning

It is indeed becoming very difficult to live a meaningful life in this era without the knowledge of ICT. It has impacted on the quality and the quantity of teaching, learning and research in both traditional and distance learning institutions (Abolarinwa, 2010). Technology in the twenty-first century put instantaneous access to information, and the Internet can be handily accessed through numerous technology tools such as laptop, computer, and Smartphone (Fu, 2013). The United Nations Educational, Scientific, and Cultural Organization (UNESCO, 2016) stated that Science and Technology fields are crucial for sustainable development because they help in finding solutions to threats posed by global challenges such as climate change, global health epidemics, and increased income inequality. This implies that effective Science and Technology education is capable of inculcating in learners the skills that will enable them to function effectively in the modern-day society, which has been described as knowledge driven by many nations including Nigeria.

ICT can enhance teaching and learning through its dynamic, interactive and engaging content. It can also provide real opportunities for individualized instruction. It has the potential to accelerate, enrich, and deepened skills, motivate and engage students in learning; help to relate school experience to work practices, and can assist in creating economic viability for tomorrow's workers. It also contributes to radical changes in schools, strengthens teaching and provides opportunities for connection between the school and the world (Yusuf, 2005; Abolarinwa, 2010).

Also, Richter and McPherson (2012) concluded that in today's digital age, every student can access many free Internet learning resources such as online video lectures and they can watch these free contents everywhere and at their convenience. Now more than ever, students spend much of their waking time on using some sort of technology tools; by using this technology, it is possible for them to interact with friends, instructors, and learning content everywhere, not only in the class but also outside the class through distance learning (Fisher, 2009). Wang and Heffernan (2010) likewise contended that the use of traditional learning approach which focuses on the instructor as the center of knowledge is irrelevant in today's digital age. As a solution, traditional classroom activities such as lectures, labs, homework, and exams can be moved to the Web and students can study everywhere outside the classroom (Staker and Horn, 2012). The positive growth of technology has influenced the development of instructional technology in education and replaced the use of the blackboard with online video lectures (Evans, 2011).

2.1.2 Innovative learning strategies in education

Advance tutoring is the way to enhance teaching and learning performance. Different innovative teaching methods are now in use across the globe. Hybrid teaching includes e-learning in addition to the face to face teaching, the use of technology and multimedia, use of smart gadgets for different tasks like teaching, designing question papers, assessment of student, and feedback among others are all modern ways of improving teaching and learning. The application of innovative teaching and learning methods is critical if there is motivation and stimulation of the spirit of learning as well as enthusiasm on the part of students (Naga and Iyappan, 2018).

Furthermore, the transfer of knowledge becomes very easy and convenient, as well as effective when aided by technology. The reliance and dependence of such an innovation, that simply makes life an easy, smooth journey is completely unavoidable these days even in schools, universities and colleges. Students like to see appealing visuals and something that entices them to think rather than just reading words. Using projectors and Visual images always have a strong appeal compared to words (Raja and Nagasubramani, 2018).

In addition, Khairnar, (2015) highlighted Advance Innovative Methods of Teaching and Learning which include, the SMART Board, Blogging, Bookmarking, Voice Thread, Moodle, Polling, Podcasts, Screencasts, among others which the author defines as follows:

SMART Board: interactive whiteboards make learning a visual, engaging experience for students, which helps deepen understanding and promote retention of course material. It transforms your learning spaces into interactive, collaborative environments where students are both inspired and focused.

Blogging: is a public post. Blogging for study sessions is to be practiced. Students can post case studies in a class blog. Students can be asked to post notes on class blog. You can analyze, evaluate and create the material. Blogging causes you to reflect. Teachers naturally think back on what has happened in their classroom, and often wonder what they could have done better. Blogging can help with this process, enabling teachers to keep an ongoing personal record of their actions, decisions, though processes, successes and failures, and issues they have to deal with. Blogging can crystallize your thinking. As we write, we invest a part of ourselves into the medium. The provision of the medium makes blogging conducive to drafting and redrafting. The act of composing and recomposing ideas can enable abstract thoughts to become more concrete. Your ideas are now on the screen in front of you; they can be stored, retrieved and reconstructed as your ideas become clearer. You don't have to publish if you want to keep those thoughts private. Save them and come back to them later. The blog can act as a kind of mirror to show you what you are thinking. Sometimes we don't really know what we are thinking until we actually write it down in a physical format.

Bookmarking: is the simple process of saving the address of a website in the favorite folder of your web browser so that you can find it again later. Social bookmarking takes these process two steps further. Firstly, instead of saving the bookmarks to your favorite folder, it saves them online. The great advantage of this is that you can then access them from any computer, not just the one you saved them on, simply by logging into your social bookmarking account. This enables you to access your favorite sites from wherever you are, rather than wherever you bookmarked the site. The second advantage is the social part. Saving bookmarks online enables you to easily share them with other internet users and for you to access their bookmarks as well. This can help you find and access many more useful websites; especially as many social bookmarking sites enable you to join special interest groups and finds people who have similar interests with you. The benefits of social bookmarking are that it is easy to share and manage social bookmarks. Searching and storing in database is also easy.

Voice Thread: is a web service that allows users to upload PowerPoint slides, videos, photos, plus others and add voice narration to create a multimedia presentation. Voice Thread is an application that runs inside your web browser and it allows you to transform collections of media, like images, videos, documents, and presentations, into a place for a conversation. These conversations are not live, but take place whenever it's convenient for the people to participate. They are also secure, with simple controls that let you dictate who can participate and what they can do. Educators use Voice Thread for many different reasons, from extending and documenting classroom conversations, online tutoring, virtual class spaces, professional development training, and a thousand things in between. The advantages of the voice thread are as follows. It starts student driven discussions with better understanding. It is a great way to deliver projects and solicit feedback. The information about voice threads is available on the following links

Moodle: is Virtual Learning Environment which provides staff and students with access to electronic teaching and learning materials such as lecture notes and links to useful websites and activities such as discussion forums, group it is something that lets you capture your experience, note, website and photos.

Polling: can be used as a means of reflection in generating an issue for Science experiments, Discipline, Understanding and feedback. Using polling and smart phones to keep students engaged.

Podcasts: are serial recordings, posted regularly online. Basically, producing podcasts is the technology based equivalent of oral lectures, as much as lectures and news have been shared with listeners, who download the files online. The advantages of podcast are its flexibility, reusability of your lecture. It is advantageous for the hearing impaired students.

Screencasts: have emerged as a prominent teaching tool on the Internet. Screencasts are an effective way to share ideas, deliver content, and obtain student feedback. Screencasts can be used for describing a step-by-step process, explaining a particular concept, or presenting a PowerPoint presentation with narration and multimedia elements. A screencast can be used in any class as a part of real time instruction or as the lesson itself as in the flipped teaching model. With the flipped teaching method, instructors use screencast videos to deliver their lectures, assigning them as homework. Then, in class, students can ask questions as they work through problems that they normally would have done at home without teacher help. Creating an educational screencast that meets content objectives requires a systematic approach to planning. It seems clear that screen casting is a powerful, highly effective, and affordable learning tool that can facilitate learning across any curriculum area. Screen casting is a remarkable instructional tool. These are the free software’s available for instructors which teach and saves time. Jing, Screen jelly, screen, Screencast are some of the freebies available.

Naga and Iyappan (2018) concluded that any teaching method without destroying the objective could be considered as innovative methods of teaching. The researchers believe that the core objective of teaching is passing on the information or knowledge to the minds of the students. There are a number of ways that teachers can bypass the system and offer students the tools and experiences that spur an innovative mindset. Education is a light that shows the mankind the right direction to surge. The purpose of education is not just making a student literate but adds rationale thinking, knowledgeability and self-sufficiency. When there is a willingness to change, there is hope for progress in any field. Creativity can be developed and Innovative teaching and learning benefits both students and teachers.

Other Innovative Teaching Options:

Chat rooms, Discussions board, Webinars, Emails, Social media in class rooms and Image creators.

2.1.3 The concept of Physics and instructional strategies at secondary school in Nigeria

Science was not taught in any school in Nigeria before 1859. At the establishment of the first senior secondary School in Nigeria in 1859, (Church Missionary Society Grammar School, Lagos) arithmetic, algebra, geometry and physiology were introduced into the school curriculum (Omolewa, 1977; Adeyemo, 2003). A number of Secondary and Teacher training institutions were later founded between 1859 and 1929, and their curriculum were science subjects friendly. These science subjects include astronomy, chemistry, physiology, geology and botany (Adeyemo, 2010). Physics is one of the science subjects taught at the senior secondary school level of the Nigeria educational system. After the Junior Secondary School class three (JSS III) examination, Physics is compulsory for all qualified science students at senior secondary school level. It was stated by the Federal Republic of Nigeria (FRN, 2013) in its National Policy on Education that Physics can be taken as one of the “core” science subjects.

Physics as a course of study is perceived generally to be very interesting, vast, mathematical and experimental. Almost all aspect of life science, both living and nonliving has something to do with Physics, ranging from engineering to mathematics, biology, chemistry. Physics is one of the pre-requisite subjects for the study of engineering, technological, medical and other applied science courses in the university. Physics is the study of the laws of nature that govern the behavior of the universe, from the very smallest scales of sub-atomic particles to the very largest scales of cosmology (Amuche and Iyekekpolor, 2014). The principle of Physics has been widely used for various purposes; economic, scientific and technological advancement such as in information technology, which has reduced the world into a global village through the use of satellites and computers.

Also, the knowledge of Physics had led to sustainable development in the area of industrialization for improvement of materials useful to the well-being of human race. Furthermore, Physics education enables the learners to acquire problem-solving and decision-making skills that pave way for critical thinking and inquiry that could help them to respond to widespread and radical changes in all facets of life (Bello, 2012). Despite the importance of Physics to the scientific and technological development of our nation, there are still some identified and deep-rooted concerns peculiar to Physics subject in secondary schools which need to be addressed.

2.1.4 Challenges encountered in studying Physics at the secondary schools in Nigeria

As important as Physics is to the development and growth of our nation, Bello, (2012) conversely discovered and highlighted problems confounding the study of Physics in secondary schools in Nigeria as:

i) Inadequacy of materials and personnel with respect to teaching the subject

ii) Lack of laboratories and Equipment

iii) Inability of the teachers to impact the subject to the students, which might be due to the problem of teachers' qualification and effectiveness.

iv) The overloading of West African examination council syllabus

v) Shortages in the supply of Physics teachers and poor environments in which Physics practical are taught

vi) The ability of this subject to inspire and interest pupils, particularly girls; and other factors such as careers advice which affect pupils' desire to study Physics at higher levels

vii) The inflexibility, irrelevance and repetitiveness of the curriculum

viii) The limitations on practical and fieldwork

ix) Non implementation of ICT in science teaching

x) The shortage of qualified science teachers is a well-known problem.

The increasing demand for science graduates in other more lucrative sectors and the decreasing number of graduates in these subjects means that we are caught in a seemingly endless cycle of decline in specialist science teachers

xi) Insufficient inventory of students' previous learning and attainment, including what they had already learned in primary school

Physics has some features which are generally accepted and believed to widen the knowledge and increase the horizon of understanding of the subject by the learners. It is believed that if they are duly and critically followed and applied in any given situation and at any given period of time will be able to make this subject easy to comprehend by learners. And as a result nullify the misconceptions of people, students, teachers of Physics, other subjects teachers, parents and community at large about Physics (Adeyemo, 2010).

These features demand that Physics instruction should be guided by the following procedures:

1. The method of teaching Physics should be guided discovery method instead of the old and routine lecture method used in teaching the subject. This was recommended due to the fact that, learning efficiency and effectiveness takes place during explanation, experimentation and discussion (Adeyemo, 2010).
2. There should be interaction between the teacher of Physics and the students. In this case, it is believed that it is genuine and helpful interaction between the teacher and the students, the students will be able to expose their minds and what and when, they find difficult in Physics topics to their teacher and thereby reduce the difficulties they encounter (Adeyemo, 2010).
3. It was also recommended that each topic should have a target and specific objectives to be met at the end of this lesson and that lesson. This is necessary and important if Physics is to be appreciated by the students and community at large. Before a topic could be appreciated, it must have attainable goods and objectives and if these objectives are not met, then it is said to be aimlessly taught and of course, have no contribution to the development of the students in terms of cognitive, affective, and psychomotor domains and also has nothing to add to the society (Adeyemo, 2010).
4. Each topic should cut across other topic that is the knowledge guided in previously taught topic should be transferable. This means that it should have to contribute to this new topic and aids the understanding of the new topic. In a nutshell, topics should be sequentially arranged in a logical order so that the knowledge gained could be retained, transferable and applicable to any physical challenges (Adeyemo, 2010).

5. Evaluation should not only be based on the recalling of facts but also on the affective and psychomotor. This is recommended so that students could be wholly and all round developed on the demands of their societies (Adeyemo, 2010).
6. It was recommended that emphasis should be placed on the theoretical aspect as well as practical aspect of the subject. This is suggested and recommended so that any theory taught in Physics could be tested and trusted to be consistent at any considerable situations (Adeyemo, 2010).
7. Above all, each topic should be taught in a way that takes into consideration its relevance to the societal norms and values so that each student can appreciate the values, norms of his society in which he/she lives (Adeyemo, 2010).

It was also opined by Gambari and Yusuf, (2017) that Physics education is aimed at training students to acquire proper understanding of basic principles as well as their applications. It is also aimed at developing appropriate scientific skills and attitudes as a prerequisite for future scientific activities. To achieve these objectives, active participation and collaborative learning activities become imperious and these need functioning instructional media to make Physics instruction effective.

Collaborative strategies among students which are the main variables in this work increases students' engagement and a shift from passive listening to active learning, like the flipped classroom collaborative learning strategy and will assist in achievement and retention of acquired knowledge (Bergman, 2011).

2.1.5 Concept of flipped classroom learning strategy

The face-to-face approach has been the standard method in education. However, online learning has grown significantly in the past decade. DiRienzo and Lilly (2014) states that, more students require flexibility in their schedules to meet both work and family obligations.

With technology becoming more popular, educators have tried to find new learning strategies to increase the effectiveness of the learning process. However, using technology alone is not as effective as integrating it into teaching approaches. A new concept of blended learning called the flipped classroom emerged. The definition of the flipped classroom model is fairly new and has been open to interpretation. It is routinely defined as a new pedagogical approach to blended learning that flips the traditional classroom pedagogy. In the flipped model, the delivery of content takes place outside the classroom, and what is traditionally done outside the classroom is instead done in class.

There are many factors that influence the learning environment in a flipped classroom but there are two key components without which it is impossible to flip a classroom. One of them is the educational technology and the other is classroom activities and learning (Strayer, 2007). This is illustrated further in Figure 2.2.

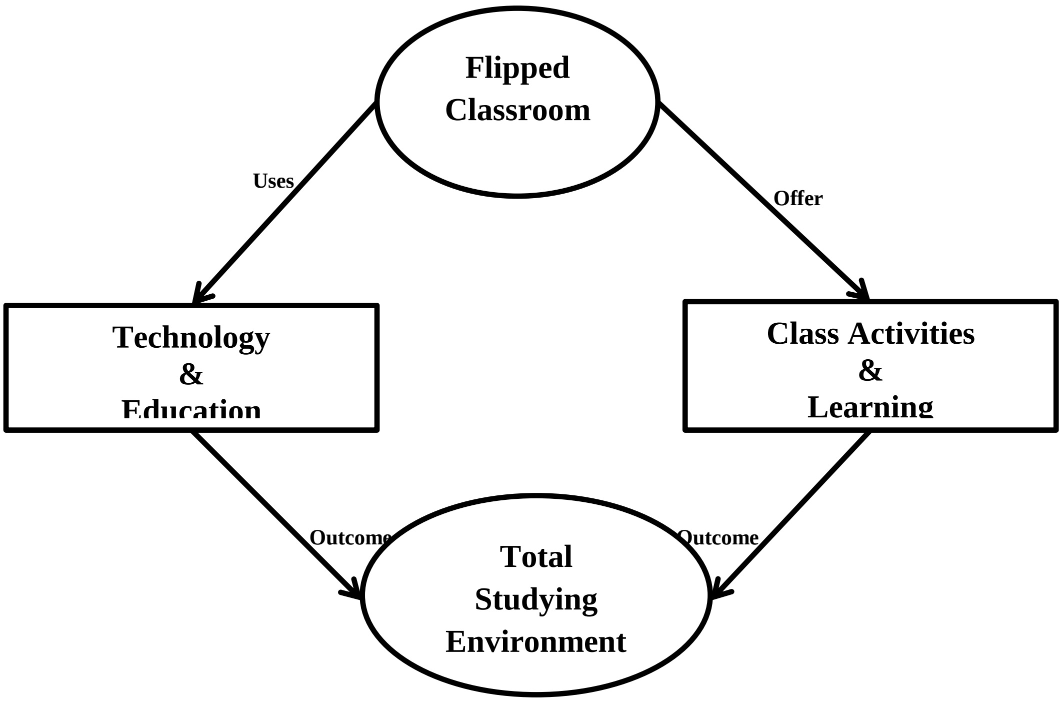


Figure 2.2: Flipped classroom model. Modified (Strayer, 2007)

This concept of flipped classroom illustrates that with the use of technology and videos at home and activities in the classroom, an enhanced learning environment can be acquired.

The idea of flipping the classroom with resources like the Khan Academy is simple (Khan 2012). Rather than the teacher providing synchronous in-class group instruction, students are expected to use the video resources provided, along with other materials, to learn concepts and complete tasks on their own at their own pace and at locations convenient to the student. Individual students can focus their efforts on their individual learning needs so that they are not left behind by class discussions that go too fast or become bored by class time that is spent covering content they already know.

This approach allows the teacher to use class time in different ways, such as adapting time allocation based on reports of where students need help. Students can participate in in-class discussions or receive remedial assistance on things they were not able to learn on their own. Moreover, students need attend class only if they need help beyond what is provided by the other learning resources, resulting in time savings for those who do not need in-class help.

There are a variety of ways that teachers implement a flipped classroom (Hughes 2012), but the concept is basically the same (Bergmann and Sam 2012; Berrett 2011; Talbert 2012). Direct instruction is blended with constructivist learning pedagogies so that individualized differentiated learning is facilitated. Learning is not limited to the classroom, students can read at their own pace and direct their efforts based on their own individual needs, thus personalizing instruction. Students are expected to take responsibility for their own learning. The teacher's role as a course designer shift somewhat from structuring in-classroom time to providing learning resources that can be consumed asynchronously as needed.

In this modern time, the flipped classroom has become one of the emerging technologies in education and it can be a standard of teaching-learning practice to foster students' active learning in higher education (Hamdan, *et.al*, 2013). The flipped classroom is an approach to teaching and learning activities where students watch a video lesson outside the class through distance learning and have hands-on activities in the class. Halili and Zainuddin (2016) note that the flipped classroom or reverse classroom is an element of blended learning, integrating both face-to-face learning in the class through group discussion and distance learning outside the class by watching asynchronous video lessons and online collaboration. Blended learning is simply defined as the activity of teaching and learning which combined face-to-face physical activities with online learning (Heilesen, 2010; Lean *et al.*, 2014; Poon, 2014). Blended learning was practiced by mixed face -to-face and distance teaching and learning or the integration of both distance and face-to-face modalities to deliver instruction.

Flipped classroom is also known as a student-centered approach to learning where the students are more active than the instructor in the classroom activity. In this case, the instructor acts as a facilitator to motivate, guide, and give feedback on students' performance (Sams and Bergmann, 2012). Hence, by applying the flipped classroom approach to teaching and learning activities, the instructor can move the traditional lecturer's talk to video and the students can listen to the lectures anywhere outside of class. The flipped classroom allows students to watch the video according to their preferred time and need, and they can study at their own pace; this type of activity also increases students' collaborative learning in distance education outside the class. Thus, by flipping the class, the students will not spend so much time listening to long lectures in the classroom, but will have more time to solve problems individually or collaboratively through distance learning with peers. Applying flipped classroom approach also contributes to better understanding of technology use in teaching and learning activities; students will use various technology media in learning activities independently, while the lecturer will use various technology media in their teaching practices (Zainuddin and Attaran, 2015).

Flipped classroom also encourage individualized learning strategy because students are able to approach material and study it at their own pace. By covering lecture material at home and from a video-based platform, students can privately view the material. This allows them to approach things at their own pace without worry of peers noticing them moving slower or faster. Students can stop, pause, rewind, and fast forward material so that they can examine things in their own way. By taking the lecture portion of the classroom home with them, students are able to utilize their teachers' one-on-one attention more successfully in the classroom. Students sit through lecture, gather questions, and prepare themselves for the day with the teacher to tackle "homework". Because the actual exercises are done in the classroom rather than at home with this model, students have their teacher available for questions with problems when they occur. Similarly, flipped classroom can be used for group learning.

When students watch or listen to lectures at home, and then solve problems and apply the new knowledge in the classroom, they get less frustration with their homework since they are not alone in it. They ask for others opinions and ideas; this can be when students work together in groups to create, find meaning, find solution to problems, debate or carry out experiment in a collaborative manner. It could be done in a face-to-face conversation, or in a chat-room, on e-mails or WhatsApp among other; this is referred to as Collaborative Learning Setting.

The Four Major Features of Flipped Classroom Learning Strategy

Flexible environment: Flipped Learning allows for a variety of learning modes; educators often physically rearrange their learning spaces to accommodate a lesson or unit, to support either group work or independent study. They create flexible spaces in which students choose when and where they learn. Furthermore, educators who flip their classes are flexible in their expectations of student timelines for learning and in their assessments of student learning (Hamdan *et. al.*, 2013).

Shift in learning culture: In the traditional teacher-centered model, the teacher is the primary source of information. By contrast, the Flipped Learning model deliberately shifts instruction to a learner-centered approach, where in-class time is dedicated to exploring topics in greater depth and creating rich learning opportunities. As a result, students are actively involved in knowledge construction as they participate in and evaluate their learning in a manner that is personally meaningful (Hamdan *et. al.*, 2013).

Intentional content: Flipped Learning Educators continually think about how they can use the Flipped Learning model to help students develop conceptual understanding as well as procedural fluency. They determine what they need to teach and what materials students should explore on their own. Educators use Intentional Content to maximize classroom time in order to adopt methods of student-centered, active learning strategies, depending on grade level and subject matter (Hamdan *et. al.*, 2013).

Professional educator: The role of a Professional Educator is even more important, and often more demanding, in a Flipped Classroom than in a traditional one. During class time, they continually observe their students, providing them with feedback relevant in the moment, and assessing their work. Professional Educators are reflective in their practice, connect with each other to improve their instruction, accept constructive criticism, and tolerate controlled commotion in their classrooms. While Professional Educators take on less visibly prominent roles in a flipped classroom, they remain the essential ingredient that enables Flipped Learning to occur (Hamdan, *et.al.*, 2013).

Flipped classroom approaches are characterized by:

A change in use of classroom time;

A change in use of out-of -class time;

Doing activities traditionally considered 'homework' in class;

Doing activities traditionally considered as in-class work out -of -class;

In-class activities that emphasize active learning; peer learning; problem solving;

Pre -class activities;

Post-class activities;

And Use of technology (especially video).

Example of a typical flipped classroom is show in Figure 2.3 below.

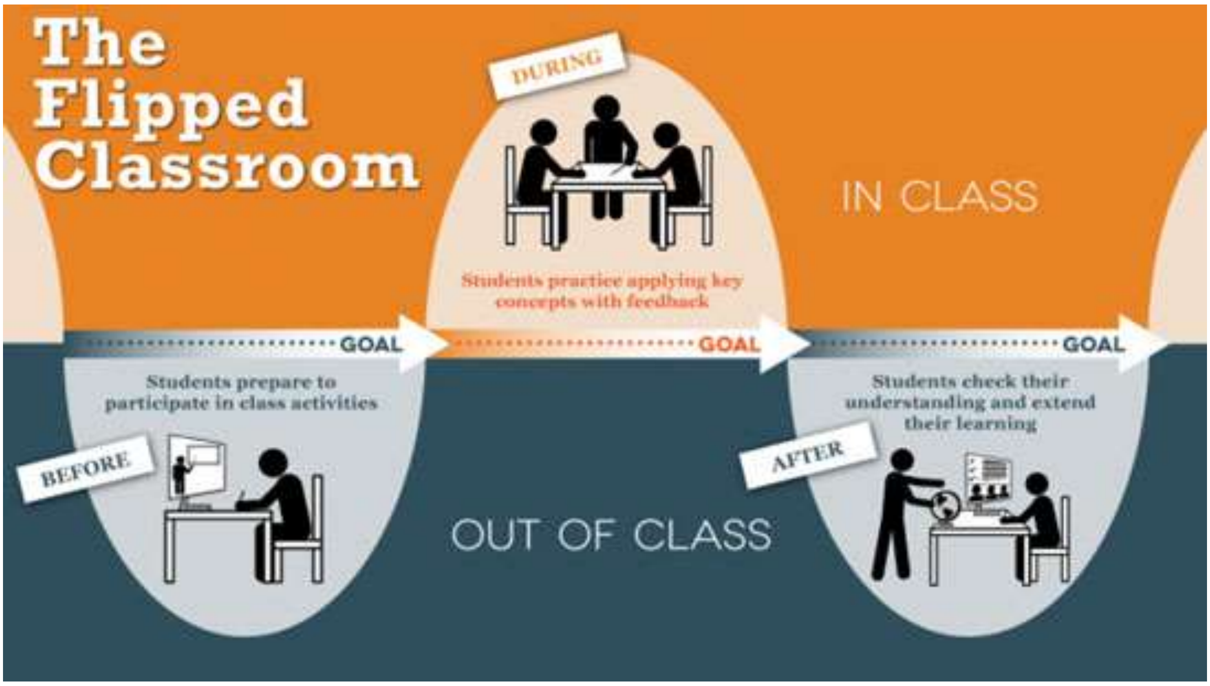


Fig 2.3: Example of flipped classroom

Benefit of the Flipped Classroom Model to both the teacher and the students:

With the popularity of flipped classroom instruction growing every year, a wide variety of opinions and observations have been expressed about its effectiveness (Hall and DuFrene, 2016). One benefit is an increased efficiency of time usage. Since a flipped classroom typically involves watching video versions of course material online as homework, students can then come to class the next day ready to actively engage in the material (Martin, 2015). It also allows teachers to spend more time individually interacting with students, which creates more opportunities to check for understanding and clear up misconceptions (Bergmann and Sams, 2014). An additional benefit regarding time efficiency is that once teachers have recorded and chronicled course materials online they can easily refer to it in the future, which saves them the time of repeating themselves and allows them to focus their productivity addressing other student needs (American School Board, 2014).

Improvements in student engagement are also frequently supported by existing research. This could be because the flipped classroom approach presents material through digital mediums which students can more easily relate to (Greenfield, 2009; Vanessa, 2016). Considering most of today's youth grew up with a reliance on web based forms of information consumption and communication perhaps computer based modes of learning resonate with them more naturally (Bergmann and Sams, 2012; Goodwin and Miller, 2013). They also presented another explanation for students finding video lectures more engaging than traditional lectures is founded in research into human nature and physiology, which has found that learners typically lose interest in an activity after about ten minutes. This works perfectly with the structure of a flipped classroom since the video lectures used are kept short in order to remain engaging (Engin and Donanci, 2015).

Additionally some schools have found that student performance appears to improve when utilizing flipped classroom techniques. One high school outside of Detroit which was struggling with high failure rates was able to cut their student failure rate by two-thirds after assigning video lectures as homework and completing assignments together in class (Rix, 2012). This is not an isolated finding but rather an effect that has been experienced across age levels and content areas. At an elementary school that decided to provide students with iPads and change the way they approached their curriculum researchers witnessed that, after just one semester, these students have the highest math and reading scores, the best attendance, and the fewest instances of out-of-school suspension in the district. This is because, as both students and parents say, they are “more engaged in their learning.” (Smith, 2016) It appears that some preliminary nonscientific data supports that teachers share a favorable view of flipping as well.

In a survey of 453 teachers who flipped their classrooms a majority of the teachers reported improvements in student performance and attitudes and 99% of the teachers agreed that they would continue to use the flipped classroom approach in the following school year (Flipped Learning Network, 2012). Additional strength of the flipping is that it allows students to re-visit material at their own pace by re-playing video lectures or reviewing content at a later date. In other words, flipping allows students to enjoy the benefits of self-paced learning or differentiation (Sams and Bergmann, 2013). Students may learn at slightly different paces from one another, with some zipping through concepts on the first try and others needing to have concepts repeated and clarified before they can really grasp what was said. The ability for students to access lectures online and watches them repeatedly if needed means that a major weakness of traditional oral lectures, namely the inability to revisit content, can be bypassed (Keene, 2013).

For the teacher, the lesson only has to be delivered once, even though the same teacher may have five classes in this subject. All students in those five classes will have access to this ‘best of all lessons’, the teacher does not have to deliver it five times. This saves time for the teacher. It also frees the teacher during class time. Once the video is online, it can be used year after year as long as the content is relevant. Once the lesson is available for all students in his/her class, the teacher can also reach students who are part of the global audience. This will also allow teachers to have more time to give one-on-one support or challenge gifted students during class because less time is dedicated to delivering instruction (Hall and DuFrene, 2016). Sams and Bergmann (2013), the original developers of flipping, have also shared that a component of their approach to flipping involves allowing students to re-take tests or quizzes. Since they consider self- paced learning to be an important benefit of flipping, this policy gives students a chance to demonstrate that they have mastered course content even if they required additional time to do so. They shun the idea that assessment scores must remain static or punitive and encourage the use of flexibility in assessment as a component of flipping (Sams and Bergmann, 2013). Flipped classroom strategies are also conducive to improvements in communication. Since course content is shared online through videos on blogs or other virtual classroom spaces it is much easier for students to stay informed about what a teacher is covering in class and parents can also watch over student progress and take a more active role in their child's education.

Online sharing also facilitates the distribution of teaching resources and best practices with others in the educational community so that wisdom can be shared collectively (Vanessa, 2016). Envisage what this could mean for students in countries where they may not have access to regular school, or for those adults who would like to train themselves, or for anyone who would like to brush up on some skills. The availability of online lessons has great potential for kids who miss school due to travelling or being kept out of school because they are sick. Students who are unable to attend school due to illness or other personal circumstances can remain up-to-date on assignments by checking what has been posted online. Conversely if a teacher is absent they can easily share that day's lesson with a substitute teacher by directing them to their website (Bergmann and Sams, 2012). This fosters a stronger sense of connection between home and school and allows for increased transparency.

It has also been cited that students become more empowered through the use of technology in and out of the classroom and are able to take a more active role in their own education (Vanessa, 2016). She also explained that by teaching students to use technology as a tool for acquiring knowledge teachers are helping them to pursue learning independently. This is Personalized Learning in nature.

2.1.6 Outcome of flipped classroom on learners' achievement

Research indicates that the flipped classroom model at its core allows instructors to simultaneously teach course content and practice the application of the content (Demski, 2013). The exposure of course context outside of the class provides students with opportunities to experience group discussions and activities in class. This experience, in turn, fosters a connection between application and content, such as lectures, textbook readings, and homework. Class time becomes a platform through which instructors can review student work, engage in student group discussions, and answer students' questions or concerns. This greater interaction between instructor and students along with students' interactions amongst teammates fosters critical thinking skills, communication skills and practical experience (Al-Zahrani, 2015).

Furthermore, through flipped classroom, students listen to the different viewpoints of teammates and learn through experiences how teammates communicate and process ideas. In the meantime, students are enhancing their processes of organizing, reviewing, analyzing and evaluating information. Consequently, the nurturing of critical thinking skills through active collaborative learning occurs (Reddan *et al.,* 2016). Through this open teaching method, students perceive greater control over their learning, students engage in meaningful discussions with their instructors and peers, in-class instructor support, experiential class activities, and following course contents without class constraints (Butt, 2014; Sengel, 2016). Consequently, flipped learning supports social and collaborative opportunities while nurturing competencies needed for today's workplace (Brunsell and Horejsi, 2013; Hamdan *et al.*, 2013).

2.1.7 Effect of flipped classroom on retention

Flipped classroom instructional practice, is a new model for effective teaching, Leo and Puzio (2016) referred to it as the process by which students gain first hand exposure to learning content outside the class, usually via reading or lecture videos, and then use class time to do the harder work of assimilating that knowledge through problem solving, discussion or debates. Flipped classroom is a form of blended learning in which learners learn content online by listening to audio lectures or the watching the video lectures, mostly at their various home, and assignment is done together in the class with teachers and students discussing and solving questions. Students can work together on a task, exchange their opinion, experiences, views, discuss and negotiate strategies, actions and results through flipped classroom (Ichinose and Clinkenbeard, 2016; Zhonggen and Guifang, 2016). These actions can provide students with opportunity to help, discuss, review teach, influence each other and thereby enhance their retention for developing a learning community. In flipped classroom, teacher's role is of a mentor or facilitator of the learning process. The achievements of individual member within the group are shared among the group members.

Fakayode (2012) defined retention as individual ability to hold information or store learned material for future use. The prevalent problem in secondary schools is poor retention among secondary school students offering science subjects including Biology. Concepts learned tend to fade with time when not put to use, or not properly retained, hence, lead to forgetting and loss of knowledge.

Traditional classroom lectures often follow a one-pace-fits-all philosophy. Teachers try to adjust their lectures based on the feedback they get from students, because some students assimilate the lectures at a fast rate while others assimilate slowly. Video lectures provided through the flipped classroom model allow students to be able to fast forward through examples they already understand, or pause and rewind to revisit topics which may require more processing and assimilating time (Goodwin and Miller, 2013). Videos allow lectures to be broken into pieces, as opposed to traditional instruction which often contains a large volume of content delivered at once and thus improve the retention rate of students (Brecht and Ogilby, 2008).

2.1.8 Group assisted collaborative learning

Collaborative learning is a parasol term for a variety of instructive tactics involving joint rational effort by students, students and teachers together. In this environment all are working in group of two or more, mutually working on a common problem by collecting useful material and knowledge and disseminating the same in the group for the better outcome. This promotes the activities in today's era to participate in discussion group, sharing the knowledge and experience, and doing real experiments with proper sharing the resources and thoughts. This makes the environment healthier and makes the learning more strong in the collaborative way (Johnson *et al.*, 2014).

Collaborative learning is a technique that involves group of students working together to impact learning in a positive way. Working together and learning together always results into more learning outcomes then working or learning individually. Successful implementation of collaborative work for the educational domain likely to provide add on input for the better outcome to the students as well as teachers. It allows explicit procedures that encourage the students to work together. It helps teacher to monitor groups, group activities, and also help teachers to make more decisions about the learning of the student in the teaching-learning environment (Wecker and Fischer 2014).

In addition, a flipped classroom can provide the opportunity to use active learning approaches in the classroom, because students can engage with the pre-studied materials using higher-order intellectual skills such as analysis, synthesis and evaluation (Tucker, 2012; Roehl *et al.*, 2013; Gilboy *et al.*, 2015). Through this approach, low-level or surface learning (i.e. defining and understanding basic content) can take place outside the classroom, and high-level deeper learning (i.e. apply and evaluate the materials) can be achieved inside the classroom (Roach, 2014; Gilboy *et al.,* 2015), thereby realizing different learning levels according to Bloom's taxonomy (Bloom *et al.,* 1956). Active learning activities, such as brainstorming, case-based instruction, simulation, peer-teaching, and role-play are generally introduced in four instructional approaches: individual activities, paired activities, informal small groups, and cooperative student projects (Zayapragassarazan and Kumar, 2012).

2.1.9 Concept of individualized learning

Many of the educational field had seen new technologies as powerful tools to help schools meet the needs of ever-more-diverse student populations. The idea is that digital devices, software, and learning platforms offer a once-unimaginable array of options for tailoring education to each individual student's academic strengths and weaknesses, interests and motivations, personal preferences, and optimal pace of learning. Individualized learning is an adjustable, individualized pace combined with an adjustable, differentiated learning approach (with and without mobile devices) that allows students to incorporate their interests and choices into the overall experience (Friedrich *et al.*, 2013).

Four Pillars of Individualized learning:

Learner Profile: Each student should have a "learner profile" that documents his or her strengths, weaknesses, preferences, and goals.

Learning Path: Each student should pursue an individualized learning path that encourages him or her to set and manage personal academic goals.

Competency-Based Progression: Students should follow a "competency-based progression" that focuses on their ability to demonstrate mastery of a topic, rather than seat time.

Students' Learning Environments: This should be flexible and structured in ways that support their individual goals (Friedrich *et al.*, 2013).

In many schools, students are given district-owned computing devices or allowed to bring their own devices from home. The idea is that this allows for "24-7" learning at the time and location of the student's choosing, hence encouraging a student-centered learning strategy.

2.1.10 Concept of collaborative learning strategy

Collaborative learning activities allow students to provide explanations of their understanding, which can help students to elaborate and reorganize their knowledge as explained by Van Boxtel, (2000). Social interaction stimulates elaboration of conceptual knowledge as group mates attempt to make themselves understood, and research demonstrates that providing elaborated explanations improves student comprehension of concepts. Once conceptual understandings are made visible through verbal exchange, students can negotiate meaning to arrive at convergence, or shared understanding.

Bill, (2010), itemized and described five examples of Collaborative Learning Techniques out of which this study applied.

(i) **Reciprocal Teaching (RT):** This learning activity involves students teaching to one another in groups. Students jointly read a text or work on a task. Students take turns being the teacher for a segment of the text or task. In their teaching role students lead the discussion, summarize material, ask questions, and clarify material.

Example: Instructor preps students by showing how to read a text. In groups students jointly read course material (e.g., primary source, article and artifact). Students take turns being the teacher and leading discussion of a segment of text. Student summarizes the segment, asks a question, and clarifies material.

Bill, (2010), further explains the reasons for using them as: To improve students' ability to do specific intellectual activities such as reading primary sources, interpreting graphs and analyzing artwork. The role of teaching puts student in position of monitoring their comprehension and re-organizing the material. It likewise exposes student to other ways to interpret the material

(ii) **Think-Aloud Pair Problem Solving (TAPPS):**

The learning activity involves solving problems. Students work in pairs and alternate roles. For each problem one is the solver while the other is the listener. The solver thinks aloud—narrating his/her reasoning process—while solving the problem. The listener prompts the solver to keep talking and asks for clarification but does not intervene to help (Kim, 2002).

Example: Ask students to form pairs and explain the roles;

Problem solvers: talk through their reasoning process as they solve a problem;

Listeners: encourage Pair Share to think aloud and ask for clarification as needed. Pairs solve a set of problems and alternate role for each new problem.

Reasons for using them: he said that, they emphasize process rather than product; Students can practice formulating ideas, rehearse routine skills, attend to sequence, and identify gaps and errors in understanding; Instructors can observe students' reasoning process;

(iii) **Think-Pair-Share (TPS):** This learning activity involves explaining answers/ideas to another student. The instructor poses a question to the class. Students write a response and then share it with a student nearby. Students clarify their positions and discuss points of agreement and disagreement. The instructor can use several answers to illustrate important points or facilitate a whole class discussion (Leahy *et al.,* 2005)

How Think-Pair Share works: Instructor poses question to class; Students write a response (1-2 minutes); Students pair up with another student nearby; Each student explains his/her response to the other; If they disagree, each clarifies his/her position and determines how/why they disagree.

Reasons for using them: They keep students engaged in large classes; Prime students for whole class discussion; Target key concepts for review; Enhance students' meta-cognition—they become more aware of gaps in their thinking; Student responses are feedback to the instructor about how they are making logic of the material.

(iv) **Group Grid (GG):** The learning activity involves analyzing, classifying, organizing subject matter. The instructor creates a grid or matrix based on several categories or criteria. Students use the grid to classify course concepts. After groups complete their grids the instructor shows the correct version. Students compare their work, ask questions and revise their ideas.

Example: Form groups and distribute blank grid as a handout; Give students uncategorized, scrambled items of information; Groups categorize the information in the grid; Instructor should recommend process -open discussion, take turns, divide categories within group; Instructor displays correct version of the grid. Students compare their work, ask questions and revise.

Reasons for using them: To help students process and re-organize information; Useful when students are trying to absorb a lot of new information; Analyzing and re-organizing the material is better than simply re-reading it.

(v) **Group Writing Assignments (GWA):**

The learning activity involves collaborative work that culminates in a group-authored document. Assign groups to write (and submit) Wikipedia entries on course-related topics or create study guides for the course.

Example: Use a wiki, Google Docs, or Office Live for collaborative writing; Use assignment that has authentic purpose and audience such as creating Wikipedia entries or study guides for the course; Establish guidelines to scaffold the process.

Reasons for using them: Use writing-to-learn to help students develop and revise ideas; Students have opportunities to see how other students view the same topic; Can make an assignment with an authentic purpose and audience can increase students' interest and commitment.

Collaborative learning covers a broad territory of approaches with wide variability in the amount of in-class or out-of-class time built around group work. Collaborative activities can range from classroom discussions interspersed with short lectures, through entire class periods, to study on research teams that last a whole term or year. The goals and processes of collaborative activities also vary widely. Some faculty members design small group work around specific sequential steps, or tightly structured tasks. Others prefer a more spontaneous agenda developing out of student interests or questions. In some collaborative learning settings, the students' task is to create a clearly delineated product; in others, the task is not to produce a product, but rather to participate in a process, an exercise of responding to each other's work or engaging in analysis and meaning-making (Johnson *et al.*, 2014).

2.1.11 History of collaborative learning strategy

Much of the research on collaborative and cooperative learning is rooted in the work of Piaget and Vygotsky (Dillenbourg, 1996). For example, socio-constructivists borrow Piaget's system of developmental stages describing children's cognitive progress, as well as ideas related to cognitive conflict, which refers to the sense of dissonance experienced when one becomes aware of a discrepancy between one's existing cognitive framework and new information or experiences. According to the socio-constructivist approach, cognitive conflict is critical in triggering growth. Social interactions help to facilitate such conflict to the extent that students interact with peers at more advanced developmental levels (Dillenbourg, 1996).

Within this school of thought, group heterogeneity is an important consideration, as group mates are expected to possess different knowledge, different knowledge representation schemes, and different reasoning mechanisms (as reviewed in Dillenbourg, 1996). For example, research in the Piagetian tradition suggests that when conservers (i.e., children who realize that pouring a glass of water into another glass that is differently-sized and differently-shaped does not change the quantity of water) are paired with non-conservers on a conservation task, non-conserving members are highly likely to reach conservation as a result of interaction, whereas the regression of conserving members is rare (as summarized in Tudge, 1992).

Dillenbourg, (1996) point out that this approach is probably too mechanistic, that disagreement and conflict in and of themselves are not as important as the communication they engender. Vygotsky's work placed more emphasis on the value of social interaction itself for causing individual cognitive change, as opposed to being merely stimulated by it (as reviewed in Dillenbourg, 1996). In this formulation, social interaction is internalized, which causes conceptual changes as participant's appropriate new understandings. Like Piaget Vygotsky emphasized the importance of heterogeneous groupings of collaborators. According to Vygotsky, the zone of proximal development is the distance between what a student can accomplish individually and what he/she can accomplish with the help of a more capable "other." Whereas Piagetian studies typically pair children from different developmental stages to facilitate cognitive conflict, studies in the Vygotskian tradition frequently pair children with adults. Rather than focusing on cognitive conflict as a trigger for conceptual change, socio - culturists view collaborative learning as learning that occurs within the zone of proximal development (as summarized in Dillenbourg, (1996)).

More recently, the shared or situated cognition approach - informed by researchers in sociology, anthropology, and even computer science - emphasizes the social structures in which interactions occur (Dillenbourg, 1996). This approach sees the environment as an integral part of cognitive activities associated with collaboration. Accordingly, attempts to investigate collaboration that ignore social structures are likely to be biased. Under this view, knowledge is not something that is handed down from one partner to another. Rather, knowledge is co-constructed through interactions among collaborators. This approach emphasizes that the whole of group behavior is more than the sum of its individual parts. In other words, group interactions evolve in ways that are not necessarily predictable based on the inputs of group members. This latter insight suggests that viewing the group rather than individual group members as the unit of analysis could produce qualitatively different conclusions about collaboration. Since the late 1990s, a new strand of research on collaborative learning focusing on new technologies for mediating, observing, and recording interactions during collaboration has emerged (Kreijns *et al.,* 2003).

This new strand of research, commonly called computer-supported collaborative learning (CSCL), typically uses online networks for facilitating and recording online interactions among two or more individuals who may be geographically and/or temporally dispersed. Much of this research has grown in parallel to new technologies for supporting distance interactions, such as email, chat, instant-messaging capability and more recently, resources for synchronous video conferencing (such as Sky) (Zemel *et al.*, 2005).

2.2 Theoretical Framework

2.2.1 Bloom's revised taxonomy of cognitive domain

Benjamin Samuel Bloom, who chaired the committee of educators that devised the taxonomy and also edited the taxonomy of education objectives, was born on February 21, 1913 in Lansford Pennsylvania. He developed a concept of learning, which is often depicted as a pyramid with various levels of learning. This is commonly referred to as "Bloom's taxonomy". This taxonomy provides six levels of learning. The explanation is arranged from the lowest level to the highest level as shown is Figure 2.5.

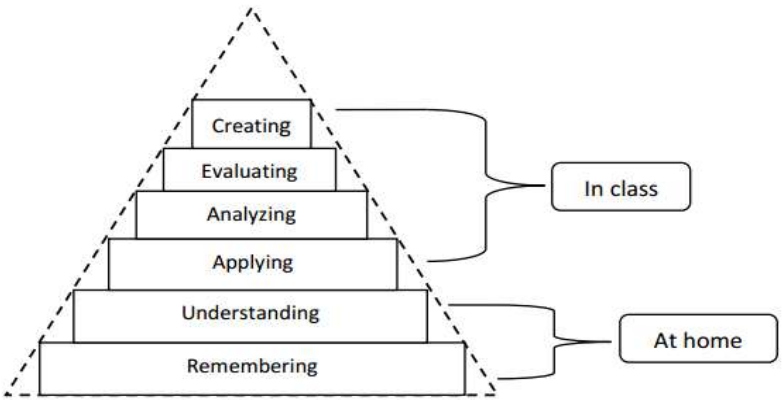


Figure 2.4: Bloom's revised taxonomy in the flipped classroom

Remembering: in this stage, the students try to recognize and recall the information they receive; they also try to understand the basic concepts and principles of the content they have learned.

Understanding: the students try to demonstrate their understanding, interpret the Information and summarize what they have learned.

Applying: the students practice what they have learned or apply knowledge to the actual situation.

Analyzing: the students use their critical thinking in solving the problem, debate with friends, compare the answer with peers, and produce a summary. The students obtain new knowledge and ideas after implementing critical thinking or a debate in group activities. In this level of learning, the students also produce creative thinking.

Evaluating: in this stage, students are evaluating the whole learning concepts and they could evaluate or make judgment on how far they successfully learned.

Creating: the students are able to design, construct and produce something new from what they have learned (Bloom *et al*., 1956).

In implementing flipped classroom, remembering and understanding as the lowest levels of cognitive domain are practiced outside the class hour (Krathwohl and Anderson, 2010). While in the classroom, the learners focused on higher forms of cognitive work, including applying, analyzing, evaluating, and creating. Figure 2.4 illustrates the level of students' learning in the flipped learning according to Bloom's revised taxonomy. With the flipped model, the lower levels are presented before class through recorded lectures and video. Readings, simulations, and other materials also provide this foundational support for learning so that in-class time can be spent working on higher levels of learning from application to evaluation.

In flipped classrooms, students go from the lowest level (remembering) to achieve the highest level (creating). Lankford (2013) mentioned that the flipped classroom focuses on how to support the learners in achieving a higher level of the taxonomy domain. Additionally, Nederveld and Berge (2015) added that in flipped learning, classroom activity is spent on application and higher-level of learning rather than listening to lectures and other lower -level thinking tasks. Implementing flipped learning allows the students to spend more time supporting higher-level learning tasks such as a group discussion, while lower-level tasks such as knowledge and comprehension are completed independently outside the class. These levels of learning are described in Table 2.1 below.

Table 2.1: Comparison between Traditional Classroom and Flipped Classroom in Achieving Higher Order Thinking of Bloom's Taxonomy

Level of Learning	Traditional Classroom Tools	Flipped Classroom Tools
Remembering	Face-to-face lecture	Pre-recorded lecture, reading material, and watching video lectures independently
Understanding	Question and Answer	Reflection, peer-to-peer discussion and collaboration
Analyzing	Homework	Classroom activities such as a group discussion
Applying, Evaluating, Creating	Homework or nothing	Student projects, Presentations, peer evaluation and instructor evaluation.

This framework can often be used as a lens through which to view the various stages of learning. The process of learning from a knowledge acquisition to critical thinking activities was amended by Lorin Anderson in the 1990's. This revised version of Bloom's Taxonomy is relevant to flipped learning in that the transmission of information, which is the basis for learning, is obtained independently and outside of class; while the assimilation of information, which requires greater critical reasoning occurs during class under the guidance of an instructor or mentor. The higher the level portrayed on the pyramid, the more assimilation is required; whereas, the lower the level, the more transmission of information occurs somewhat independently, but not completely, of assimilation. The areas in the middle may require a more balanced or less skewed combination of the two. The notion of describing flipped learning in terms of assimilation and transmission was highlighted by Talbert (2012).

While Bloom's taxonomy is valuable at showing the stages of learning and the type of learning that occurs at each stage, it does not explain best practices in how to master each level in a given context. The benefit of flipped learning as it relates to Bloom's taxonomy is that students are actively helped /supported during some of the activities that require higher order thinking. In addition, flipped learning as a pedagogical approach lends itself to the Mastery Model as outlined by Bloom *et al.*, (1956) and described by Anderson (1975) which also shows some relation to the work of Skinner and operational conditioning.

2.2.2 Mastery learning

Benjamin Samuel Bloom also popularized Mastery Learning in the 1960s. Instead of being a theory that supports the use of flipped learning in general, it highlights the importance of using flipped learning in a meaningful and structured manner. Using mastery learning assist students learn at their individual pace. Therefore learning is differentiated. Based on the tenets of Mastery Learning, all students are required to learn common, well-structured objectives. When a student does not master an objective, remediation is required. Bergman and Sams (2012) argue that Mastery Learning supports flipped learning because it provides instruction that is differentiated, asynchronous and student-centered; and it provides a context for remediation and efficient feedback. This aligns with flipped learning where students have the potential to learn in their own time with a certain amount of autonomy in regards to time management.

Mason *et.al*, (2013) used a semi-Mastery Learning model in their study of flipped learning in engineering courses. They used a mixture of project work, group work and quizzes during the class. While the study had elements of Piaget and Vygotsky, there were quizzes and elements of assessments which resembled Mastery Learning. They found that the students' performance overall did not change from traditional learning but that there were benefits to using flipped learning techniques in the classroom such as greater student autonomy and differentiated and active learning. The concept of reinforcement as part of behaviorism and the ideas of operant conditioning is related to Mastery Learning and the study of flipped learning in several different ways. For one, akin to mastery learning, students have a stimulus, making a good grade or obtaining knowledge, and based on the theory, they will continue to study until they have mastered the concept to an acceptable extent.

Using the flipped classroom scenario, the students need to study the materials (i.e. the videos), in such a way as to prepare for the classroom activities. According to Skinner, in the initial phase students may be confused but over time they understand the concept or at least the process needed to understand the stimuli. Like mastery learning, a learner will produce a certain output, based on formative or summative assessments that will determine whether he needs to relearn or move on to another stage or topic. According, to Skinner after a period of time, students will be trained to respond appropriately if they want the intended reward or if they do not want the opposite – a bad grade, lack of understanding. So, while, the reinforcement theory may not be the main theory supporting the pedagogical underpinnings of flipped learning, it could explain the successful transition from traditional style learning environments to one that is supported by flipped classrooms; and also the conditioning-stimuli relationship of flipped learning and to some extent mastery learning.

Though quantitative and rigorous qualitative data about the flipped classroom is limited, however there is a consistent body of research that reports improvements in students' achievements as well as their perceptions of the learning environment, their engagement and their motivation while utilizing the flipped classroom. Constructivism has emerged as a powerful theory for explaining how humans learn about the world around them and how new knowledge is formed (Felder, 2012; Gordon, 2008; Neo and Neo, 2009; Nie and Lau, 2010; Prakash, 2010). The theory of constructivism is that knowledge is not waiting to be discovered but rather it is constructed by humans by interaction with the world and with each other (Felder, 2012; Gordon, 2008; Neo and Neo, 2009; Nie and Lau, 2010; Prakash, 2010).

2.2.3 The constructivism learning theory

Lev Vygotsky was a Soviet psychologist, who was born on 17 November 1896. He was the founder of 'sociocultural theory'. He viewed learning as a process that occurs when a learner is assisted by others who are more competent in the skills being learnt, and that learning is optimized by collaboration within the learner's zone of proximal development. Vygotsky (1978) defines the zone of proximal development (ZPD) as "the distance between the actual developmental 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 peers". In other words, learning occurs when a student works either with a more skilled adult or peer to solve problems that are just beyond her/his actual abilities.

Hence, while using the flipped classroom technique, students are assigned problem-solving tasks where they need to utilize the information they learnt through watching the video outside of the classroom. To solve these tasks students either work individually or in groups under the supervision of the teacher. Research shows that students learn best when taught according to their particular learning style that may be dependent, collaborative or independents. Piaget's theory of cognitive development is based on a belief that learners are like scientists trying to make sense of reality. Learners, in order to acquire new knowledge, are not directly presented with information they are supposed to immediately understand and use. Instead, learners must "construct" their own knowledge. They build their knowledge through experience. Experiences enable them to create schemas or mental models in their heads. These schemas are changed, enlarged, and made more sophisticated through two complementary processes namely assimilation and accommodation.

According to the Piagetian cognitive constructivist theory, to reach a higher level of learning, students need to interact with peers with the main mechanism driving development being "cognitive conflict" to reach accommodation of knowledge. These two key principles of cognitive constructivism are practiced in the flipped classroom. The first principle is that learning is active. Practically, prior to attending class, the teacher gives the students a video that introduces the information that needs to be learned. This information is introduced as an aid to problem solving. It is a tool that furthers and facilitates. Gannod (2008) conducted a study in which the use of the flipped classroom in a software engineering class was investigated. He made 65 podcasts available to students and devoted class time to collaborative learning where students collaborated to create, analyze and evaluate software. In-class activities that require students to work in pairs or in groups and to utilize the information gained from the video to solve real problems were designed. The methodology reflects the precepts of a Vygotskian approach to learning.

Lage *et al.*, (2000) carried a study where they explored the use of the inverted classroom to teach economics. They designed in-class activities where students worked in groups under the supervision of the instructor to conduct economic experiments. During the activities, the students brought to the task their different understandings of the information presented, and worked together through continuous assimilation and accommodation of new information to reach an understanding of the information. The results of the study showed that students positively perceived the use of that methodology.

2.2.4 Theory of collaborative learning strategy

Cooperative learning is a structured, systematic instructional technique in which small groups work together to achieve a common goal. Cooperative learning employs many of the following characteristics and strategies in the classroom: positive interdependence, face-to-face interaction, individual accountability, social skills, and group processing. Positive interdependence is the belief that students are linked together with other students in such a way that one cannot succeed unless the group members also succeed (Caviglia-Harris, 2010).

He added that, Face-to-Face interaction is the expectation that students will explain to each other how to solve problems and individual accountability is a requirement of students to complete their share of the work. Individual accountability can become problematic for educators when and if a portion of the students are not participating actively in the cooperative learning strategy.

Social skills are also needed to accomplish mutual goals, students must know and trust each other, communicate effectively, and support and encourage each other (Caviglia-Harris, 2010). In terms of effective social skills and cooperative learning strategies, students need to be properly instructed as to how to communicate effectively within a group setting. Educators must monitor the communication dynamics within each group. Group processing enables group members to reflect on a group session to describe what actions of the group members were helpful and not helpful. Caviglia-Harris, (2010).

Collaborative learning is frequently researched in education. Collaborative learning is a learning situation in which two or more students are working together to complete a common task (Siegel, 2005). Integrating cooperative learning strategies have proven to be effective in increasing student achievement across all grade levels and subject areas (Johnson and Johnson, 1989). The use of collaborative learning is an effective teaching and learning strategy. Schools are faced with pressure to produce competent students in an era of standardized tests, which has raised many questions about what is the best way to teach social studies (Soares and Wood, 2010). Educators can choose between lecture style, teacher centered methods and active or cooperative learning strategies.

2.3 Empirical Studies

2.3.1 Empirical studies on flipped classroom collaborative learning strategies

Three types of flipped classroom collaborative learning strategies and an individualized learning will be considered. These include: Think-Pair-Share (TPS), Reciprocal Teaching (RT) also known as Reciprocal peer tutoring, Think-Aloud Pair Problem Solving (TAPPS) and Individualized Learning Strategy.

i. Empirical studies on students achievement in think-pair-share (TPS) collaborative learning strategies

Aditi *et al.*, (2014) also examined the learning effectiveness of TPS in a CS1 course. A quasi experimental study was performed and found that students who learned via TPS performed significantly better on a post-test than students who learned the same concept via lecture. They also conducted a survey and focus group interviews to understand student perceptions of learning with TPS. The majority of students agreed that TPS activities helped improve their conceptual understanding. From an instructor’s point of view, TPS was useful to address the challenges of a large class, such as students tuning out or getting distracted and was easy to implement even in a large class.

Also, Bamiro and Adekunle (2015) investigated the effects of three strategies (i.e., guided discovery, think-pair-share, and lecture) on senior secondary school students’ achievement in chemistry. A pretest, posttest, control group quasi-experimental design with a 3 × 3 × 2 factorial matrix was adopted for the study. Treatment was at three levels (guided discovery, think-pair-share, and lecture strategies). Intervening variables were cognitive entry behavior at three levels (high, middle, and low) and gender at two levels (male and female). Two hundred forty-two Senior Secondary 1 students in intact classes from six secondary schools in Ijebu Ode and Odogbolu Local Government Areas of Ogun State were randomly assigned to the treatment and control groups. Three instruments were developed and used to collect data from students during the 8-week treatment program. The data collected were subjected to analysis of covariance and multiple classification analysis. Scheffe test was further used as post hoc measures. Where significant interactions were observed, they were represented with graphical illustrations. It was found that students taught with guided discovery and think-pair-share strategies obtained significantly higher posttest mean scores than those in the lecture strategy, $F(4, 223) = 51.66$, $p < .05$. The use of guided discovery and think-pair-share strategies had great potential for improving achievement in chemistry and science learning generally.

Similarly, James (2015) researched on Comparing Student Performance in Thermodynamics using the Flipped Classroom and Think-Pair-Share Pedagogies. The goal of this research was to determine if student performance in thermodynamics on both computational and conceptual questions was increased when the flipped classroom model was used compared to students who were instructed using the Think-Pair-Share model. For this study in the Fall of 2013, two sections of thermodynamics at Trine University were taught by the same instructor using the same homework and exams. For the first section (N = 20) the students were instructed using the flipped classroom model. For the second section (N = 8) the students were instructed using the Think-Pair-Share model. While the relatively small number of students limits the statistical significance of this study, results indicate that there was no difference between the educational performance of these two groups on either computational or conceptual tasks as indicated by their exam scores. However, students in the flipped classroom did state that they enjoyed the flipped classroom model and wished that more faculty members used this method.

Equally, Bawadi and Mohammad (2017) surveyed A Flipped Classroom Technique in Improving Students Guide to Transport Phenomena Course. An implementation of a partially flipped classroom for over one semester of enrolment of Transport Phenomena course has been conducted to look at how far the flipped classroom is effective in helping the students to improve their results. Learning materials such as videos, notes, and postcards are given to students before the commencement of the class. Meanwhile, group activities such as informal cooperative learning activities (think-pair-share), Intermittent focused discussion were also implemented during the class. The results showed improved marks for test, assignment, and quiz obtained by students as a comparison before implementation of a flipped classroom. For instance, 61% of the students improved in their test marks, 70% improved in the assignment, and, 31% improved in the quiz. Students were also improved in their communication skill and team work amongst them. In a nutshell, a flipped classroom method can help students in enhancing their method of learning.

Recent research on the Effect of Think Pair Share (TPS) Strategy on the Achievement of Third Grade Student in Sciences in the Educational District of Irbid was carried out by Hamdan, (2017). The study aims at knowing the impact of Think Pair Share strategy on the achievement of third grade student in sciences in the educational district of Irbid. In this study, the sample of study consisted of (120) students of third grade student in the educational district of Irbid, They were distributed into two groups: the control group which consisted of (30) male students and (30) female students; and the experimental group which consisted of (30) male students and (30) female students, the findings of the study show that there are statistically differences in grades of students due to group variable at the significance level (0.05), and the differences were in favor of the experimental group and there are statistically differences due to gender at the significance level (0.05) in favor of females. The study recommended to entry (Think – Pair – Share) strategy within the teaching strategies used by students during the teaching and the involvement of teachers in training courses on Think Pair Share strategy.

Furthermore, Hetika *et al.,* (2018) conducted a study on Think Pair Share (TPS) as Method to Improve Student's Learning Motivation and Learning Achievement. This research aims to find out the application of Think Pair Share (TPS) learning method in improving learning motivation and learning achievement in the subject of Introduction to Accounting I of the Accounting Study Program students of Politeknik Harapan Bersama. The Method of data collection in this study used observation method, test method, and documentation method. The research instruments used observation sheet, questionnaire and test question. This research used Class Action Research Design which is an action implementation oriented research, with the aim of improving quality or problem solving in a group by carefully and observing the success rate due to the action. The method of analysis used descriptive qualitative and quantitative analysis method. The results showed that the application of Think Pair Share Learning (TPS) Method can improve the Learning Motivation and Achievement. Before the implementation of the action, the obtained score is 67% then in the first cycle increases to 72%, and in the second cycle increases to 80%. In addition, based on questionnaires distributed to students, it also increases the score of Accounting Learning Motivation where the score in the first cycle of 76% increases to 79%. In addition, in the first cycle, the score of pretest and posttest of the students has increased from 68.86 to 76.71 while in the second cycle the score of pretest and posttest of students has increased from 79.86 to 84.86.

In the same vein, Sumekto (2018) investigated on the influence of think-pair-share approach toward students' reading achievement. This classroom action research involved 35 public secondary school students in Pandowoharjo, Sleman, Special Region of Yogyakarta. They were selected by purposive sampling method. Data collection used the naturalistic observation technique and narrative reading text in the selected meetings. After a series of reading activity, a twenty-numbers multiple choice test was given to all respondents. Data were analyzed by using mixed analysis; self-reflective spiral model and descriptive statistics. Think-pair-share stimulated students' participation and performance in reading, in which it increased the functional communication, discussion, decision taking, and conflict reduction in groups learning. The finding also showed that students' mean of reading performance was 63, 85 in the first cycle and increased to 66,00 in the second cycle. These cyclical outputs fulfill the minimal passing grade criteria. This research concludes that applying think-pair-share as a suitably alternative learning approach that helps the students develop their collaborative skills.

Recent study by Indra *et al.*, (2018) also investigated the effect of think pair share method and students' creativity on students' learning outcome. This research was begun by doing the related surveys for current situation of social science in the history subject where teaching the subject did not provide yet the expected learning outcome. For that reason, it needed a think pair share method to strengthen students' creativity in order to improve student's learning outcome as well as their self-evaluation in enhancing their creativity and learning competence. This research used quantitative approach with survey method. The collection of the data used questionnaires, interviews, documentary studies, and field notes. Quantitative data were analyzed by using an experimental method. Data analysis used multiple linear regression and correlation test. The experimental results on the three classes showed that think pair share method and students' creativity can improve students' learning outcome better than conventional class, but there is no interaction between the think pair share method and creativity with the eighth grade students' learning outcomes. Teacher could use this model to Junior High School students' level for improving students' learning outcome in the lesson of social science.

Also, Uraiwan and Panuwat (2019) experiment on The Development Of A Flipped Classroom Teaching Model Using Think-Pair-Share And Project-Based Learning. The research sample consisted of 40 second year students majoring in computer education from the Faculty of Science and Technology, Nakhon Pathom Rajabhat University who were selected using random sampling. The research tools were a flipped classroom teaching model using think-pair-share and project-based learning, a teaching plan, a teacher's manual, as well as a pretest and posttest. The statistics used for data analysis were mean, standard deviation, t-test for dependent variables and efficiency value or Ej/E2. The results of this research revealed that the quality of content ($\bar{x}$ = 4.50, S.D. = 0.13) and media production ($\bar{x}$ = 4.63, S.D. = 0.08) was at the great level while the teaching plan ($\bar{x}$ = 4.28, S.D. = 0.29) and teacher's manual ($\bar{x}$ = 4.47, S.D. = 0.19) were at the good level. The efficiency E1/E2 was 82.22/86.04, which was higher than the specified 80/80. When the pretest and posttest were compared, it was found that the average scores of post-test (=51.63, S.D. = 5.61) were higher than the ones of pre-test ($\bar{x}$ = 33.33, S.D. = 10.31).

ii. Empirical studies on students achievement in reciprocal teaching (RT) collaborative learning strategies

In the same manner, Abdul-Majeed (2013) investigated on the Effect of Using Reciprocal Teaching on Improving College Students' Achievement in Reading Comprehension. To fulfill the aim of the study, the researcher has adopted two null hypotheses: first, there is no significant difference between the achievement of students' who practice the reciprocal teaching technique and that of students who do not practice it. Second, there is no statistically significant difference between the experimental group students' achievement in the pre and posttests of reading comprehension. To achieve the aim of the study, a four-week experiment was conducted using pretest-posttest nonequivalent groups design. Two groups of thirty students each were selected from the population of first year students/college of education for women-department of English. One group was selected as the experimental group (namely section C D) and other group was selected as the control group (namely section E F). Both students of the experimental and control groups were exposed to pre and posttests. Using the t-test for two independent samples, it is found that there is a statistically significant difference in favour of the experimental group. This indicates that reciprocal teaching technique is more effective than the presentation practice production teaching or the Lecture Method teaching.

Likewise, Agoro (2013) investigated on differential effectiveness of reflective- reciprocal teaching and reflective- reciprocal peer tutoring on pre-service teachers' achievement and science process skills in integrated science. The pretest- posttest, control groups, quasi experimental design with a 3x2x3 factorial matrix was used. Two hundred and ninety-four (294) pre-service science teachers with high, medium and low numerical ability constituted the sample. Six instruments used were: Pre-service Teachers Achievement Test (α= 0.85); Pre-Service Teacher Science Process Skills Rating Scale (Scott's π), Pre-Service Teacher Numerical Ability Test (α=0.79); stimulus instruments as operational guides for lecturers using the two treatments and control groups. Four Null hypotheses were tested at 0.05 level of significance. Data were analyzed using descriptive statistics. The treatment had a significant main effect on pre-service teachers' achievement in integrated science concept (F2,294 = 56.149; P< 0.05). Pre-service Science Teachers exposed to RRPT attained higher achievement mean score (x =24.8) than those in the RRT (x = 21.02) and control group (x = 18.891). Also, for Science Process skills, the RRT group had higher mean score (x = 57.50), than those in the RRPT (x = 49.28) and the control groups (x = 47.04). The Reflective-Reciprocal Teaching as well as the Reflective-Reciprocal Peer Teaching Strategies enhanced pre-service science teachers' achievement and science process skills in integrated science when employed by the teachers of the subject. The two strategies should, therefore, be used for teaching Integrated Science at the College of Education level and Basic Science at basic education level.

An examination on the effect of using reciprocal teaching on improving female college students' achievement in reading comprehension was carried out by Tjut (2015). The researcher has adopted two null hypotheses: first, there is no significant difference between the achievement of students' who practice the reciprocal teaching technique and that of students who do not practice it. Second, there is no statistically significant difference between the experimental group students' achievement in the pre and posttests of reading comprehension. To achieve the aim of the study, a four-week experiment was conducted using pretest-posttest nonequivalent groups design. Two groups of thirty students each were selected from the population of first year students/college of education for women-department of English. One group was selected as the experimental group (namely section C D) and other group was selected as the control group (namely section E F). Both students of the experimental and control groups were exposed to pre and posttests. Using the t-test for two independent samples, it is found that there is a statistically significant difference in favour of the experimental group. This indicates that reciprocal teaching technique is more effective than the presentation practice production teaching or the Lecture Method teaching. At the end of the research paper, conclusions, recommendations and suggestions for further studies are put forward.

Equally, Alsaraireh and Mohd (2016) conducted a study on the Effect of the Reciprocal Teaching Model on Developing Jordanian Students' Reading Comprehension at Mutah University. 176 participants took part and were arbitrarily selected and divided into two gender mixed groups; the experimental group which was exposed to the reciprocal teaching model (RT), and the control group which was taught using the traditional method (TM). A total of fourteen independent sample T-tests and paired samples T-tests were used for the purpose of comparing and analyzing the scores of the pre-tests and the post-tests, and with the intention to pinpoint the effect of using RT as well as to measure the extent of such effect on the development of the students' reading comprehension skills. Through the analysis of the results and in line with the two questions of this study, it has emerged that the use of the RT model has a positive effect on the first year students' reading comprehension achievement in the experimental group; a fact that is reflected in the significant statistical difference when compared to the reading comprehension achievement of the students from the control group taught using the TM. It has also emerged that although the male students' scores are better than the scores attained by the female students, the use of the RT remains of great benefits for both; male and female students.

Also, Pilten (2016) investigated on the Evaluation of Effectiveness of Reciprocal Teaching Strategies on Comprehension of Expository Texts. The research was designed with mixed method. The quantitative dimension of the present research was designed in accordance with pre-test-post-test control group experiment model. The quantitative dimension of the present research was designed in accordance with descriptive case study. The work group of the present research consists of 54 students of a primary school in the Konya province in 2014-2015. Reading Comprehension Evaluation Scale was developed by the researcher and implemented as pre-test and post-test on the work-group. Teacher / students interview forms were used for collecting qualitative data. At the end of 11-week teaching process, expository text comprehension skills of experiment group students, on who reciprocal teaching strategy was implemented, developed more than control group students, on who teaching process projected in the curriculum was implemented, at a statistically significant level.

iii. Empirical studies on students achievement in think aloud pair problem solving (TAPPS) collaborative learning strategies

Moreover, Pate and Miller (2011) investigated the Effects of Think–Aloud Pair Problem Solving on Secondary–Level Students' Performance in Career and Technical Education Courses. A randomized posttest–only control group experimental design was used to determine the effects of think– aloud pair problem solving (TAPPS) on the troubleshooting performance of 34 secondary–level career and technical education students. There was no significant difference in success rate between TAPPS students and students who worked alone (χ 2 (1) = .747, p = .39, ϕ = .148). There was no significant difference in completion time between students who successfully completed the troubleshooting task using TAPPS and those who were successful working alone (t (9) = –.74, p = .48, d = 0.45). The researchers tentatively concluded that the use of TAPPS may not be an appropriate strategy at the secondary level if the agricultural instructors' focus is a higher success rate and a reduction in the time to complete the task. However, agricultural instructors may have other legitimate reasons for using TAPPS such as a way to facilitate collaborative learning or as a way for instructors to identify student misunderstandings that could be used to inform decisions about individualized or even group instructional interventions.

Similarly, AbdulKani and Shahrill (2015) conducted a study on Applying the Think Aloud Pair Problem Solving Strategy in Mathematics Lessons. This study explored the effectiveness of applying TAPPS on students' mathematics performance in Brunei Darussalam. A Year 9 class from one of the secondary schools participated in this research study. The students' problem solving behaviour and mathematics achievement were investigated to see any significant differences after learning using the TAPPS method. Data reported were mainly collected through mathematics achievement tests, questionnaire surveys and classroom observations. The study revealed that there was a significant improvement in students' problem solving behaviour especially in understanding the problem. Although TAPPS did not help in improving students' conceptual knowledge in mathematics rather, it required the students to have a strong grasp of the conceptual knowledge beforehand in order to be able to devise a plan to solve the problems.

Recent research by Nufus and Arnawa (2018) on the Effect Of Thinking Aloud Pair Problem Solving Type Cooperative Model On Student Problem-Solving Ability aims to determine the effect of type cooperative model Thinking Aloud Pair Problem Solving on students' problem solving abilities. This study was a quasi-experimental study with the randomized group only design. The research subjects were students of SMPN 1 Sungai Tarab district in the 2018/2019 school year. Sampling was done randomly after testing for normality, homogeneity, and average similarity. The instrument used is a problem solving test. From the results of research conducted shows the ability of problem solving students of experimental class is better than the control class. Thus the type cooperative model Thinking Aloud Pair Problem Solving contributes to students' problem solving.

These researchers, Widuri and Musdi (2018) also investigated the Effectiveness of Mathematical Learning Tools Based on Thinking Aloud Pair Problem Solving (TAPPS) Towards the Problem Solving Ability of Grade X High School Students, Batang Anai. The purpose of this research is to know the effectiveness of mathematical learning tools based on Thinking Aloud Pair Problem Solving (TAPPS) towards the problem solving ability of grade X high school students. TAPPS's technique is applied by using student's worksheet. The trial is done on 32 grade X students at SMAN 1 Batang Anai. The testing of effectiveness is refers to provision in quasi experiment. The design model is Posttest-Only Control. The conclusion of this study is the student's problem solving ability that use mathematical learning devices based on Thinking Aloud Pair Problem Solving (TAPPS) are higher than the student's problem solving ability without TAPPS of Trigonometry lesson.

iv. Empirical studies on students achievement in individualized learning (IL) strategies

Furthermore, AgwuUdu (2018) examined the Comparative Effects of Individualized and Cooperative Learning Instructional Strategies on Senior Secondary School Students' Academic Achievement in Organic Chemistry. The study was guided by 2 research questions and 3 null hypotheses. The design was quasi-experimental. The population comprised 3,366 senior secondary class two (SS2) chemistry students. A sample of 602 students from 6 schools (339 males and 263 females) was drawn from the population using balloting technique. The experimental groups were taught with IIS and CLIS while the control groups were taught with Lecture method in each of the sampled schools. Both the experimental and control groups were taught Organic Chemistry by their regular chemistry teachers. The instruments used for the study were Chemistry Achievement Test on Organic Chemistry (CATOC), Cooperative Learning Instructional Manual and Learning Activity Package Manual, which were validated by three experts. The reliability of the CATOC was determined using KR20 with index of 0.82. The research questions were answered using mean with standard deviation while the null hypotheses were tested using Analysis of Covariance. The findings revealed that both IIS and CLIS significantly enhanced students' achievement in Organic Chemistry better than the Lecture method. However, the CLIS was more effective than the IIS. The researcher recommended among others, that chemistry students should be exposed to student-centred and activity-based teaching strategies such as the Individualized Instructional Strategy and Cooperative Learning Instructional Strategy, for enhanced students' academic achievement.

Current study by Mazana *et al.,* (2019) investigated Students' Attitude towards Learning Mathematics in Tanzania. It also sought to ascertain reasons for the liking or disliking mathematics and the relationship between attitude and performance. They employed the ABC

Model and the Walberg's Theory of Productivity to investigate students' attitudes towards mathematics and associated factors. The quantitative and qualitative data were collected from 419 primary school students, 318 secondary school students, and 132 College students from 17 schools and 6 colleges in mainland Tanzania using a survey. The collected data were analysed using percentages, means, standard deviations, ANOVA, correlation, regression and thematic analysis. The results show that initially students exhibit a positive attitude towards mathematics, but their attitude becomes less positive as the students move forward to higher levels of education. A significant positive weak correlation between students' attitude and performance was established. Mathematics' enjoyment and attitude significantly predicted students' performance in our data. The factors influencing the students' liking or disliking of mathematics constituted student's aptitude attribute, instructional and social psychological environmental factors. Furthermore, the results show that failure in examinations is attributed to teacher didactic strategies, institutional resources, poor learning and examination strategies, and failure to understand instructions. The results provide insights for future research and inciting changes in teaching- learning practices that would promote mathematics enjoyment and subsequent better performance in the subject.

2.3.2 Empirical studies on flipped classroom collaborative learning strategies on retention

Empirical studies on think pair share (TPS) and retention

Additionally, Abdurrahman (2015) researched on Using the Think-Pair-Share Strategy to Improve Students' Speaking Ability at Stain Ternate. This research was conducted to improve students' English speaking ability by using the think-pair-share strategy designed in CAR. The findings in Cycle 1 was unsuccessful because the students' average scores was 74.18 and classroom atmospheres were "mid" that did not meet the criteria of success.

Therefore, the implementation of the strategy was continued cycle 2 by revising the plan. The students' average score in cycle 2 achieved 81.68 and classroom atmospheres were "mid". It means that the results in cycle 2 met the criteria of success and judged as successful. So, it can be stated that the think-pair-share strategy was effective to be implemented at STAIN Ternate in order to improve the students' speaking ability.

Study by Lestari *et al.,* (2017), an investigation on Digital Storytelling and Think-Pair-Share to Improve the Ability of Critical Thinking. The purpose of this research is to develop digital storytelling learning media in the form of website storytelling as an effort to improve critical thinking ability of high school students. One of the learning models that educate students to think critically is the think pair share model. The method used in this research is the method of Research and Development applying media for students in high school. This study is examined by the steps of the preliminary research procedure, the development and testing stage. Data analysis technique used in this research is simple descriptive analysis. This study compares the pretest post test results to find out the results of the study. This research is expected to improve students' critical thinking ability in economic learning.

These researchers, Henny and Uyun (2017) also experimented on the Collaborative Think Pair Share Method When students are facing challenge especially difficult lesson and focus on teacher centre. TPS method consist of three steps, there are think independently (think step), pair discuss (pair step) and sharing the discussion result (share step). The aim of this action class research were, knowing how to implement the TPS and to know if the effort of implementing TPS method could improve the student's achievement in adjusting entries lesson. This research used qualitative description by using the mastery learning as the indicator of achievement. The open questionnaire data processing results in cycle 1 and observer's note. The result showed that TPS could improve the student's achievement with pretest 1 (pre cycle) score rate 72, 74 (not mastering) increase to 80,14 (mastering) in pre-test

2 (cycle 1). In posttest 1 (pre cycle) reach score rate 48, 10 (not mastering) then in post-test 2 (cycle 1) increase to 85,06 (mastering). In post-test 3 (cycle 2) student mastery reach 100% with score rate 94,53.

Likewise, Lee *et al.*, (2018) investigated on Utilising the Think-Pair-Share Technique in the Learning of Probability. The main objective of this study is to investigate the effects of collaborative learning on students' understanding of probability and their attitudes towards mathematics. The participants were 15 Year 10 students selected by convenience sampling at a secondary school in Brunei Darussalam. In total, six intervention lessons with the application of Think-Pair-Share strategy were conducted. Data collection methods included a series of tests (pre-test, post-tests and delayed post-test), surveys, students' interviews and lesson observations. The findings revealed improvements in the students' test scores and they were able to retain their knowledge after a period of time. From the triangulated data, it was found that the students demonstrated an increase in their self-efficacy, participation, understanding and enjoyment levels after the intervention. Their enjoyment towards learning probability was derived from being able to communicate with their peers. The students showed more enthusiasm and participation in class as the lessons progressed.

Also, Ardhy (2018) researched a study which aims were to find out (1) the extent to which Think-Pair-Share strategy improves speaking ability of the fourth semester students of Cokroaminoto Palopo University; (2) the students’ perceptions on the application of Think-Pair-Share strategy in speaking activities. This research was carried out in the fourth semester students of English Language Education Study Program, Faculty of Teacher Training and Education, Cokroaminoto Palopo University. The method used was quasi-experimental research with pre-test, ten meetings of treatment, and post-test. The sample was selected through purposive sampling technique. The data were collected through speaking test, questionnaire, and recorder instruments, and were analyzed with nonparametric test and frequency test. The result of Mann-Whitney U test and the students' score on post-test was $p < 0.05$. It means that, there is a significant difference between the students taught with Think-Pair-Share strategy and without Think-Pair-Share strategy. The mean score of experimental group on pretest was 2.16, and increased to be 4.02 on posttest. The analysis of questionnaire indicated that the students' perceptions on the application of Think-Pair-Share strategy were very positive. Thus, it can be concluded that the application of Think-Pair-Share strategy could significantly improve the students' speaking ability.

Empirical studies on reciprocal teaching (RT) and retention

Similarly, Ghorbani *et al.,* (2013) examined the effect of reciprocal teaching-which focuses on four reading comprehension strategies, namely summarizing, questioning, clarifying, and predicting-on improving EFL students' writing ability. Assessment was made based on an evaluation sheet including five criteria (content, macro structure, micro structure, and language range and complexity, and language errors) for evaluating the compositions. In this study, true-experimental design was used to study two classes of 104 randomly selected intermediate learners. The pre-test inter-rater reliability for the two raters who rated the students' compositions was 0.95 and the posttest inter-rater reliability was 0.97. Since this study was conducted under the supervision of a supervisor and an advisor, its validity was taken for granted. The results of the independent samples t-test supported the effectiveness of reciprocal teaching of comprehension strategies in improving the learners' writing ability. Since teaching comprehension strategies seems to have facilitated the process of writing, its application can be suggested to reinforce EFL students' writing ability. The findings of this study imply that students will get motivated to read more if they realize the importance of reading in improving their writing performance.

Research by Ashegh (2018) investigated the effects of reciprocal teaching strategy on reading comprehension, reading motivation and reading meta-cognition in reading comprehension among Iranian EFL learners at universities. The researcher used a mixed method to examine the effects of using reciprocal teaching strategy instruction. The participants were purposively selected and assigned into experimental and control groups. The experimental group was taught through reciprocal teaching while the control group was taught through conventional method of instruction. The reading sections of Reading through Interaction Book, reading comprehension test, reading motivation questionnaire, reading meta-cognition questionnaire and interviews were used to collect the data. The quantitative survey consisted of reading comprehension test, reading motivation questionnaire and reading meta-cognition questionnaire with a sample of 60 participants from two universities in Iran. The results of this study indicated that reciprocal teaching strategies had significant positive effects on reading comprehension, reading motivation and reading meta-cognition of Iranian EFL university learners. The posttest mean score of the experimental group was significantly higher than that of the control group at 0.05 confident levels. The qualitative findings of this study provide evidence on the fact that Iranian EFL university learners expressed positive attitudes and beliefs about using reciprocal teaching strategy instruction and this strategy met their teaching needs and goals. The main implication of this study is that student centered approaches to teaching and learning processes, such as the xviii reciprocal teaching strategy, is very much needed to improve students' reading comprehension, reading motivation and reading meta-cognition skills.

Empirical studies on think aloud pair problem solving (TAPPS) and retention

Study by Dike *et al.,* (2017) investigated on the effect of metacognitive teaching strategies on secondary school students’ performance in chemistry. The study adopted pretest post test quasi experimental design. Three hundred and sixty senior secondary school II (SSII) chemistry students were drawn from three secondary schools in Obio/Akpor Local Government of Rivers State Nigeria. Three research questions and three hypotheses were posed for the study. The instrument for data collection was a twenty five-item multiple choice chemistry achievement test (CAT) developed by the researcher. Students were divided into two experimental groups and one control group. Students in the experimental groups were subjected to treatment using thinking-aloud and self-assessment metacognitive teaching strategies while students in the control group were taught with conventional method. Mean, standard deviation, t-test and ANCOVA were used for data analysis. The results showed that students taught with thinking-aloud metacognitive strategies performed better in chemistry achievement test followed by self-assessment metacognitive strategy than the conventional strategy. It was concluded that metacognitive teaching strategy such as thinking-aloud and self-assessment if effectively utilized and applied by teachers in the instructional delivery in chemistry could significantly improve the performance of students.

These scholars, Widuri and Musdi (2018) researched on the effectiveness of mathematical learning tools based on Thinking Aloud Pair Problem Solving (TAPPS) towards the problem solving ability of grade X high school students. TAPPS's technique is applied by using student's worksheet. The trial is done on 32 grade X students at SMAN 1 Batang Anai. The testing of effectiveness is refers to provision in quasi experiment. The design model is Posttest-Only Control. The conclusion of this study is the student's problem solving ability that use mathematical learning devices based on Thinking Aloud Pair Problem Solving (TAPPS) are higher than the student.

2.3.3 Empirical studies on flipped classroom collaborative learning strategies on attitude

i. Empirical studies on think pair share (TPS) and attitude

In the same vein, Özlem (2004) investigated the effects of cooperative learning activities on student attitudes towards English reading courses and cooperative learning. Possible differences in attitudes in terms of gender and achievement level of students were also investigated. The study was conducted with one control and one experimental group. In total, 40 students participated in the study. Following a work shop on the implementation of cooperative learning activities, the teacher taught the experimental group using cooperative learning activities. The control group was taught using traditional whole class methods. Questionnaires were given to both groups before and after the four-week treatment. Interviews were also conducted with the teacher and randomly selected students. Questionnaire data were analyzed by t-tests and ANOVA tests. According to the results of these tests, no significant differences after the treatment were found between the control group and the experimental group responses related to their attitudes towards English reading courses and cooperative learning. In within-group comparison, however, the experimental group's attitudes towards the English reading course was significantly more negative, whereas no change was found in the control group. Gender and achievement level were found to have no significant influence on students' attitudes towards English reading courses and cooperative learning. Data collected in teacher and student interviews, however, suggested that cooperative learning had positive effects on attitudes towards English reading courses. In addition, both the teacher and the students reported positive attitude towards cooperative learning.

In this study, Ogunyebi (2013) examined the effects of think-pair share strategies on college of education students' class participation and performance in Integrated Science in Ekiti State. The study adopted a quasi-experimental pre-test, post-test, control group design. Four null hypotheses were generated and tested at 0.05 level of significance. The sample consisted of 90 Integrated Science students selected from part two (2017/18 academic session) through simple random sampling technique. The instrument that was used for the study was Integrated Science Achievement Test (ISAT). It is a self-designed instrument that consisted of information on bio-data of the respondents and 40 multiple-choice items. Expert judgments were used to ensure face and content validity. Test-retest method was used to determine the reliability and reliability Coefficient of 0.72 was obtained. The data were analyzed using inferential statistics of t-test. The study found out that there was a significant difference between the posttest means scores of students exposed to think-pair share and conventional strategies. It was also revealed in the study that there was no significant difference between the posttest means scores of male and female students exposed to think-pair and conventional strategies. Based on this finding, it was recommended among other things that integrated science lecturers should adopt think-pair share strategy in lecture rooms to enable students participate actively and interact to arouse their interest and improve performance.

These group of scholars, Yuli *et al.,* (2018) investigated on the effect of Cooperative Learning type TPS with Autograph to the students Mathematical Representation Ability and the effect of Cooperative Learning model type TPS with Autograph helping to the students Self-Efficacy. The research samples comprised 36 XI 5 graders (experiment I class) and 36 XI 6 graders (experiment II class) from a Senior High School (SMA) in Medan. They used a quasi-experimental design with Cooperative Learning type TPS with Autograph and Cooperative Learning type TPS without Autograph as the independent variables. The dependent variables included the mathematical representation ability and students self-efficacy. The instrument used consisting of the initial mathematical abilities (KAM) test, mathematical representation ability test and self-efficacy questionnaire. The analysis used two-way ANOVA. The research findings indicate that there is a significant effect of Cooperative Learning model type TPS with Autograph to the students' mathematical representation ability and there is a significant effect of Cooperative Learning model type TPS with Autograph to the students of self-efficacy.

ii. Empirical studies on reciprocal teaching (RT) and attitude

Additionally, Peng and Wang (2015) investigated on the effects of Reciprocal Teaching on EFL fifth graders' reading ability, in terms of word recognition and reading comprehension in an elementary school in Taiwan. The participants in this research were fifty-three fifth-graders of an elementary school, 25 males and 28 females, in two intact classes in Taiwan. Students in one fifth-grade class, the control group, received regular English instruction, while those in the other fifth-grade class, the experimental group, received reciprocal teaching program, in two-hour English classes per week for 12 weeks, the duration of this study. Pretest-posttest of word recognition tests and reading comprehension tests were applied to evaluate students' progress of reading ability before and after reciprocal teaching program. Six students were interviewed after the program, and students' attitudes toward reciprocal teaching in English reading were recorded. The research results indicated that most students made prominent improvement in their English reading ability, word recognition, and reading comprehension. In addition, most participants had positive attitude toward reciprocal teaching, and they liked reciprocal teaching to be incorporated into English classes. Finally, based on the findings, some implications are also proposed to be of help to those who are English teachers or educational practitioners in elementary schools.

In this project, Doveston and Lodge (2017) investigated on the Reflections of Staff and Students on the Introduction of Reciprocal Teaching as an Inclusive Literacy Initiative in an English Secondary School. The findings of this small-scale research project illustrate some of the challenges inherent in implementing an inclusive literacy approach (reciprocal teaching) across the curriculum in a secondary school. They gathered the perceptions of staff and students on the implementation of this literacy initiative and used these to reflect on the multiple and complex factors at play in this situation. The key findings that emerged from the research were, first, the influence of factors external to the school, particularly the focus on examination results produced by the dominance of the 'standards agenda' in English schools. Second, the importance of strong leadership in convincing staff of the need for this type of whole-school literacy approach and in creating a sense of shared purpose in its use. Finally, the need for sufficient training and on-going support for staff, so that they understand the theory and methods of the chosen approach and are confident in their pedagogical skills in delivering this to students.

iii. Empirical studies on think aloud pair problem solving (TAPPS) and attitude

These authors, Simpol *et al.,* (2013) implemented two pedagogical strategies, the Thinking Aloud Pair Problem Solving and Pólya's Problem Solving, to support students' learning of fractions. The participants were 51 students (ages 11-13) from two Year 7 classes in a government secondary school in Brunei Darussalam. A mixed method design was employed in the present study, with data collected from the pre- and post-tests, problem solving behaviour questionnaire and interviews. The study aimed to explore if there were differences in the students' problem solving behaviour before and after the implementation of the problem solving strategies. Results from the Wilcoxon Signed Rank Test revealed a significant difference in the test results regarding student problem solving behaviour, $z = -3.68$, $p = .000$, with a higher mean score for the post-test ($M = 95.5$, $SD = 13.8$) than for the pre-test (M = 88.9, SD = 15.2). This implied that there was improvement in the students' problem solving performance from the pre-test to the post-test. Results from the questionnaire showed that more than half of the students increased scores in all four stages of the Pólya's problem solving strategy, which provided further evidence of the students' improvement in problem solving.

Similarly, Mason and Singh (2016) surveyed on college introductory Physics students' attitudes and approaches to problem solving. They developed and validated an Attitudes and Approaches to Problem Solving (AAPS) survey and administered it to students in the introductory Physics courses in a typical large research university in the US. They also discussed the development and validation of the survey and analysis of the student responses to the survey questions in introductory Physics courses. The introductory Physics students' responses to the survey questions were also compared with those of Physics faculty members and Physics Ph.D. students. They found that introductory students were in general less expert-like than the Physics faculty members and Ph.D. students. Moreover, on some AAPS survey questions, the responses of students and faculty have unexpected trends. Those trends were interpreted via individual interviews, which helped clarify reasons for those survey responses.

iv. Empirical studies on individualized learning (IL) and attitude

Investigation by Blazar and Kraft (2016) on the Teacher and Teaching Effects on Students' Attitudes and Behaviors also shows how teachers affect students' achievement on tests despite evidence that a broad range of attitudes and behaviors are equally important to their long-term success. They found that upper-elementary teachers have large effects on self-reported measures of students' self-efficacy in math, and happiness and behavior in class. Students' attitudes and behaviors are predicted by teaching practices most proximal to these measures, including teachers' emotional support and classroom organization. However, teachers who are effective at improving test scores often are not equally effective at improving students' attitudes and behaviors. These findings lend empirical evidence to well-established theory on the multidimensional nature of teaching and the need to identify strategies for improving the full range of teachers' skills.

Moreover, AgwuUdu (2018) compared the effects of Individualised Instructional Strategy (IIS) and Cooperative Learning Instructional Strategy (CLIS) on male and female senior secondary school students' academic achievement in Organic Chemistry. The study was guided by 2 research questions and 3 null hypotheses. The design was quasi-experimental. The population comprised 3,366 senior secondary class two (SS2) chemistry students. A sample of 602 students from 6 schools (339 males and 263 females) was drawn from the population using balloting technique. The experimental groups were taught with IIS and CLIS while the control groups were taught with Lecture method in each of the sampled schools. Both the experimental and control groups were taught Organic Chemistry by their regular chemistry teachers. The instruments used for the study were Chemistry Achievement Test on Organic Chemistry (CATOC), Cooperative Learning Instructional Manual and Learning Activity Package Manual, which were validated by three experts. The reliability of the CATOC was determined using KR20 with index of 0.82. The research questions were answered using mean with standard deviation while the null hypotheses were tested using Analysis of Covariance. The findings revealed that both IIS and CLIS significantly enhanced students' achievement in Organic Chemistry better than the Lecture method. However, the CLIS was more effective than the IIS. The researcher recommended among others, that chemistry students should be exposed to student-centred and activity-based teaching strategies such as the Individualised Instructional Strategy and Cooperative Learning Instructional Strategy, for enhanced students' academic achievement.

Current study by Mazana *et al*., (2019) investigated on Students' Attitude towards Learning Mathematics in Tanzania. It also sought to ascertain reasons for the liking or disliking mathematics and the relationship between attitude and performance. They employed the ABC Model and the Walberg's Theory of Productivity to investigate students' attitudes towards mathematics and associated factors. The quantitative and qualitative data were collected from 419 primary school students, 318 secondary school students, and 132 College students from 17 schools and 6 colleges in mainland Tanzania using a survey. The collected data were analysed using percentages, means, standard deviations, ANOVA, correlation, regression and thematic analysis. The results show that initially students exhibit a positive attitude towards mathematics, but their attitude becomes less positive as the students move forward to higher levels of education. A significant positive weak correlation between students' attitude and performance was established. Mathematics' enjoyment and attitude significantly predicted students' performance in our data. The factors influencing the students' liking or disliking of mathematics constituted student's aptitude attribute, instructional and social psychological environmental factors. Furthermore, the results show that failure in examinations is attributed to teacher didactic strategies, institutional resources, poor learning and examination strategies, and failure to understand instructions. The results provide insights for future research and inciting changes in teaching- learning practices that would promote mathematics enjoyment and subsequent better performance in the subject.

2.3.4 Empirical studies on the influence of collaborative learning strategy on gender

Alongside, Ella *et al.,* (2007) reported the results of a study aimed to establish whether the amount and types of conflicts vary in all male, all female and mixed gender groups working in asynchronous collaborative learning online settings. Sixty psychology majors were divided into three groups conducted online by the same teacher. The study show that the levels of participation in the three groups varied in relation to gender composition. Further the results evidenced all female group did have more conflicts then male and mixed groups, but primarily they did not have interpersonal conflict. The female groups´ conflicts seem to be related to goal-oriented process of work.

Also, Sulisworo (2012) investigated on the effectiveness of online collaborative learning especially using the wiki to improve student learning motivation. This paper also seeks the possibility gender will affect to the learning motivation in this environment. The article explores for the possibility to design the collaborative learning on the Jig Saw technique framework using wiki. The paper reports the findings from a quantitative research which had two independent variables i.e. gender and learning strategy. The control group was classroom based collaborative learning and the experimental group was online collaborative learning. The dependent variable was student motivation learning which measured by questionnaire. The proposed hypotheses were tested using two way ANOVA to find the main effect of gender and learning strategy, and the interaction of both variables. The findings of this research are that gender did not give significant effect to student learning motivation. But, learning strategy gave the significant effect to student learning strategy which the online collaborative learning had better effect to the motivation than classroom based collaborative learning. Both independent variable had slight interaction but statistically not significant. The results presented here will assist researchers, teachers or lecturers, and higher-education administrators to take the beneficial of the wiki to improve student learning motivation that would increase the learning performance as well.

Researchers Takeda and Homberg (2013) examined the effects of gender on group work process and performance using the self- and peer-assessment results of 1,001 students in British higher education formed into 192 groups. The analysis aggregates all measures on the group level in order to examine the overall group performance. Further, a simple regression model is used to capture the effects of group gender compositions. Results suggest that students in gender-balanced groups display enhanced collaboration in group work process associated with less social loafing behaviours and more equitable contributions to the group work. However, the results imply that this cooperative learning environment does not lead to higher student performance. Students' comments allow us to explore possible reasons for this finding. The results also indicate underperformance by all-male groups and reduced collaborative behaviours by solo males in male gender exception groups (i.e. groups consisting of one male student and other members being female). The results thus have implications for the composition of groups. The pedagogical implications of these findings are discussed.

In the same vain, Gupta *et al.*, (2014) determined how the adoption of cooperative learning as an instructional strategy for teaching mathematics influences students' achievement. The study also determined how moderating variables like gender affect students' achievement in mathematics when cooperative learning is used as an instructional strategy. They aimed at studying the effect of co-operative learning strategies i.e. team assisted individualization (TAI) and student teams achievement division (STAD) on the mathematics achievement among ninth graders in relation to gender. This is an experimental study with 3x2 factorial designs. Students of ninth standard of the schools affiliated to Haryana Board in Rohtak city constituted the population of the study. 144 students of ninth standard (74 boys and 70 girls) selected through multi-stage random sampling technique were taken as a sample for the study out of which 52 students taught through TAI formed experimental group-1 (E1); 46 students taught through STAD formed experimental group-2 (E2) and 46 students taught through conventional method of teaching formed control group (C). Sample of the students were also equated on the basis of socio-economic status and achievement in the subject concerned. Achievement test in mathematics developed and standardized by the investigators was used to assess the achievement of the subjects. Lesson plans, worksheets, check-outs and formative tests were developed for both the strategies TAI and STAD separately to carry out the teaching and learning process in all the three groups for ten weeks only. At the end of the experiment, achievement test in mathematics was given to the subjects. Data were analyzed by using ANOVA and t-test to determine the performance by comparing the mean scores of all the groups. Data analysis revealed that boys and girls students taught through co-operative learning strategies TAI and STAD outscored significantly the control group on post-test showing the obvious supremacy of co-operative learning over conventional method of teaching. Hence, the ultimate result of the study indicated that co-operative learning was found more effective instructional paradigm for mathematics as compared to conventional method of teaching.

In this research, Cen *et al.,* (2014) investigated on the role that the students' gender plays in their engagement during collaborative learning and their learning performance as assessed by the teacher. In the context of the EBTIC developed Collaborative Learning Environment deployed at Khalifa University along the sequence of 3 group coursework over 2 semesters, we intend to explore the differences between the collaborative learning style and quality in female, male and mixed-gender groups. The series of detailed cross-gender learning engagement and performance comparisons indicate that female groups tend to work simultaneously and achieve better results while male group members engage less and work in sequence. As a result female groups exploit the added benefits of collaborative learning more than the male groups. What is striking, however, the members of the mixed-gender groups excel the most, significantly improving their engagement, focus and the quality of group work comparing to same-gender groups. They believe this outcome delivers yet another proof of the synergies and efficiencies of interactive learning in a diverse group of students and encourages mixing genders when composing groups for collaborative learning

Similarly, Lim (2016) researched on Collaborative Learning, Gender Groupings and Mathematics Performance. The study was conducted to find how students perform in class if they work in groups. It also wanted to find out which gender groupings will students be working comfortably and obtaining better results. Experimental research design was utilized where the subjects were randomly assigned. The subjects of this study was composed of 9 groups, three all-male groups, three all-female groups, and three mixed groups. Using ANOVA, data revealed that the subjects' formative tests mean score had no significant difference which implies that subjects if working by himself/herself obtained more or less similar results due to they were randomly assigned. While the collaborative learning where the subjects worked in different gender groups showed that there was a significant difference in their performance where all-female groups obtained the highest mean score followed by mixed groups implying that if subjects work with whom they are comfortable would have better results. In the Math achievement test which was taken individually posited that there is a significant difference in the mean scores obtained due to the level of improvement of their learning which could be attributed to whom they worked and learned the concepts with.

On the other hand, Adolphus and Omeodu (2016) investigated on the effect of gender and collaborative learning approach on students' conceptual understanding of electromagnetic induction in Secondary Schools in Nigeria. Three research questions and 2 hypotheses were formulated to guide the research. The research design adopted for this study is the quasi-experimental design. In particular, the design is the non-randomized, pretest-posttest, control group design. The population of the study is made up of the 323 Senior Secondary III Physics students in all 6 public co-educational Senior Secondary schools in Port Harcourt local Government area. A sample of 90 students, comprising of 60 male and 30 females were selected for the study. The research instrument developed and used for this study is the Test on Electromagnetic Induction (TOEI). The instrument is composed of 50 questions covering the content area and testing the various levels of understanding. Simple means, standard deviation and variance were used to answer research questions while inferential statistics such as t-test, Analysis of variance (ANOVA) and 2x2 factorial analysis of variance were utilized for the testing of the hypotheses. The results show that gender does not significantly affect the understanding of students in electromagnetic induction when taught with collaborative teaching approach. The study also showed that gender and teaching approaches do not jointly affect students' conceptual understanding of electromagnetic induction at the secondary school level.

2.4 Summary of Literature Reviewed

The review of literatures was arranged into three categories; the conceptual, the theoretical and the empirical frameworks, all reviewing achievement, retention and attitude as variables. A moderating variable of gender was also considered, that is the attitude of male and female to Physics and how it affect achievement and retention. The history of constructivism learning theory was reviewed. The concept of science and technology, Physics and science, Physics curriculum, the flipped classroom, collaborative learning strategy and personalized learning were also examined. Empirical studies on flipped classroom as its affect achievement, retention, attitude and gender in a collaborative and individualized learning setting were also reviewed. It likewise covered related literatures of studies conducted on flipped classroom in a collaborative setting.

Several of the reviewed literature shows that students find it easier to adapt to flipped classroom collaborative learning strategies (Think Pair Share, Reciprocal Teaching and Think Aloud Pair Problem Solving). Application of Think Pair Share as a suitable alternative learning approach helps the students develop their collaborative skills. It simulates students' participation and performance in reading in which it increases the functional communication, discussion, decision taking and conflict reduction in group learning. Other studies revealed that students should be exposed to students centered and activities-based teaching strategies such as the Individualized learning strategies and collaborative learning instructional strategies for enhanced students' academic achievement.

Furthermore, some results shows that failure in examination is attributed to teacher didactic strategies, institutional resources, poor learning and examination strategies, and failure to understand instruction. The results provide insight for future research and inciting changes in teaching-learning practices that would promote Physics enjoyment and subsequent better performance in the subject.

In conclusion, many studies revealed that students find flipped classroom collaborative learning strategies quite effective because it allows them to reach the information easily and review and revise things that they do not understand very well, helps them come to class prepared, makes remembering easier, increases interest, allows students to learn at their own pace by letting them progress based on their skills and it provides students who miss classes due to absenteeism as a result of extra curriculum activities or illnesses with opportunities to reach the content whenever and wherever they want it.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Design

The research design that was employed for this study is a quasi-experimental design which includes a pretest, posttest, non-equivalent, control group design. It involves four levels of independent variables, (three treatments – three collaborative learning strategies and a control – individualized learning strategy), three levels of dependent variables (achievement, retention and attitude) and a moderating variable of gender (male and female). All the experimental and control groups were pre-tested, and post-tested, and thereafter retention test (post post-test) was conducted. A descriptive survey of Students' Attitude Questionnaire was also used to draw data from respondents on Students' Attitude Towards Physics (SATP) and Students' Attitude Towards Flipped Classroom (SATFC) for learning Physics at senior secondary schools. The participating schools (namely, Brighter School Minna, Hill Top Model School Maitunbi, Minna, Police Secondary School Minna and Fema School Tundun fulani, Minna) were assigned to Think Pair Share (TPS), Think Aloud Pair Problem Solving (TAPPS), Reciprocal Teaching (RT) and Individualized Learning (IL) respectively. The design layout is as shown in Table 3.1.

Table 3.1 Research Design Layout

Groups	Pre-test	Treatment	Post-test	Retention test
Exp Group 1	O_1	X_1	O_2	O_3
Exp Group 2	O_1	X_2	O_2	O_3
Exp Group 3	O_1	X_3	O_2	O_3
Control Group	O_1	X_o	O_2	O_3

Where,

O_1 = Pre-test for all the groups.

O_2 = Post-test for all the groups.

O_3 = Retention test for all the groups.

X_1, X_2, X_3 = Treatment for experimental group one (RT), two (TAPPS) and three (TPS))

X_o = Treatment for the control group (IL)

3.2 Population of the Study

The population of this study comprised all the 27,621 senior secondary school students in Minna, Nigeria. The target population of this study comprised all the 11,663 senior secondary II (SSII) Science students in Minna Metropolis, Niger State as at 2018/2019 academic session. (Education Resource center Minna, Niger State).

3.3 Sample and Sampling Techniques

The sample of this study consists of 146 science students from four senior secondary schools two (SSII) in Minna (See Table 3.2).

Table 3.2: The summary of the sampled schools

S/N	Name of School	Male	Female	Total
1.	Brighter Schools Mjnna	8	8	16
2.	Police Secondary School Minna	21	21	42
3.	Hilltop Model School Minna	17	28	45
4.	FEMA Schools Minna	21	22	43
	Total	67	79	146

Three sampling techniques were employed in this study. Firstly, purposive sampling procedure were adopted to select four senior secondary schools in Minna, Nigeria. The schools was selected based on the following criteria (i) gender consideration (co-educational schools), (ii) school that offers Physics subject and (iii) schools that has computers/computer laboratory. Secondly, the selected four equivalent co-educational schools was randomly assigned to each of the three experimental and control group using simple random sampling technique. Each school was assigned to the three collaborative learning strategies: (i) Reciprocal Teaching (RT), (ii) Think Pair Share (TPS), (iii) Think-Aloud Pair Problem Solving (TAPPS), and the control group to Individual Learning (IL) strategy respectively. Thirdly, a stream of class was randomly selected from each of the schools. There was a distance of at least five kilometres among the selected schools to avoid interaction of subjects during and after the treatment which can pose threat to internal validity. An intact class was used in this study.

3.4 Research Instruments

Four research instruments were used in this study: (i) Flipped-classroom instructional package (FIP), (ii) Physics Achievement Test (PAT), (iii) Students' Attitude towards Physics Questionnaire (SATPQ), and, (iv) Students' Attitude towards Flipped Classroom Questionnaire (SATFCQ).

3.4.1 Treatment Instrument

3.4.1.1 Development of flipped-classroom instructional package (FIP)

Flipped-classroom instructional package (FIP) for teaching Physics at senior secondary school class II (SSSII) usable at two different settings (Collaborative and individualized instructional settings) was developed by the researcher and video producer. The local production of flipped classroom using video instructional package for Physics concepts stem from the facts that the commercially produced ones may not really fit for Nigeria curriculum and may be culturally biased. Hence, there is need to develop a Flipped-classroom instructional package by the researcher with the assistance of a Programme Director who adapted the lesson notes into illustrative video, audio and annotation for the study.

In the FIP production, the lesson plan was used for all contents included in the FIP, it guided the overall development of the instrument. Action Script 3.0 programming and scripting language and the Adobe Flash professional were used for all the contents animations, transitional navigation, backend workings and the overall interface structure of the FIP. The voice, after being recorded was edited with the Adobe soundbooth and Adobe audition before it was added to the FIP. The lesson quiz questions were structured with extensible Mark-up Language (XML) and were loaded into the game at runtime to achieve a perfect synchrony.

The concepts of Physics (light waves) selected for this study are from senior secondary school class two (SSII) curriculum. Lesson plans was prepared by the researcher, this covered the scheme of work which was produced in video instruction and was used for flipping the classroom. The FIP contains video lesson explaining the concept of Light Waves in Physics. This FIP consist of four lessons which were given to the students to access both at home and in the school. For instance, the students can watch the FIP in the school computer laboratory at their convenient time. The video can be viewed as many times as possible. This enabled them to come to class with adequate knowledge of the concept to be taught.

Both the experimental and control group were subjected to this instrument (FIP). They were instructed to watch the video after school hour and come the following day to work through problems and engage in collaborative learning discussion on what they have watched. This was done in two different ways: the experimental groups were assigned to three Collaborative Learning (CL) strategies: (i) Think Pair Share (TPS), (ii) Reciprocal Teaching (RT), (iii) Think-Aloud Pair Problem Solving (TAPPS), while the control group was assigned to Individual Learning (IL) strategy.

3.4.2 Test Instrument

3.4.2.1 Development of Physics Achievement Test (PAT):

The test instrument that was used in collecting data for this study was a 50 items - multiple choice objective questions developed by the researcher from Physics text books covering the Concept of light Waves in Physics. It contains five option answers (A – E) with one correct answer and four distracters. This instrument was used to collect data on students' achievement after the treatment has been applied. It was used for the pilot testing to find the reliability of the PAT. This PAT was administered to the experimental and the control groups as pre-test and later be administered for the posttest and retention test respectively. These questions were reshuffled and administered in a random order in the tests. The scoring format is 1 mark per correct answer and zero for wrong answer.

3.4.3 Questionnaire

i. Students Attitude Towards Physics Questionnaire (SATPQ)

This instrument is tagged "Students' Attitude towards Physics Questionnaire" (SATPQ) which consist of two sections, Section A is the Bio data of the respondent – the name of the school and the gender while Section B contains 15 items constructed by the researcher to elicit responses from students with respect to their attitude toward Physics subject. It contains 5 Point Likert scale ranked and scored as: 5 for Strongly Agree (SA), 4 for Agree (A), 3 for Neutral (N) 2 for Disagree (D) and 1 for Strongly Disagree (SD) respectively. (See appendix XIV)

ii. Student Attitude Towards Flipped Classroom Questionnaire (SATFCQ)

This instrument is tagged "Students' Attitude towards Flipped Classroom Questionnaire" (SATFCQ) made up of two sections, Section A is the Bio data of the respondent; the name of the school and the gender while section B contains 14 items of the instrument. It was constructed by the researcher to elicit responses from students with respect to their attitude toward flipped classroom. A 5 Point Likert scale was scored as: 5 for Strongly Agree (SA), 4 for Agree (A), 3 for Neutral (N) 2 for Disagree (D) and 1 for Strongly Disagree (SD) respectively. (See appendix XV)

Decision rule for attitude rating:

For the research questions on attitude, the limit for decision rule was calculated by dividing the sum of response rating 5,4,3,2 and 1 by 5. The average mean of 5+4+3+2+1 divided by 5 is 15/3 =3. Therefore an average mean of 3.0 was considered agreed while that of 2.90 and below was considered disagreed.

3.5 Validation of the Instruments

3.5.1 Validity of flipped-classroom instructional package

The validation of these treatments was done in three stages:

The Content validation, Expert validation and Field trial validation

Content Validity

The Physics contents, PAT and marking scheme were given to nine Physics Experts. These include: Three senior lecturers from Physics Department, Federal University of Technology, Minna and three senior Physics teachers from secondary schools in Minna, three experts from Test and Measurement Department of National Examination Council (NECO), Minna. All the experts examined and assessed the contents and test items to determine the face and content validity before producing the final copy of the instrument. The face validity of FIP was checked focusing on arrangement and logical sequence while the content validity focused on material taught whether it adequately covered the syllabus of Secondary School Physics. Comments, corrections, suggestions and opinions of these experts were used to make the final copy of the instrument.

Expert Validity

This was done by some group of experts; computer specialists, Physics experts, and Educational Technology experts. The developed flipped-classroom instructional package was given to these experts to determine the appropriateness of the FIP in terms of legibility, clarity, simplicity of the package, audibility, font size and font type. Their suggestions, corrections and recommendations were used for the modification of the package.

Field Trial Validation: In order to ascertain the potency of the FIP, 20 Physics senior secondary students from Maryam Babangida Girls' Science College (MBGSC) Minna, were trial tested, which are part of the study populations but not part of the sampled schools. The sampled students were exposed to topics on Light waves using the FIP for a single period of 40 minutes' duration. They were instructed to watch the video lesson/ video notes after which they were engaged in collaborative learning discussion on what they have watched. The FIP Validation Questionnaire was then administered on them. (See appendix XIII)

3.5.2 Validity of physics achievement test (PAT)

This PAT was subjected to experts' validation in relation to content and face validity by three senior lecturers from Physics Department, Federal University of Technology, Minna and three senior Physics teachers from secondary schools (since the study is carried out in secondary schools) in Minna, three experts in Test and Measurement Department of National Examination Council (NECO), Minna. The comments, corrections and suggestions given by these experts were used to modify and adjust the instrument.

3.5.3 Students' attitude towards physics questionnaire (SATPQ)

The Students' Attitude towards Physics Questionnaire (SATPQ) was used for attitude rating of the subject (Physics). It was prepared by the researcher and validated by three experts from the Department of Educational Technology Federal University of Technology Minna and three Senior lecturers from Physics Department Federal University of Technology Minna. The SATPQ was face and content validated by three experts. All the observations and suggestions pointed out were used to produce the final copy of the instrument.

3.5.4 Students' attitude towards flipped classroom questionnaire (SATFCQ)

The Students' Attitude towards Physics Questionnaire (SATPQ) was used for attitude rating of the Model App. It was prepared by the researcher and validated by three experts from the Department of Educational Technology Federal University of Technology Minna and two Senior lecturers from Physics Department Federal University of Technology Minna. The SATFCQ was face and content validated by three experts. All the observations and suggestions pointed out were used to produce the final copy of the instrument.

3.6 Reliability of the Research Instruments

3.6.1 Pilot testing

PAT, FIP, SATPQ and SATFQ was pilot tested on 20 randomly selected students of Bosso Secondary School, Minna, which is not part of the sampled schools but part of the research population, thus they were not used for the real study.

Pilot test was also conducted in the study to determine reliability of the students' attitude towards flipped classroom. The data obtained were subjected to statistical data analysis to determine the reliability of the instruments. The reliability of SATPQ and SATFCQ was determine using Cronbach alpha formula and a reliability value of 0.73 was obtained for SATPQ and reliability values of 0.81 obtained for SATFC which was considered reliable as the Cronbach alpha level obtained for the variables were all above the recommended edge of 0.6 alpha levels (Nunnaly, 1974). The reliability of PAT was also determined using Split half reliability and a reliability value of 0.84 was obtained.

3.6.2 Field trial testing of FIP

The field trial test was carried out in order to ascertain the suitability of the treatment instrument (FIP) before it was used for the real study. Flipped Instructional Package (FIP) was trial tested on 20 Senior Secondary two (SSII) Physics students from Maryam Babangida Girls Science College Minna. The result of the findings were analyzed and presented using simple percentage. The data obtain from the field trial testing was evaluated as shown in appendix IX.

3.7 Method of Data Collection

The researcher visited the schools to get official permission and cooperation of the school authorities to use the schools and their facilities. The facilities and the students were examined to determine their suitability for the study. Orientation was conducted for one week followed by administration of the pre-test. Some Physics teachers were trained as research assistants in the use of the Flipped-classroom instructional package (FIP), individualized and collaborative learning strategies. Training was done in each of the schools on the use of FIP and collaborative setting as assigned to each school. The sampling techniques procedure and team building exercise followed immediately for two weeks.

The four weeks Physics lesson in the flipped-classroom instructional package burnt in DVD (digital versatile disc) were distributed to the students through the research assistants. Time frame was given to the students to watch the video lessons/ read the video notes before the class lesson period. During the lesson period, students were assembled into groups. Each group comprised of two to three members. The groups were formed heterogeneously based on gender. Each group member was assigned a responsibility (leader, time keeper, scribe and others) while the teacher (research assistant) went round the groups to monitor the students as a facilitator in order to ensure that guideline outlined for the method are followed.

Before the commencement of the experiment, pre-test was administered to all the groups using PAT to determine the level of their equivalence. This was to ensure that students have equal abilities to participate in the study. This was followed by the flipped-classroom instructional package (FIP) which lasted for four weeks based on the school's time table and scheme of work. Each group used the Flipped-classroom instructional package (FIP) before the class lesson period. After which each group now followed specific Collaborative instructional strategies procedures.

3.7.1 Experimental group one: think-pair-share (TPS):

i. Students' learning activity involves explaining answers or ideas to another student.
ii. The instructor poses a question to the class.
iii. Students write a response and then share it with their peer.
iv. Students clarify their positions and discuss points of agreement and disagreement.
v. The instructor can use several answers to illustrate important points or facilitate a whole class discussion.
vi. The teacher (research assistant) went round the groups to moderate the students in order to ensure that guideline outlined for the method are followed appropriately.

3.7.2 Experimental group two: reciprocal teaching (RT):

i. Students' learning activity involves teaching one another in the group.
ii. Students jointly read a text or work on a task.
iii. Students take turns being the teacher for a segment of the text or task.
iv. In their teaching role students lead the discussion, summarize material, ask questions, and clarify material.
v. The teacher (research assistant) went round as a facilitator.

3.7.3 Experimental group three: think-aloud pair problem solving (TAPPS):

i. Students' learning activity involves solving problems.
   (The teacher /research assistant pose a problem)
ii. Students work in pairs and alternate roles.
iii. For each problem one is the solver while the other is the listener.
iv. The solver thinks aloud - narrating his/her reasoning process—while solving the problem.
v. The listener prompts the solver to keep talking and asks for clarification but does not intervene to help.
vi. Pairs solve a set of problems and alternate role for each new problem.
vii. The teacher (research assistant) went round the groups to monitor the students in order to ensure that guideline outlined for the method are followed appropriately.

3.7.4 Control group: individualized learning (IL) strategy:

i. Students in this group did their learning alone on individualized bases and proceed at their own pace.
ii. Learner progresses through the material at different speeds, according to his or her own learning needs and abilities.

This specific treatment was given to each group for four weeks. PAT was administered to all the groups after the treatment. The retention test was administered to each of the four groups after two weeks of the posttest. The pre-test, post-test and retention test were marked according to the marking scheme and the results were subjected to data analysis.

3.8 Method of Data Analysis

The data collected from the pretest, posttest and retention test was analyzed using descriptive and inferential statistics. Descriptive statistics of Mean and Standard Deviation was used to answer the eleven research questions while the inferential statistics of ANCOVA (Analysis of

Co-variance) was used to test Hypotheses one to ten and ANOVA (Analysis of Variance) was used to test Hypothesis eleven. Sidak test was used as post hoc measures to determine the area of differences that occurred. The hypotheses were tested at 0.05 levels of significance. Statistical Package for Social Sciences (SPSS) Version 23.0 was used for data analysis.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Pretest Result

To determine the equivalence of the group on treatment, a pretest was conducted and the result obtained was analyzed with analysis of variance (ANOVA), the finding is presented in Table 4.1.

Table 4.1: ANOVA comparison of pretest mean scores of students taught using flipped classroom collaborative in different learning settings.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	498.740	3	166.247	8.871*	.001
Within Groups	2661.178	142	18.741		
Total	3159.918	145			

*=Significant at 0.05

Table 4.1 Shows the ANOVA comparison of pretest mean scores of students taught using flipped classroom collaborative in different learning settings. The result shows that there were statistically significant differences in the pretest mean scores of these groups, $F (3, 142) = 8.871$, $p = 0.01$ ($p < 0.05$). This shows that at the entrance level the groups used for the study were not on the same level (not equivalent). Therefore, the pretest scores were used as covariates to test the formulated hypotheses (see Table 4.1). Table 4.2 presents the ANOVA comparison of Students' Attitude toward Physics before treatment.

Table 4.2: ANOVA comparison of Students' Attitude toward Physics before treatment

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	28.303	3	9.434	5.688*	.001
Within Groups	235.532	142	1.659		
Total	263.836	145			

*=Significant at 0.05

Table 4.2 shows the ANOVA comparison of Student Attitude toward Physics before treatment. The Table shows that there were statistically significant differences in the pretest mean scores of these groups, $F(3, 142) = 5.688$, $p = 0.01$ ($p < 0.05$). This shows that there was significant difference in attitude of the students in the experimental groups used for the study towards Physics at the entry level. On this basis, the students pre-inventory was used as covariates to test the formulated. All the hypotheses were tested at 0.05 significant levels. The results were presented based on the research questions and hypotheses:

4.2 Research Questions Results

Research question one: What is the difference in the mean achievement scores of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS) and those taught using individualized learning (IL) setting?

For the purpose of this research question, mean gain (which is the difference between pretest and posttest) was used to check for the improvement within the different learning settings. The result is presented in Table 4.3.

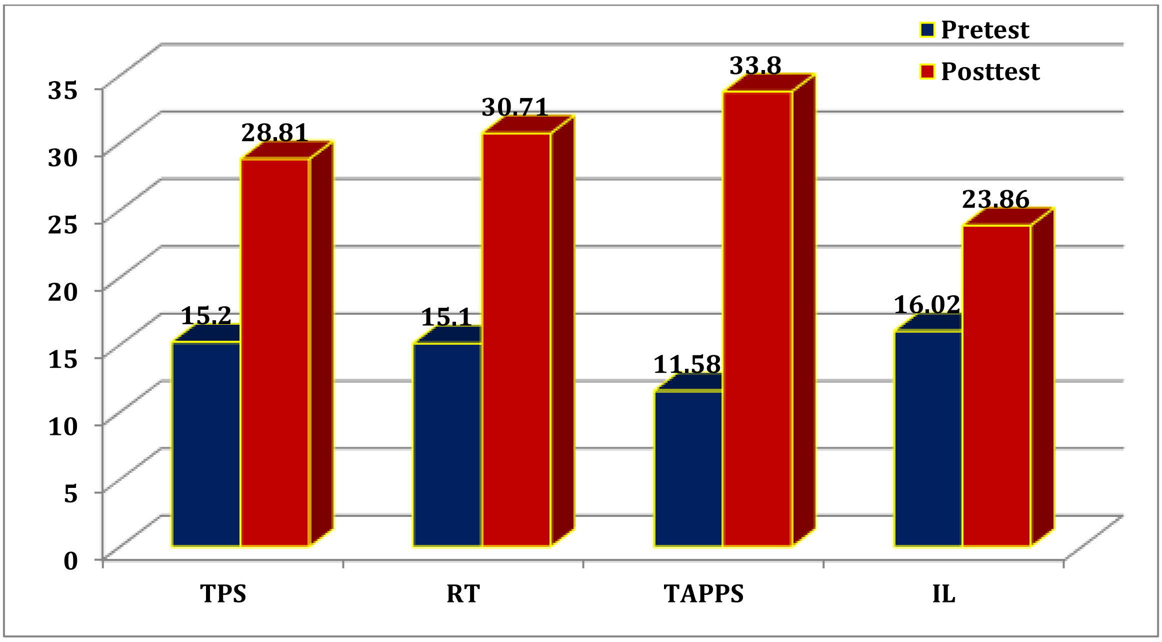
Table 4.3: Mean gain scores of students taught Physics using flipped classroom collaborative strategies in different learning settings

	Pretest		**Posttest**		
Learning Setting	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean gain**
TPS	15.20	4.95	28.81	5.02	13.61
RT	15.10	5.07	30.71	4.01	15.61
TAPPS	11.58	3.69	33.80	2.16	17.65
IL	16.02	3.89	23.86	4.18	7.84

*TPS: Think Pair Share, RT: Reciprocal Teaching, TAPPS: Think –aloud Paired Problem Solving, IL: Individualized Learning

Table 4.3 is the Mean gain scores of students taught Physics using flipped classroom collaborative strategies in different learning settings. It shows the achievement scores of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS) and those taught using individualized learning (IL) setting. TPS with a mean score of 15.20 during the pretest has a mean score of 28.81 during the posttest with S. D. of 4.95 and 5.02 respectively. RT also recorded a mean score of 15.10 and 30.71, and S. D. of 5.07 and 4.01 for both pretest and posttest respectively. TAPPS lead the group with a mean score of 11.58 and 33.80 with S. D. 3.69 and 2.16 for pretest and posttest respectively.

The table also show that all the groups benefited from the use of flipped classroom collaborative learning strategies as the mode of lesson delivery, but at different levels. TPS setting has a mean gain of 13.61 which almost doubles their score during the pretest. RT benefited obviously with the mean posttest score doubling the mean pretest score. Although scoring the least during the pretest, TAPPS stand out as the most benefitted group in all as the posttest scores increases as high as three time the pretest scores. The table shows that the pretest score for TAPPS is 11.58 and posttest score is 33.90 making this group the highest scoring group within groups (Fig 4.1).



*TPS: Think Pair Share, RT: Reciprocal Teaching, TAPPS: Think –aloud Paired Problem Solving, IL: Individualized Learning

Figure 4.1: The performance of Physics Students Taught Using TPS, RT, TAPPS and IL.

Research question two: What is the difference in the mean retention scores of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think aloud paired problem solving (TAPPS) and think pair share (TPS) and those taught using individualized learning (IL) setting?

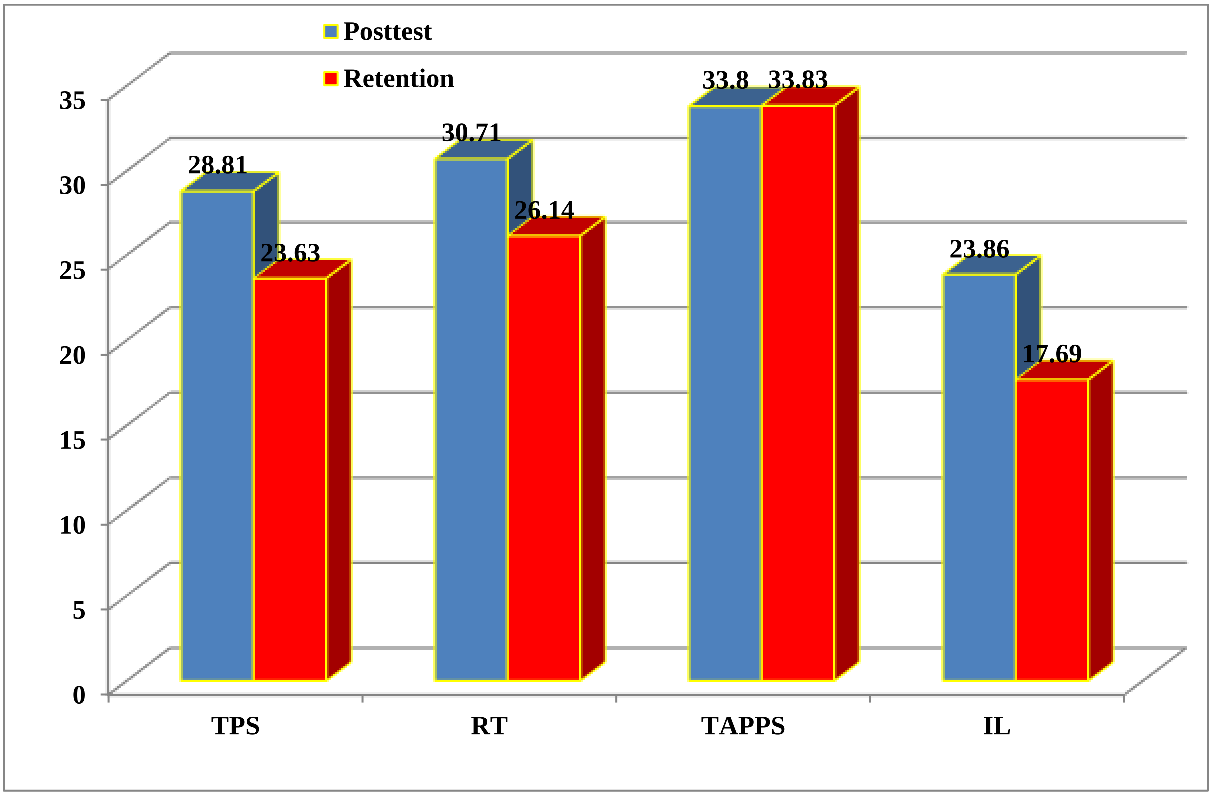
To answer this research question, the Mean retention scores of students taught Physics using flipped classroom in different learning settings were analysed in Table 4.4.

Table 4.4: Mean retention scores of students taught Physics using flipped classroom in different learning settings.

Treatment		**Posttest**		**Retention**		**Mean difference**
		Mean	**S.D.**	**Mean**	**S.D.**	
Experimental	TPS	28.81	5.02	23.63	2.73	5.18
(Collaborative learning)	RT	30.71	4.01	26.14	3.47	4.57
	TAPPS	33.80	2.16	33.83	3.36	0.03
Control (Individualized Learning)	IL	23.86	4.18	17.69	4.06	6.17

*TPS: Think Pair Share, RT: Reciprocal Teaching, TAPPS: Think –aloud Paired Problem Solving, IL: Individualized Learning

Table 4.4 shows the mean retention scores of students taught Physics using flipped classroom in different learning settings. After posttest, the students were administered the same questions to test their ability to retain knowledge impacted using flipped classroom method of teaching. Think aloud pair problem solving (TAPPS) which is a sub-group under the experimental group ranked first with a mean retention score of 33.83, this is followed by the Reciprocal learning and Think pair share with mean scores of 26.14 and 23.63 respectively which are both under the experimental group. Individualized learning (control group) was ranked least with a mean retention score of 17.69. The result shows that the experimental group was able to retain more knowledge than the control group. The mean difference, which is the difference in retention and posttest scores, was calculated. TAPPS has the least mean difference with a mean difference of 0.03 which depicts very small increment during retention test. TPS and RT had mean differences of 5.18 and 4.57 respectively. On the other side, IL (control group) recorded a mean difference of 6.17 (Fig 4.2).



*TPS: Think Pair Share, RT: Reciprocal Teaching, TAPPS: Think aloud Paired Problem Solving, IL: Individualized Learning.

Fig. 4.2: Mean retention scores of students taught Physics using flipped classroom in different learning settings

Research question three: What is the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings. Table 4.5 presents the Mean and Standard Deviation of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings.

Table 4.5: The Mean and Standard Deviation of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings.

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Male	8	15.13	4.91	27.63	5.29	12.50
Female	8	15.25	5.34	30.00	4.78	14.75

Table 4.5 shows the mean and standard deviation of the pretest and posttest scores of students taught Physics using Flipped Classroom in Think Pair Share collaborative learning setting. The result revealed that the mean and standard deviation of pretest and posttest scores of male students is 15.13, standard deviation of 4.91 and 27.63 is the mean score of male students at posttest with 5.29 standard deviation. The mean gain for male students in Think Pair Share is 12.50. Similarly, the mean and standard deviation of the pretest and posttest scores of female students was found to be 15.25 and standard deviation of 5.34 at pretest while posttest mean score of 30.00 and standard deviation of 4.78 was obtained by female students. The mean gain for female students in Think Pair Share is 14.75. This implies that that female students in TPS had mean gain higher than the male students in the same group. The graphical representation of the student performances in various groups is illustrated in Fig. 4.5.

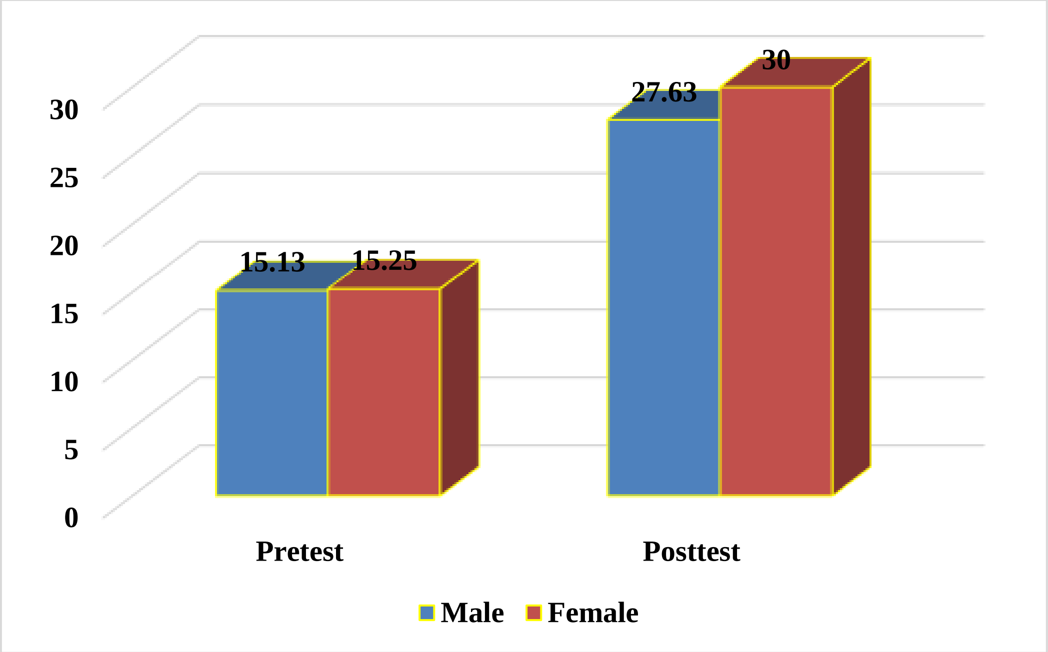


Figure 4.3: Posttest of Male and Female Students Taught Physics using flipped classroom in Think Pair Share collaborative learning settings

Research question four: What is the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings. Table 4.6 shows the answer to this question.

Table 4.6: The Mean and Standard Deviation of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings.

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Male	17	11.18	3.70	28.82	1.47	22.76
Female	28	11.82	3.74	29.21	2.50	21.89

Table 4.6 shows the mean and standard deviation of the pretest and posttest scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings. The result revealed that the mean and standard deviation of pretest and posttest scores of male students as 11.18, standard deviation of 3.70 and 28.82 is the mean score at posttest with 1.47 standard deviation. The mean gain for male students in in Think Aloud Pair Problem Solving is 22.76. Similarly, the mean and standard deviation of the pretest and posttest scores of female students was found to be 11.82 and standard deviation of 3.74 at pretest while posttest mean score of 29.21 and standard deviation of 2.50 was obtained by female students. The mean gain for female students in in Think Aloud Pair Problem Solving group is 21.89. This implies that the male students in TAPPS had mean gain higher than female students in the same group. The graphical representation of the student performances in this group is illustrated in Fig. 4.4.

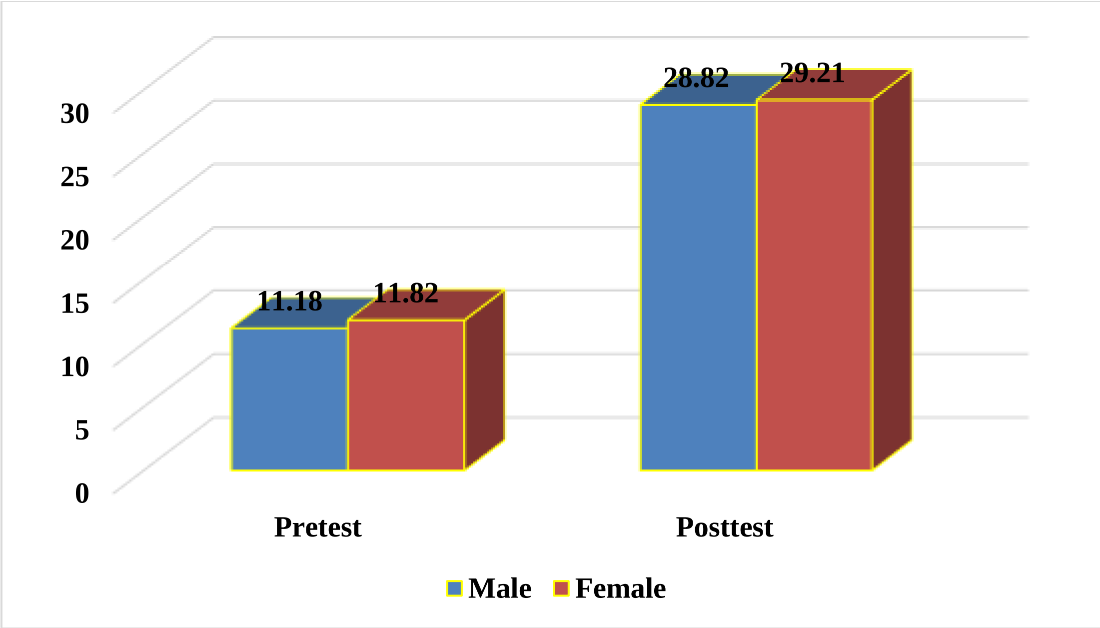


Figure 4.4: Posttest of Male and Female Students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings.

Research question five: What is the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. Table 4.7 presents the Mean and Standard Deviation of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings.

Table 4.7: The Mean and Standard Deviation of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings.

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Male	21	15.65	3.79	30.5	3.76	14.86
Female	21	14.52	6.15	30.87	4.26	16.35

Table 4.7 shows the mean and standard deviation of the pretest and posttest scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. The result revealed that the mean and standard deviation of pretest and posttest scores of male students as 15.65, standard deviation of 3.79 and 30.05 is the mean score at posttest with 3.76 standard deviation. The mean gain for male students in Reciprocal Teaching is 14.86. Similarly, the mean and standard deviation of the pretest and posttest scores of female students was found to be 14.52 and standard deviation of 6.15 at pretest while posttest mean score of 30.87 and standard deviation of 4.26 was obtained by female students. The mean gain for female students in Reciprocal Teaching is 16.35. This implies that the female students in RT had mean gain higher than male students in the same group. The graphical representation of the student performances in this group is illustrated in Fig. 4.5.

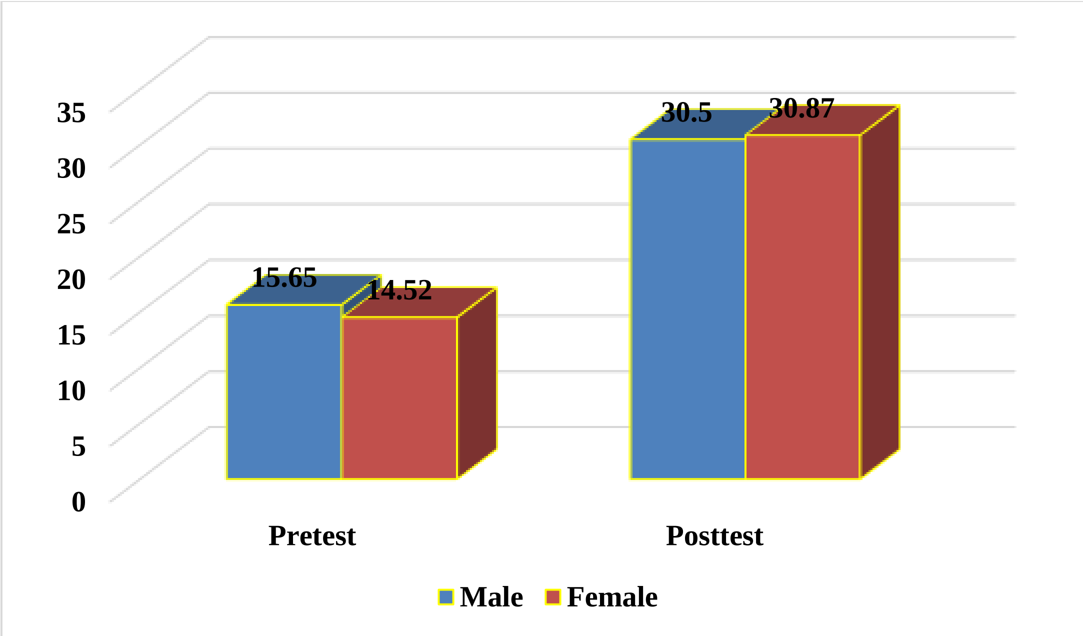


Figure 4.5: Posttest of Male and Female Students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings.

Research question six: What is the difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Individualized learning settings.

Table 4.8 shows the analysis of the result.

Table 4.8: The Mean and Standard Deviation of male and female students taught Physics using flipped classroom in Individualized learning settings.

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Male	21	16.05	2.42	23.59	4.69	7.59
Female	22	16.00	5.00	24.14	3.66	8.09

Table 4.8 is the Mean gain scores of students taught Physics using flipped classroom in individualized learning settings based on gender. It shows that on the average, the female students performed better than their male counterpart. The females scored a little bit higher than the males during the posttest. Looking at the group, during the posttest the male had 23.59 while the female had 24.14 with S. D. of 4.69 and 3.66 respectively. The mean gain scores also favored the female student with slight difference with score of 7.59 and 8.09 for male and female students respectively.

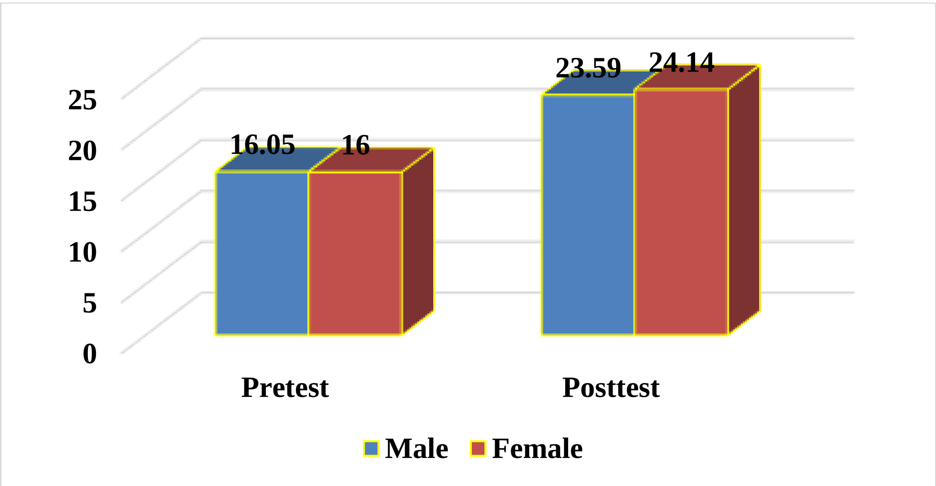


Figure 4.6: Posttest of Male and Female Students taught Physics using flipped classroom in Individualized learning settings.

Research question seven: What is the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings. The answers to this question were analysed in Table 4.9.

Table 4.9: Posttest and Retention Mean Scores and SD of Male and Female Students Taught Physics using flipped classroom in TPS collaborative learning settings

Group	N	Posttest		Retention Test		Mean Loss
		Mean	SD	Mean	SD	
Male	19	23.59	4.69	22.25	1.67	1.34
Female	16	24.14	3.66	25.00	2.98	-0.86

Table 4.9 shows the mean and standard deviation of the posttest and retention test scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings. The result revealed that the mean scores of posttest and retention scores of male students is 23.59, standard deviation of 4.69 and 22.25, standard deviation 1.67 respectively. Similarly, the mean and standard deviation of the posttest and retention scores of female students was found to be 24.14 and standard deviation of 5.55 at posttest while retention mean score of 25.00 and standard deviation of 2.98 was obtained by female students. The mean gain for female students in Think Pair Share is 0.86. This implies that male students in TPS had mean gain higher than those female students in the same group. The graphical representation of the student performances in various groups is illustrated in Fig. 4.7.

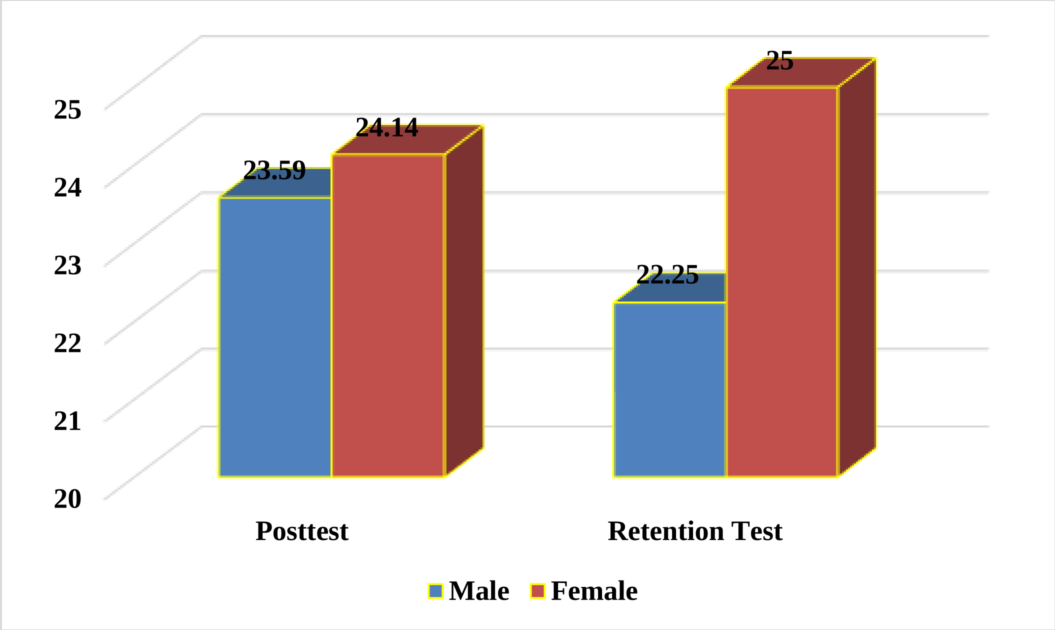


Figure 4.7: Posttest and Retention of Male and Female Students taught Physics using flipped classroom in Think Pair Share collaborative learning settings.

Research question eight: What is the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings. Table 4.10 shows the Posttest and Retention Mean Scores and SD of Male and Female Students Taught Physics using flipped classroom in TAPPS collaborative learning settings.

Table 4.10: Posttest and Retention Mean Scores and SD of Male and Female Students Taught Physics using flipped classroom in TAPPS collaborative learning settings

Group	N	Posttest		Retention Test		Mean Loss
		Mean	SD	Mean	SD	
Male	19	28.82	1.47	33.94	3.38	5.12
Female	16	29.21	2.50	33.71	3.41	4.5

Table 4.10 shows the mean and standard deviation of the posttest and retention test scores of students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings. The result revealed that the mean and standard deviation of posttest scores of male students is 28.82, standard deviation of 3.53 and retention score 33.94, standard deviation 3.38, while female students at posttest scored 29.21, standard deviation 2.50 and at retention had 33.71, standard deviation 3.41. The mean gain for male students in Think Aloud Pair Problem Solving collaborative learning settings is 5.12. The mean gain for female students in Think Aloud Pair Problem Solving collaborative learning settings 4.5. This implies that male students in TAPPS had mean gain higher than those female students in the same group. This also implies that contrary to the mean loss expectation, the students in this group scored higher during the retention test. The graphical representation of the student performances in various groups is illustrated in Fig. 4.8.

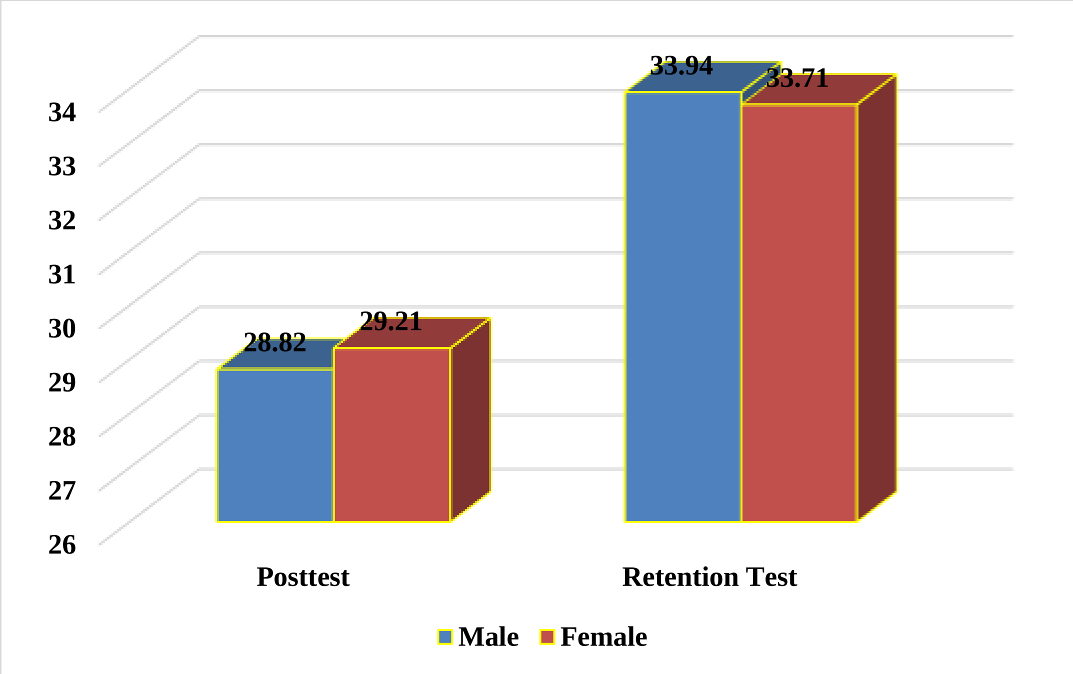


Figure 4.8: Posttest and Retention of Male and Female Students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning.

Research question nine: What is the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. The answer to question nine is explained in Table 4.11.

Table 4.11: Posttest and Retention Mean Scores and Standard Deviation of Male and Female Students Taught Physics using flipped classroom in RT collaborative learning settings

Group	N	Posttest		Retention Test		Mean Loss
		Mean	SD	Mean	SD	
Male	19	30.50	3.76	25.52	3.14	4.98
Female	16	30.87	4.26	25.00	2.98	5.87

Table 4.11 shows the mean and standard deviation of the posttest and retention test scores of students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. The result revealed that the mean and standard deviation of posttest scores of male students is 30.5, standard deviation of 3.76 and retention score 25.52, standard deviation 3.14, while female students at posttest scored 30.87, standard deviation 4.26 and at retention had 25.00, standard deviation 2.98. The mean loss for male students in Reciprocal Teaching collaborative learning settings is 4.98 while the mean loss for female students in Reciprocal Teaching collaborative learning settings 5.87. This implies that that female students in RT loss more mean than those male students in the same group. The graphical representation of the student performances in various groups is illustrated in Fig. 4.9.

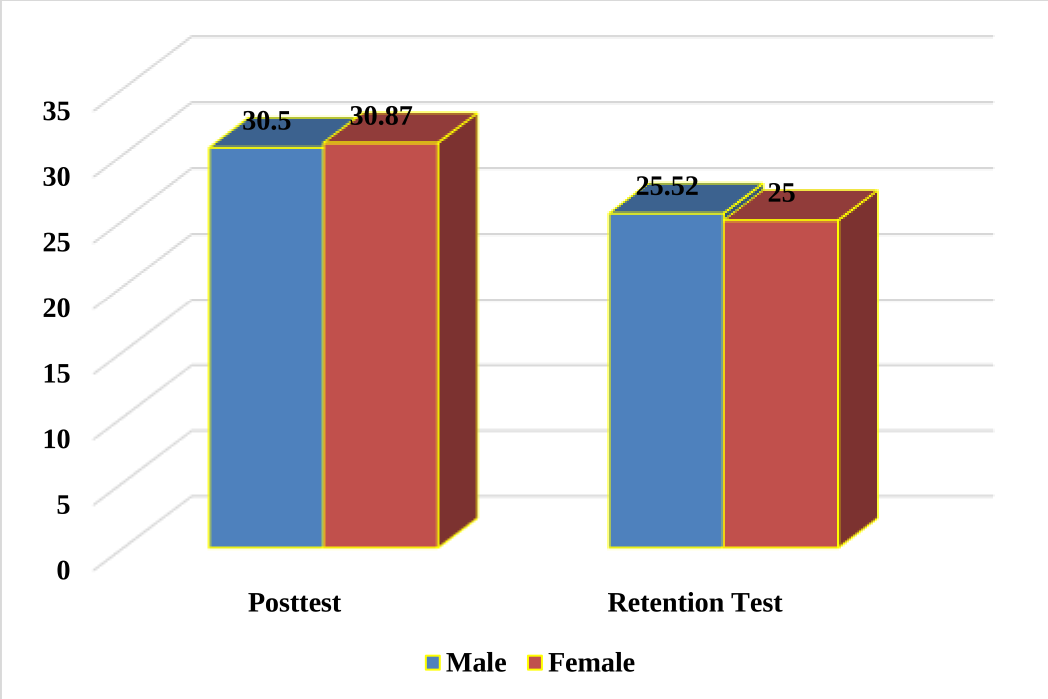


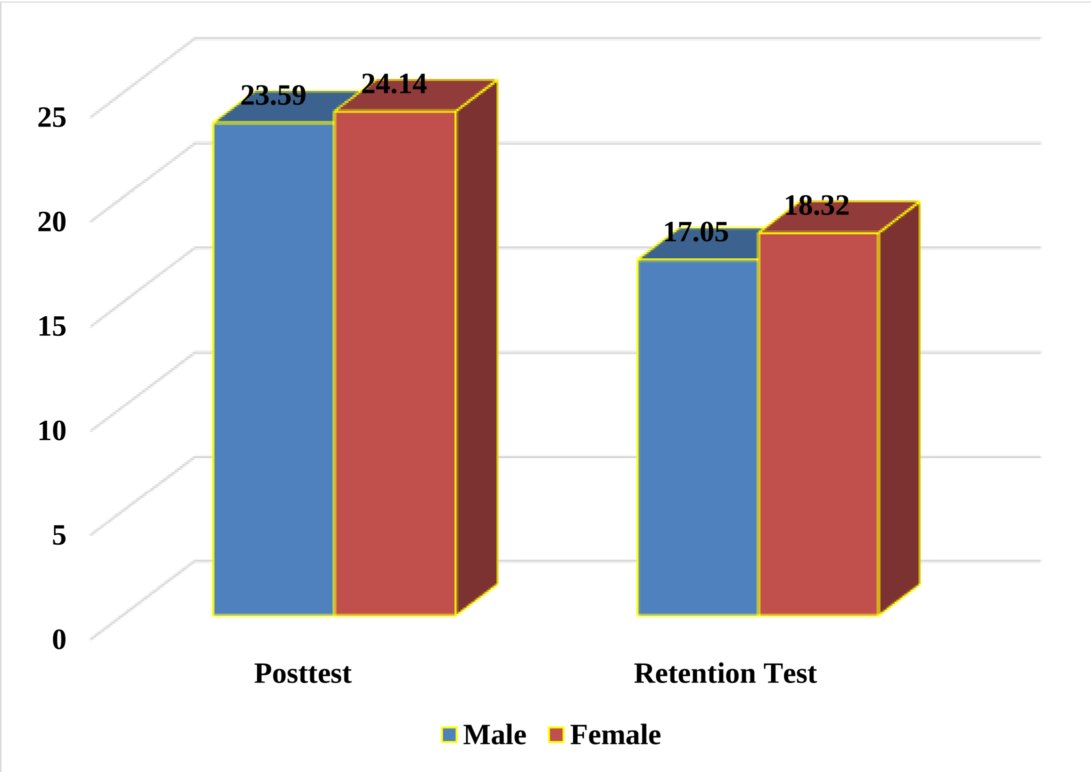
Figure 4.9: Posttest and Retention of Male and Female Students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning.

Research question ten: What is the difference in the mean retention scores of male and female students taught Physics using flipped classroom in Individualized learning settings. Table 4.12 analysed the result of using Posttest and Retention Mean Scores and Standard Deviation of Male and Female Students Taught Physics using flipped classroom in Individualized learning settings.

Table 4.12: Posttest and Retention Mean Scores and Standard Deviation of Male and Female Students Taught Physics using flipped classroom in Individualized learning settings.

Group	N	Posttest		Retention Test		Mean Loss
		Mean	SD	Mean	SD	
Male	19	23.59	4.69	17.05	2.90	6.54
Female	16	24.14	3.66	18.32	4.98	5.82

Table 4.12 shows the mean retention scores of the Individualized learning settings. Although they both benefited from the flipped classroom largely, the female students were the most benefited from these learning methods except in the learning setting. From the result, IL learning setting has 24.14, standard deviation 3.66 and 23.59, standard deviation 4.69 for female and male students respectively. The graphical representation of the student performances in various groups is illustrated in Fig. 4.10.



*TPS: Think Pair Share, RT: Reciprocal Teaching, TAPPS: Think –aloud Paired Problem Solving, IL: Individualized Learning

Figure 4.10: Posttest and Retention of Male and Female Students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning.

Research question eleven: What is the difference in the mean attitude rating of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning (IL) setting?

To answer research question eleven, the attitudes of all the learning settings (collaborative and individualized) were scored and the means were gotten for both settings. The means show the average attitude score of the groups. A mean below 3.0 is termed as disagreed while mean score from 3.0 and above is termed agreed as shown in Table 4.13.

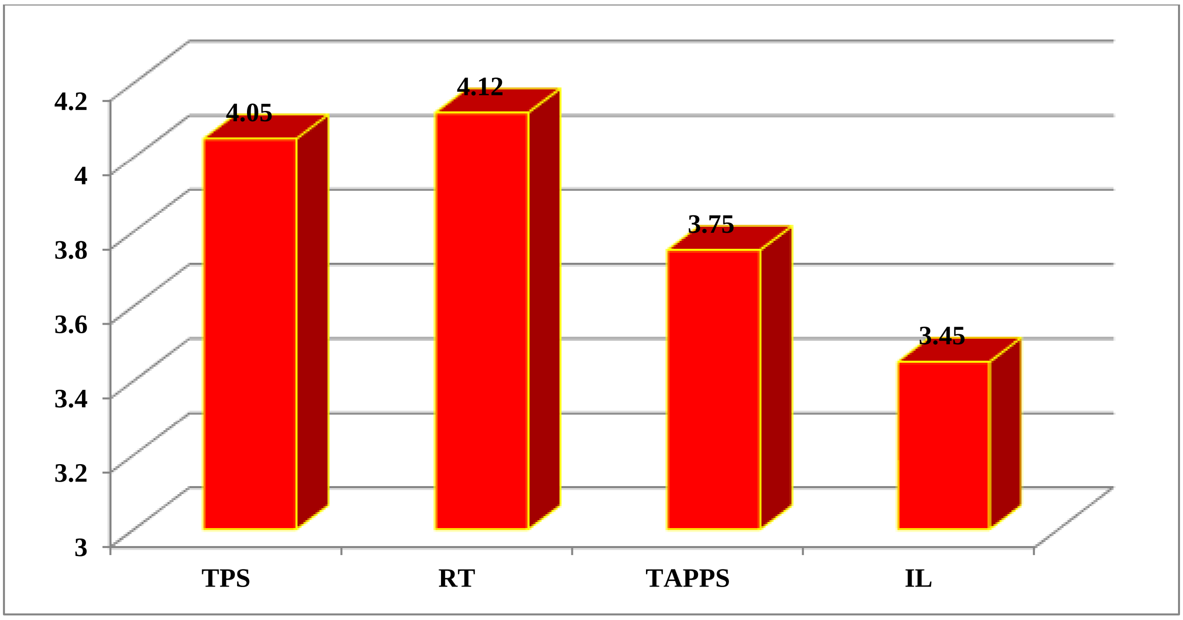
Table 4.13: Mean attitude scores of students taught Physics using flipped classroom in different learning settings.

Treatment	Mean	S.D.	Remarks
TPS	4.05	0.43	Agreed
RT	4.12	0.29	Agreed
TAPPS	3.75	0.57	Agreed
IL	3.45	0.90	Agreed

*TPS: Think Pair Share, RT: Reciprocal Teaching, TAPPS: Think –aloud Paired Problem Solving, IL: Individualized Learning

Table 4.11 is the Mean attitude scores of students taught Physics using flipped classroom in different learning settings. It shows the result of mean attitude rating of students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning (IL) setting. TPS has a mean attitude score of 4.05 (S. D. 0.43), RT also has a mean score of 4.12 (S.D. 0.29), TAPPS recorded a mean attitude score of 3.75 (S.D. 0.57) while IL recorded 3.45 mean score with S. D. of 0.90.

From the remarks, they both cross the boundary of acceptance and both agreed with a mean above 3.0. This is graphically represented in Fig. 4.11.



*TPS: Think Pair Share, RT: Reciprocal Teaching, TAPPS: Think –aloud Paired Problem Solving, IL: Individualized Learning

Figure 4.11: Attitude scores of students taught Physics using flipped classroom in different learning settings.

4.3 Hypotheses Results

Hypotheses one: HO_1: There is no significant difference in the mean achievement scores of students exposed to flipped classroom in Think pair share (TPS) collaborative learning settings, reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and those taught using individualized learning (IL) setting.

In testing the hypothesis one, the achievement scores of students exposed to flipped classroom in TPS, TAPPS, RT and those taught with IL flipped classroom were analyzed using ANCOVA (Table 4.14).

Table 4.14a: ANCOVA Result of Students Achievement Scores of TPS, TAPPS, RT and IL learning Settings

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4250.988[a]	4	1062.747	73.117	.000
Intercept	6923.155	1	6923.155	476.310	.000
Pretest	51.829	1	51.829	3.566	.061
Treatment	4244.418	3	1414.806	97.338	.000
Error	2049.430	141	14.535		
Total	106615.000	146			
Corrected Total	6300.418	145			

Table 4.14a shows the ANCOVA results of the achievement scores of the group taught using the flipped classroom in Think Pair Share (TPS), Think Aloud Pair Problem Solving (TAPPS) and Reciprocal Teaching (RT) collaborative settings (experimental group) and Individualized Learning setting (IL) (Control Group). From the table, the $F (1,141) = 97.338$, $p < 0.05$. This indicates that there is significant difference among the achievement scores of the students in TPS, TAPPS, RT and IL. Hence, hypothesis one is rejected. This reveals that the treatment has effect on the students' academic achievement of the four group. However,

Sidak's post-hoc analysis was done to identify the direction of the difference among the treatment groups as shown in (Table 4.14b).

Table 4.14b: Sidak Post-hoc analysis of Students Achievement Scores of TPS, TAPPS, RT and IL learning Settings

Treatment	Treatment	Mean Difference (I-J)	td. Error	Sig.[a]	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
TPS	RT	-1.722	1.118	.554	-4.706	1.262
	TAPPS	-.536	1.141	.998	-3.581	2.510
	IL	10.939*	1.120	.000	7.950	13.928
RT	TPS	1.722	1.118	.554	-1.262	4.706
	TAPPS	1.186	.877	.692	-1.154	3.526
	IL	12.661*	.830	.000	10.446	14.876
TAPPS	TPS	.536	1.141	.998	-2.510	3.581
	RT	-1.186	.877	.692	-3.526	1.154
	IL	11.475*	.858	.000	9.186	13.764
IL	TPS	-10.939*	1.120	.000	-13.928	-7.950
	RT	-12.661*	.830	.000	-14.876	-10.446
	TAPPS	-11.475*	.858	.000	-13.764	-9.186

*: Significant at $p \leq 0.05$

From the post hoc analysis on posttest mean scores of the groups in Table 4.14a above, the following were deduced; In posttest mean score, statistical difference was established between IL and the rest of the groups. Comparison between TPS and IL show statistically significant difference (mean diff = 10.94, $p < 0.05$) with an upper bound of 13.928. Also, comparison between RT with IL and TAPPS with IL; (mean dif = 12.66 and 1.18 respectively, $p < 0.05$) with upper bounds of 14.88 and 13.76 respectively.

Hypotheses two: HO_2: There is no significant difference in the mean retention scores of students exposed to flipped classroom in collaborative learning settings (Think pair share (TPS), reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and those taught using individualized learning (IL) setting. Table 4.15a shows the ANCOVA results of the retention scores.

Table 4.15a: ANCOVA table of Retention Mean Scores of Physics Students Taught Using TPS, RT, TAPPS and IL

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5444.484[a]	4	1361.121	90.034	.000
Intercept	1852.662	1	1852.662	122.548	.000
Posttest	.006	1	.006	.000	.984
Treatment	3225.483	3	1075.161	71.118	.000
Error	2131.625	141	15.118		
Total	104306.000	146			
Corrected Total	7576.110	145			

***: Significant at $p \leq 0.05$**

Table 4.15a shows the ANCOVA results of the retention scores of the group taught using the flipped classroom in (Think pair share (TPS), reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and those taught using individualized learning (IL) setting. From the table, the $F(1,141) = 71.118$, $p < 0.05$. This indicates that there is significant difference among the achievement scores of the students in TPS, TAPPS, RT and IL. Hence, hypotheses two is rejected. This reveals that the treatment has effect on the students' retention of the four group. However, Sidak's post-hoc analysis was done to identify the direction of the difference among the treatment groups as shown in Table 4.15b.

Table 4.15b: Sidak Post-hoc analysis of Retention Mean Scores of Physics Students Taught Using TPS, RT, TAPPS and IL

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
TPS	RT	5.868*	1.473	.001	1.939	9.798
	TAPPS	-2.651	1.149	.128	-5.718	.416
	IL	-9.819*	1.132	.000	-12.839	-6.799
RT	TPS	-5.868*	1.473	.001	-9.798	-1.939
	TAPPS	-8.519*	1.374	.000	-12.187	-4.851
	IL	-15.688*	1.251	.000	-19.025	-12.350
TAPPS	TPS	9.819*	1.132	.000	6.799	12.839
	RT	15.688*	1.251	.000	12.350	19.025
	IL	7.168*	.843	.000	4.918	9.419
TAPPS	TPS	2.651	1.149	.128	-.416	5.718
	RT	8.519*	1.374	.000	4.851	12.187
	IL	-7.168*	.843	.000	-9.419	-4.918

*: Significant at $p \leq 0.05$

From the post hoc analysis on posttest mean scores of the groups in Table 4.15a, the following were deduced; In retention mean score, statistical difference was established between all the represented groups except between TAPPS and TPS. Comparison between TAPPS with TPS did not show any significant difference (mean diff = 2.65, p > 0.05) with an upper bound of 0.416.

Hypotheses Three: HO_3: There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings. The ANCOVA result was shown in Table 4.16.

Table 4.16: ANCOVA Results of the Mean Achievement Scores of Male and Female Students taught Physics using flipped classroom in Think Pair Share collaborative learning settings.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	104.161[a]	2	52.081	2.468	.123
Intercept	681.548	1	681.548	32.304	.000
Pretest	81.599	1	81.599	3.868	.071
Gender	21.455	1	21.455	1.017	.332
Error	274.276	13	21.098		
Total	13661.000	16			
Corrected Total	378.438	15			

Table 4.16 shows the ANCOVA results of the mean achievement scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings. From the table, there is no significant difference in the mean achievement scores of the male and female students at 0.05 level of significance $F(1,13) = 1.017$, $p > 0.05$. Therefore, the hypothesis three which says "There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings" is hereby accepted.

Hypotheses Four: HO_4: There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings. Table 4.17 analysed the ANCOVA Results of the Mean Achievement Scores.

Table 4.17: ANCOVA Results of the Mean Achievement Scores of Male and Female Students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.201[a]	2	.600	.036	.965
Intercept	2109.143	1	2109.143	126.948	.000
Pretest	.940	1	.940	.057	.813
Pretest	.267	1	.267	.016	.900
Error	664.567	40	16.614		
Total	41064.000	43			
Corrected Total	665.767	42			

Table 4.17 shows the ANCOVA results of the mean achievement scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings. From the table, there is no significant difference in the mean achievement scores of the male and female students at 0.05 level of significance $F(1,40) = .016$, $p > 0.05$. Therefore, the hypothesis which states that "There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings" is hereby accepted.

Hypotheses Five: HO_5: There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. Table 4.18 illustrates the result.

Table 4.18: ANCOVA Results of the Mean Achievement Scores of Male and Female Students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.403[a]	2	1.201	.157	.855
Intercept	3539.031	1	3539.031	462.319	.000
PRE	1.878	1	1.878	.245	.623
GND	.704	1	.704	.092	.763
Error	321.508	42	7.655		
Total	37764.000	45			
Corrected Total	323.911	44			

Table 4.18 shows the ANCOVA results of the mean achievement scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. From the table, there is no significant difference in the mean achievement scores of the male and female students at 0.05 level of significance $F(1,42) = .092$, $p > 0.05$. The results of the analysis indicate that this hypothesis should not be rejected on the basis that the univariate effect of gender was not statistically significant on the posttest mean score of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. On this basis, hypothesis five is therefore accepted. This implies that male and female students performed relatively equally well when Flipped Classroom Instruction was used in RT collaborative setting.

Hypotheses Four: HO_6: There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Individualized learning settings. The results were analysed below in Table 4.19

Table 4.19: ANCOVA Results of the Mean Achievement Scores of Male and Female Students taught Physics using flipped classroom in Individualized learning settings.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	60.392[a]	3	20.131	1.137	.346
Intercept	788.269	1	788.269	44.525	.000
Pretest	36.752	1	36.752	2.076	.158
Gender	20.847	2	10.423	.589	.560
Error	672.751	38	17.704		
Total	14126.000	42			
Corrected Total	733.143	41			

Table 4.19 shows the ANCOVA results of the mean achievement scores of male and female students taught Physics using flipped classroom in Individualized learning settings.. From the table, there is no significant difference in the mean achievement scores of the male and female students at 0.05 level of significance $F (1,38) = .589$, $p > 0.05$. Therefore, the hypothesis which says “There is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Individualized learning settings” is accepted.

Hypothesis Seven: HO_7: There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings. The Analysis of Covariance of retention score of Students taught using flipped in Think Pair Share collaborative learning settings is presented in Table 4.20.

Table 4.20: Analysis of Covariance of retention score of Students taught using flipped in Think Pair Share collaborative learning settings.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	30.969[a]	2	15.485	2.492	.121
Intercept	259.276	1	259.276	41.725	.000
Posttest	.719	1	.719	.116	.739
Gender	26.280	1	26.280	4.229	.060
Error	80.781	13	6.214		
Total	9042.000	16			
Corrected Total	111.750	15			

Table 4.20 shows the ANCOVA table for retention score of TPS group with respect to gender. The result from the table shows that there is no significant difference in the mean retention score $F (1, 13) = 4.229$, $p = 0.060$ ($p > 0.05$) between the genders, whilst adjusting for posttest. The result shows that there is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings. Therefore, hypothesis four is accepted.

Hypothesis Eight: HO_8: There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings. Table 4.21 shows the analysis of Hypothesis eight.

Table 4.21: Analysis of Covariance of retention score of Students taught using flipped in Think Aloud Pair Problem Solving collaborative learning settings.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	47.000[a]	3	15.667	.929	.436
Intercept	370.135	1	370.135	21.938	.000
Posttest	.081	1	.081	.005	.945
Gender	46.306	2	23.153	1.372	.266
Error	641.119	38	16.872		
Total	13903.000	42			
Corrected Total	688.119	41			

Table 4.21 shows the ANCOVA results of the mean retention scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings collaborative setting. From the table, there is no significant difference in the mean retention scores of the male and female students at 0.05 level of significance $F (1,38) = 1.372$, $p > 0.05$. Therefore, the hypothesis which states "There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings" is hereby accepted.

Hypothesis Nine: HO_9: There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. Table 4.22 shows the ANCOVA results of Hypothesis nine.

Table 4.22: Analysis of Covariance of retention score of Students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	161.234[a]	2	80.617	5.259	.009
Intercept	69.497	1	69.497	4.533	.039
Posttest	157.307	1	157.307	10.261	.003
Gender	6.173	1	6.173	.403	.529
Error	643.877	42	15.330		
Total	51139.000	45			
Corrected Total	805.111	44			

Table 4.22 shows the ANCOVA results of the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. From the table, there is no significant difference in the mean retention scores of the male and female students at 0.05 level of significance $F(1,42) = 0.403$, $p > 0.05$. The results of the analysis indicate that this hypothesis should not be rejected on the basis that the univariate effect of gender was not statistically significant on the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings. Therefore, hypothesis which says "There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching collaborative learning settings" is accepted.

Hypothesis Ten: HO_{10}: There is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Individualized learning settings. This Hypothesis is analysed in Table 4.23.

Table 4.23: Analysis of Covariance of retention score of Students taught using flipped in Individualized learning settings.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	51.597[a]	2	25.798	2.172	.127
Intercept	776.333	1	776.333	65.368	.000
Post	35.528	1	35.528	2.991	.091
Gender	15.131	1	15.131	1.274	.266
Error	475.054	40	11.876		
Total	30222.000	43			
Corrected Total	526.651	42			

Table 4.23 is the ANOVA comparison of mean retention scores of Male and Female Students taught Physics using flipped Classroom in Individualized learning settings. The result revealed that there is no significant difference based on gender in the mean attitude of student taught using flipped in Individualized learning setting (IL), with $F(1, 40) = 1.274$ and p-Value of 0.266 ($p > 0.05$). Based on the result in the table above, the hypothesis which says "There is no significant difference in the mean retention score of male and female students taught Physics using flipped classroom in individualized learning (IL) setting" is accepted.

Hypotheses eleven: HO_{11}: There is no significant difference in the mean attitude rating of students exposed to flipped classroom in collaborative learning settings (reciprocal teaching (RT), think - aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning setting. Table 4.24a analysed Hypothesis eleven.

Table 4.24a: ANOVA comparison of mean attitude of student exposed to flipped classroom in the different collaborative learning settings (TPS, RT, TAPPS and IL).

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	11.042	3	3.681	3.477	.018
Within Groups	150.328	142	1.059		
Total	161.370	145			

***: Significant at $p \leq 0.05$**

Table 4.24a is the ANOVA comparison of mean attitude of student exposed to flipped classroom in the different collaborative learning settings (TPS, RT, TAPPS and IL). shows the result of the analysis (ANOVA) showing the significant difference for the comparison of mean attitude of student exposed to flipped classroom in the different collaborative learning settings (TPS, RT, TAPPS and IL) with $F (3, 142) = 3.477$ and $p = 0.018$ ($p < 0.05$). The result revealed that there is significant difference in the mean attitude of student taught using flipped in collaborative learning setting (TPS, RT, TAPPS) and those in individualized learning setting (IL),. Based on the above result, the hypothesis is rejected.

Table 4.24b presents Sidak Post-hoc analysis of mean attitude of student exposed to flipped classroom in the different collaborative learning settings (TPS, RT, TAPPS and IL).

Table 4.24b: Sidak Post-hoc analysis of mean attitude of student exposed to flipped classroom in the different collaborative learning settings (TPS, RT, TAPPS and IL)

Learning Settings	Learning Settings	Mean Difference	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
TPS	RT	0.28571	0.92	-0.52	1.09
	TAPPS	0.48889	0.49	-0.31	1.29
	IL	-0.18605	0.99	-0.99	0.62
RT	TPS	-0.28571	0.92	-1.09	0.52
	TAPPS	0.20317	0.93	-0.39	0.79
	IL	-0.47176	0.20	-1.07	0.12
TAPPS	TPS	-0.48889	0.49	-1.29	0.31
	RT	-0.20317	0.93	-0.79	0.39
	IL	-.67494*	0.02	-1.26	-0.09
IL	TPS	0.18605	0.99	-0.62	0.99
	RT	0.47176	0.20	-0.12	1.07
	TAPPS	.67494*	0.02	0.09	1.26

*: Significant at $p \leq 0.05$

From the post hoc analysis on posttest mean attitude scores of the groups in Table 4.11a, the following were deduced; In posttest mean attitude score, statistical difference was established between IL and TAPPS. Comparison between IL and TAPPS show statistically significant difference (mean diff = 0.68, $p < 0.05$) with an upper bound of 1.26. Also, comparisons within the other groups show no statistically significant difference ($p > 0.05$).

4.3 Summary of the Findings

1. The study revealed that the flipped classroom collaborative learning settings (TSP, RT, TAPPS and IL) had significant effect on the students' achievement in the posttest scores of students in the different learning settings. There is also significant difference within the groups (TPS, RT, TAPPS and IL) that is those who were taught using TPS, RT, TAPPS and those who were taught using IL.
2. The study also revealed that the flipped classroom collaborative learning settings (TSP, RT, TAPPS and IL) had significant effect on the students' retention in the retention scores of students in the different learning settings. It is also noted that there is significant difference within the groups (TPS, RT, TAPPS and IL) that is those who were taught using TPS, RT, TAPPS and those who were taught using IL.
3. The study further shows that there is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings.
4. Likewise, the study shows that there is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving collaborative learning settings.
5. Also the study shows that there is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching (RT) collaborative learning settings.
6. The study also shows that there is no significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in Individualized Learning (IL) settings.

7. The study also shows that there is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Pair Share collaborative learning settings.
8. The study also shows that there is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Think Aloud Pair Problem Solving (TAPPS) collaborative learning settings.
9. The study also shows that there is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in Reciprocal Teaching (RT) learning setting.
10. The study also revealed that there is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in individualized learning (IL) setting.
11. Likewise the study revealed that there is significant difference in the mean attitude of student taught using flipped in collaborative learning setting (TPS, RT and TAPPS) and those in individualized learning setting (IL).

4.4 Discussion of the Findings

The study revealed that the flipped classroom collaborative learning settings (TSP, RT, TAPPS and IL) had significant effect on the students' achievement in the posttest scores of students in the different learning settings. There is also significant difference within the groups that is those who were taught using TPS, RT, TAPPS and those who were taught using IL. These findings are in agreement with the findings of Hetika *et al.,* (2018) who recorded that the application of collaborative learning strategy method can improve the Learning Motivation and Achievement. The result is also in line with the findings of Sumekto (2018) who stated that collaborative learning strategy stimulates students' participation and performance in reading, it also increase the functional communication, discussion, decision taking, and conflict reduction in groups learning. The result of this research disagreed with the findings of James (2015) who reported that there was no difference between the educational performances of the two groups used on either computational or conceptual tasks as indicated by their exam scores.

The study also shows that there is no statistical significant difference in the mean achievement scores of male and female students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning (IL) setting although there are little visible differences. The result is in agreement with the findings of Adolphus and Omeodu (2016) which shows that gender does not significantly affect the understanding of students when taught with collaborative teaching approach. The study also showed that gender and teaching approaches do not jointly affect students' conceptual understanding at the secondary school level. The study also agreed with the findings of (Ogunyebi, 2013), which revealed that there was a significant difference between the posttest means scores of students exposed to collaborative and conventional strategies. It was also revealed in the study that there was no significant difference between the posttest means scores of male and female students exposed to think-pair (collaborative learning strategy) and conventional strategies.

This contradicts the study of Cen *et al.*, (2014) which revealed that learning engagement and performance comparisons indicate that female groups tend to work simultaneously and achieve better results while male group members engage less and work in sequence. The study also disagree with the work of Lim (2016) which showed that there was a significant difference in the performances of male and female students where all-female groups obtained the highest mean score.

The study also shows that there is no significant difference in the mean retention scores of male and female students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning (IL) setting. This is in line with the study of Sulisworo (2012) which stated that gender did not give significant effect to student learning motivation. The study also agreed with the study of (Ghorbani *et al.*, 2013) that states that students will get motivated to read more if they realize the importance of reading in improving their writing performance.

Likewise the study revealed that there is no significant difference in the mean attitude of student taught using flipped in collaborative learning setting (TPS, RT, TAPPS) and those in individualized learning setting (IL). The study is in agreement with the study of (Peng and Wang, 2015) which indicated that most students made prominent improvement in their English reading ability, word recognition, and reading comprehension. In addition, most participants had positive attitude toward reciprocal (collaborative learning strategy) teaching, and they liked reciprocal teaching to be incorporated into English classes.

The study revealed that there is no significant difference in the mean attitude rating of male and female students taught Physics using flipped classroom in collaborative learning settings (reciprocal teaching (RT), think –aloud paired problem solving (TAPPS) and think pair share (TPS)) and those taught using individualized learning (IL) setting. This is in agreement with the study of (Özlem, 2004) where gender was found to have no significant influence on students' attitudes towards English reading courses and cooperative learning. In addition, both the teacher and the students reported positive attitude towards cooperative learning.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In the course of this study, three collaborative learning strategies and individualized learning were combined into the flipped classroom method of teaching. The result from the study revealed that the flipped classroom collaborative learning settings had significant effect on the students' achievement in the posttest scores of students in the different learning settings. There is also significant difference within the groups.

The study also revealed that the flipped classroom collaborative learning settings had significant effect on the students' retention in the retention scores of students in the different learning settings. It is also discovered that there is significant difference within the groups that is those who were taught using TPS, RT, TAPPS and those who were taught using IL. This shows that learning collaboratively has shown to improve the achievement and retention of students in Physics as a subject in senior secondary schools. It also shows that flipped classroom increases student's involvement in learning irrespective of the learning set-up (collaborative or individualized).

It is also gathered that gender as a factor did not play any major role in the achievement or attitude of students taught using flipped classroom when compared across and within different learning settings. The study likewise revealed that there is significant difference in the mean attitude of student taught using flipped in collaborative learning setting and those in individualized learning setting.

The study further shows that achievement and retention level of students can be influenced by the mode of teaching and adopted learning strategies. Although the selected factors are researched for their efficacy, there are other factors that may still be accountable for students' achievement and attitude towards Physics.

5.2 Recommendations

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

1. Flipped classroom collaborative learning strategies as one of the innovative teaching methods should be used to reinforce classroom instructions in the teaching of Physics in senior secondary schools in Nigeria so as to assist students learn at their own pace, time and anywhere that is convenient for them.
2. Educational policy makers should conduct seminars and workshops on blended learning for teachers on the use of modern innovative methods of teaching and learning.
3. The ministry of education should discourage the ancient, obsolete teachers-centered approach of teaching and learning in secondary schools in favour of blended learning like the flipped classroom collaborative learning for better learning and achievement.
4. The use of flipped classroom is not gender biased, its implementation should be encouraged in all learning environment especially in subjects that have gender disputes.
5. Blended learning strategies (like the flipped classroom collaborative learning strategies) should be incorporated into the school curriculum plan processes.

5.3 Contribution to Knowledge

The study has contributed to the grounds of knowledge in the following ways:

1. The use of the three collaborative learning strategies and individualized learning (the reciprocal teaching (RT), think –aloud paired problem solving (TAPPS), think pair share (TPS) and individualized learning (IL) strategies) which were combined into the flipped classroom method of teaching to teach Physics at secondary school level and its efficacy on student's achievements, retention and attitude with respect to gender; Instead of just flipping the class normally, the collaborative strategies of teaching were incorporated.
2. The study explained how the integration of flipped classroom collaborative learning strategies (the reciprocal teaching (RT), think –aloud paired problem solving (TAPPS), think pair share (TPS) and individualized learning (IL) strategies) can be carried out at secondary school level.
3. The design, validation and administration of Flipped classroom Instructional Package (FIP) for teaching is an addition to the existing materials on flipped classroom.
4. The FIP can serve as a template and guide for teachers, instructors, curriculum planners and educational facilitators.
5. The study established that achievement and retention level of students can be influenced by the mode of teaching and adopted learning strategies and that flipped classroom increases student's involvement in learning irrespective of the learning set-up (collaborative or individualized). These have contributed to the existing literature on different types of flipped classroom collaborative strategies.

5.4 Research Limitations

The study is not without its limitations. The study looks into the effects of three modes of flipped classroom collaborative strategies on learning outcomes of secondary school students with special emphasis on senior secondary school students using physics and light waves as the subject matter. The study was particular on SSS II Physics students and did not consider other classes of students and other subjects. Using SSS I, II and III would have yielded broader results to get more extensive conclusion.

The research included gender as one of the variables under study; thereby one of the major limitations is that in some schools where facilities are available, there is non-availability of co-educational system. Also, since the concept of flipped classroom collaborative strategies is not yet very popular, the study should have been stretched over a period of full academic session for more effective findings, but due to the little or no awareness of the school authorities on flipped classroom learning, the permission for such a long period were not possible.

5.5 Suggestion for Further Studies

For the sake of further related studies, the following suggestions are made.

1. Research should be carried out on “effects of three modes of flipped classroom collaborative strategies on other subjects in secondary schools in Nigeria”.
2. Further studies should be carried out on intact classes for a selected academic period (sessional basis) so as to give time to accurately measure any source of variation.
3. Research should be carried out to enlarge the Geographical, variable, instrument, time and sample scope of the present work.

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APPENDIX A

PHYSICS ACHIEVEMENT TEST (PAT)

1. A material through which light can pass easily is said to be?

a) Translucent b) Luminous c) Non luminous d) Transparent

e) Opaque

2. Which of the following materials is not opaque?

a) Brick b) Metal block c) Frosted glass d) Wall e) Wood

3. An image which can be formed on a screen is said to be?

a) Blurred b) Erect c) Inverted d) Real e) Virtual

4. A shadow is formed by the?

a) Obstruction of light by a transparent object

b) Obstruction of light by a translucent object

c) Obstruction of light by an opaque object

d) Reflection of light from a shining surface

e) Refraction of light in a glass block

5. The point at which parallel rays of light incidents on a concave mirror is converge after reflection is called?

a) Aperture b) Centre of curvature c) Radius of curvature

d) Principal focus e) pole

6. Light causes a sensation of vision that enables us to?

a) Talk b) Read c) See d) Work e) Walk

7. The light sensitive part of a human eye is

a) Blind spot b) Retina c) Iris d) Pupil e) Cochlea

8. The bending of light rays as they pass from one medium to another is called?

a) Interference b) Polarization c) Reflection d) Refraction e) Diffraction

9. An image in which no light rays pass through is said to be

a) Real b) Virtual c) Blurred d) Erect e) Inverted

10. The three colours of light which formed white light are

a) Red, Orange & Yellow b) Red, Yellow & Blue c) Red, Yellow & Green d) Red, Green & Blue e) Red, Blue & Violet

11. The part of the eye that which regulates the amount of light entering it is?

a) Cornea b) Ciliary muscles c) Iris d) Pupils e) Retina

12. Rectilinear propagation of light explains the idea that light

a) Travel in a random pattern b) Travels in a straight line.

c) Is reflected from a shining surface. d) Can be refracted.

e) Is a form of wave

13. The height of the image produced from an object placed before a pin hole camera is two times the object height. If the object is placed at a distance of 7.5cm from the pinhole, calculate the length of the pinhole camera.

a) 30.00 cm b) 15.0 cm c) 7.5 cm d) 3.75 cm e) 1.88 cm

14. An object of height 5cm is placed at a distance of 40cm from a pinhole camera. If the length of the camera is 20cm, calculate the image height.

a) 2.0cm b) 2.5cm c) 5.0cm d) 1.5cm e) 10.0cm

15. Calculate the number of images formed by two mirror indirect at angle 80^0 to each other.

a) 2 b) 3 c) 4 d) 5 e) 6

16. The image formed by a plane mirror is

a) Magnified and real b) Upright and real c) Laterally inverted and virtual

d) Inverted and virtual e) Real and diminished

17. An object is placed between the principal focus (F) and centre of curvature (C) of a concave mirror. The image formed will be located

a) Beyond C b) Between F and C c) Between F and the pole

d) At C e) At F

18. An object is located at the focal point for a convex mirror. The image produced will be

a) Inverted and real b) Upright and real c) Inverted and virtual

d) Upright and virtual e) Magnified and virtual

19. The image produced by a concave mirror is at infinity when the object is placed.

a) At the principal focus b) At the center of curvature

c) Between the pole and the principal focus

d) Between the principal focus and the center of curvature

e) Beyond the center of curvature

20. An object is placed 40cm from a convex mirror of focal length 60cm, determine the image distance.

a) 20 cm b) 24 cm c) 40 cm d) 120 cm e) 60 cm

21. Which of the following material is the best reflector of light?

a) wooden table b) ceramic cup c) mirror d) Stone e) Black cloth

22. Light rays bounce off a smooth, shiny surface, this phenomenon is known as?

a) Refraction b) Reflection c) Transmission d) Diffraction e) Interference

23. The center of a curved mirror is known as?

a) Pole b) Focal point c) Centre of curvature

d) Principal axis e) Radius of curvature

24. Which of the statement explains why a pencil bend when placed in a cup of water

a) Light is refracted as it moves from air to water

b) Light is reflected as it moves form air to water.

c) Light is absorbed as it moves from air to water.

d) Light is destroyed as it moves from air to water

25. Which of the following types of mirror is used in simple periscope?

a) Convex Mirror b) Concave Mirror c) Plane Mirror

d) Plano concave Mirror e) Plano convex Mirror

26. Light ray dispersed when it passes through

a) Rectangular glass block b) Semi-circular glass block c) Lens

d) Convex lens e) Glass prism

27. The focal length of a converging lens is 15 cm. If an object is placed 45 cm away from the lens, the image will be

a) Smaller and real b) Larger and real c) The same size and real

d) Smaller and virtual e) Larger and virtual

28. The focal length of a diverging lens is 12 cm. If an object is placed 5.0 cm away from the lens, the image will be

a) Smaller and real b) Larger and real c) The same size and real

d) Smaller and virtual e) Larger and virtual

29. Calculate the refractive index of refraction for an object in which light travels at 1.97 x 10^8m/s. (Speed of light in air = 3.0×10^8 m/s)

a) 0.52 b) 0.66 c) 1.52 d) 1.03 e) 1.95

30. A light ray incident on a plane surface at angle 34^0 to the normal. Calculate the angle between the reflected ray and the reflecting surface.

a) 34^o b) 56^o c) 66^o d) 72^o e) 146^o

31. A man is located 1.8 m from a plane mirror. How far is the man from his image?

a) 0.9 m   b) 1.8 m   c) 2.7 m   d) 3.6 m   e) 4.5 m

32. What causes a blue block to appear blue in the sunlight?

a) The block absorbs all blue light.   b) The block bends (refracts) all blue light.

c) Only blue light is reflected by the block.

d) Only blue light passes through the block.   e) Only blue is present in sunlight.

33. Convex mirrors are used as.

a) Car headlamp   b) Shaving mirror   c) Driving mirror   d) Looking glass   e) Dressing mirror

34. The critical angle of zircon is 31°. Which of the following incident angles would result in total internal reflection?

a. 17°   b) 34°   c) 42°   d) A and C   e) B and C

35. A light ray incident on a glass surface at angle 40^o to the normal. Calculate the angle refraction in the glass, if the refractive index of glass is 1.5

a. 60.0^o b) 30.0^o c) 26.6^o d) 25.4^o e) 20.0^o

36. Light travels from medium X into medium Y. If Medium Y has a higher index of refraction. In Y, (i) The light travels faster in X. (ii) The light will bend towards the normal. (iii) The light will be reflected. From Y, which of the above statement is/are correct?

a. I only   b) II only   c) III only   d) I & II only   e) I, II & III

37. A pencil looks broken when placed in a cup of water because?

a) Light is refracted as it moves from air to water

b) Light is reflected as it moves form air to water.

c) Light is absorbed as it moves from air to water.

d) Light is destroyed as it moves from air to water.

e) Water is denser than air

38. Concave lenses are thinner in the middle and thicker at the edges so they cause light rays to

a) Converge b) Diverge c) Reflect d) Refract e) Diffract

39. White light can be separated into ____ colours?

a) 3 b) 4 c) 5 d) 6 e) 7

40. Monochromatic light is a light of

a) One wavelength b) Two wavelength c) Three wave length

d) Four wave length e) Five wavelength

41. Which of the following lists of colour can be combined to produce white light?

a) Red, Yellow, Green b) Blue, Green, Red c) Yellow, Red, Green

d) Blue, Green, Yellow e) Blue, Green, Orange

42. Which of these properties of light is responsible for the formation of rainbows?

a) Reflection b) Refraction c) Diffraction d) Interference e) Polarization

43. The center of curvature of a lens is 10cm, calculate the focal length of the lens.

a) 20.0 cm b) 10.0 cm c) 5.0 cm d) 2.5 cm e) 2.0 cm

44. Yellow colour is a combination of?

a) Red and Blue colours b) Blue and Green colours c) Orange and white colour

d) Blue and White colour e) Red and Green colour

45. Sometimes rays of light approaching curved mirrors do not all meet at the focal point. This is due to a phenomenon known as

a) Refraction b) Chromatic aberration c) Spherical aberration

d) Dispersion e) Diffraction

46. Calculate the magnifying power of a converging lens of focal length 5 cm.

a) 5 Diopter b) 4 Diopter c) 3 Diopter d) 2 Diopter e) 1 Diopter

47. Light that travels into the eye passes through several parts to get to the retina. The correct order is

a) Cornea, vitreous humour, lens, pupil b) Lens, cornea, pupil, vitreous humour

c) Cornea, lens, pupil, vitreous humour d) Pupil, cornea, lens, vitreous humour

e) Cornea, pupil, lens, vitreous humour

48. The inability of the eyes to focus in different planes is known as.

a) Hyperopia b) Presbyopia c) Astigmatism d) Myopia e) Glaucoma

49. The eye defect in which a person can see far object but cannot see near object clearly is called.

a) Hypermetropia b) Presbyopia c) Astigmatism d) Myopia e) Glaucoma

50. A convex lens produced four times magnified and upright image of the object placed in front of it. If the image height is 16cm, calculate the object height.

a) 64 cm b) 32 cm c) 16 cm d) 8 cm e) 4 cm

APPENDIX B

Answer to Physics Achievement Test (PAT)

ANSWERS TO THE PHYSICS ACHIEVEMENT TEST QUESTIONS

1. D
2. C
3. D
4. C
5. D
6. C
7. B
8. D
9. B
10. D
11. D
12. B
13. B
14. B
15. D
16. C
17. A
18. D
19. A
20. B
21. C
22. B
23. C
24. A
25. C
26. D
27. A
28. E
29. C
30. B
31. D
32. C
33. C
34. E
35. D
36. D
37. A
38. B
39. E
40. A
41. B
42. C
43. C
44. E
45. C
46. D
47. E
48. C
49. A
50. E

APPENDIX C

MONITORING OF THE GROUPS

QUESTIONNAIRE ON COLLABORATIVE LEARNING STRATEGIES

S/N	ITEMS	Strongly Agree (4)	Agree (3)	Disagree (2)	Strongly Disagree (1)
1	I do share my work with my teammates with pleasure and delight				
2	I always express myself in my group because my opinions do count				
3	If I find any problem or difficulty during learning, I turn to my teammates for help immediately				
4	When my teammates are discussing, I always encourage them with my big smile and attentive eyes				
5	I help my teammates when they need me				
6	I write “thank-you” note to one of my teammates after each class				
7	I show my appreciation in words and in deeds to anyone who helps me during class discussion				
8	I develop more confidence in presenting my points before my teammates				
9	I respect the individual differences among my teammates				
10	I enjoy every minute of our Physics class by smiling happily all the time				
11	I always late to turn in my homework				
12	I don’t laugh at my teammates when they make mistakes				
13	I often sleep in the class especially when the lesson is not interesting				
14	I do not chat with teammates during group discussion				
15	I always shout at my teammates when I am talking to them				
16	I do not take things from my teammates’ desk without permission				
17	I enjoy kick others’ feet under the table during the group discussion				
18	I always eat or chewing gum when during Physics class				
19	I do not stay up late the night before Physics class				
20	I always swing my chair while seated during Physics class				
21	Whenever I am preparing for my Physics groups work, I make up				

	questions to ask other group members				
22	When I do not understand ideas contributed by other team members, I often ask for clarification.				
23	When there is disagreement among team members of our Physics group, I fuel the crisis and scatter the group				
24	All members of our Physics group participated in the group discussions				
25	I often feel displeased when the quiet captain caution us to maintain silence				
26	In our Physics group discussion, teammates often remind each other of the time remaining to complete the group task.				
27	When working with my teammates, I often try to explain the task to other group members.				
28	I often try to work with our group members to complete our learning task.				
29	I often help our members who have difficulties in understanding our Physics task.				
30	I ask other members of our Physics group to clarify concepts I don't understand well during our task.				
31	When I can't understand the task, I ask other members of our group for help				
32	I don't allow any of my teammates to dominate us.				

APPENDIX D

Validation by Three (3) Educational Technologists From FUT Minna

EDUCATIONAL TECHNOLOGY SPECIALIST VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for teaching Physic at Senior Secondary School in Niger State, Nigeria. The validation of this Physics Contents is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, Comment on the following:

1. Suitability of the package for instruction: The package is suitable for instruction
2. Clarity and simplicity of the package: The package is clear and simple for instruction
3. Unity among illustrations: Unity among illustration is in order
4. Emphasis on key concepts: The key concepts are emphasised
5. The use of colours (e.g. background colour): The use of coloured in background was satisfactory.
6. The legibility of the texts: The texts is legible
7. Other errors (such as audibility, distraction, etc): If the instrument is projected and external speakers used it will minimise any error

Suggestions for improving on the package:

1. The package can be giving to other experts to view.
2. There should be external speakers to
3. improve the presentation

Name of the Specialist: Dr. C.S. Tukura Area of Specialization: Edu. Tech.

Rank: Senior lecturer Institution/Establishment: F U T Minna

Signature: [signature] Date: 26/9/2018

Thank you for validating the instrument

EDUCATIONAL TECHNOLOGY SPECIALIST VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for teaching Physic at Senior Secondary School in Niger State, Nigeria. The validation of this Physics Contents is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, Comment on the following:

1. Suitability of the package for instruction: The package is suitable for instruction at the level intended.
2. Clarity and simplicity of the package: The instruction is clear and simple for the audience.
3. Unity among illustrations: The illustrations are good once as it reflect the instructions used.
4. Emphasis on key concepts: Good emphasis were done on all key concepts explained.
5. The use of colours (e.g. background colour): Beautiful background shown mostly in the content.
6. The legibility of the texts: The texts used are all legible
7. Other errors (such as audibility, distraction, etc): All errors detected were highlighted and shown.

Suggestions for improving on the package:

1. Okay.
2. ...
3. ...

Name of the Specialist: Dr AKANBI .T. O Area of Specialization: Educational Technology

Rank: Ass Professor Institution/Establishment: FUT Minna

Signature: [signature] Date: 12/10/18

Thank you for validating the instrument

EDUCATIONAL TECHNOLOGY SPECIALIST VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for teaching Physic at Senior Secondary School in Niger State, Nigeria. The validation of this Physics Contents is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, Comment on the following:

1. Suitability of the package for instruction: The package is well designed and developed thus making it suitable for instruction
2. Clarity and simplicity of the package: The package is clear, vivid and in simple terms.
3. Unity among illustrations: There is adequate unity interms of illustrations
4. Emphasis on key concepts: Very sound and explicit
5. The use of colours (e.g. background colour): In harmony with the illustrations and contrast
6. The legibility of the texts: Legible and in harmony with the background
7. Other errors (such as audibility, distraction, etc): Very minimal

Suggestions for improving on the package:

1. The package should be administered in an appropriate
2. environmental conditions (classroom environment) for
3. adequate exposure.

Name of the Specialist: DR. I. I. Kuta Area of Specialization: Edutech

Rank: LI Institution/Establishment: FUT, Minna

Signature: [signature] Date: 2nd 10, 2018

Thank you for validating the instrument

APPENDIX E

Validation by Three (3) Computer Programmers from FUT Minna

COMPUTER PROGRAMMER VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for teaching Physic at Senior Secondary School in Niger State, Nigeria. The validation of this Physics Contents is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of program language used: The programming language is appropriate.
2. Typography of the package: few typos, but can be improved
3. Legibility of the package: It is legible.
4. The navigation: It can be improved, such as showing progress line ~~to~~ Relabelling of lessons.
5. The interface: It is good, but it can be improved. Differentiate between video lessons & that of the note.
6. The animation in the package: The sun light and the light through the window or door should be shown
7. Functionality of the package: The functions are appropriate.
8. The storage capacity and durability: The storage capacity is not android friendly.

Suggestions for improving on the package:

1. There should be introduction of video & lesson note.
2. Attention attracting colour should be used.
3. After each lesson, let it show End of the lesson.

Name of the Specialist: Dr. M. B. Abdullahi Area of Specialization: Computer science

Rank: Snr lecturer Institution/Establishment: FUT Minna

Signature: .... Date: November 5, 2018.

Thank you for validating the instrument

COMPUTER PROGRAMMER VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for teaching Physic at Senior Secondary School in Niger State, Nigeria. The validation of this Physics Contents is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of program language used: Program is appropriate
2. Typography of the package: Satisfactory
3. Legibility of the package: The package is legible and flexible but can be made better by making the program executable
4. The navigation: The navigation is user-friendly but when made executable it will be better.
5. The interface: the interface is also eye-friendly and satisfactory
6. The animation in the package: The animations - are video driven and well arranged.
7. Functionality of the package: Satisfactory
8. The storage capacity and durability: A total of 650MB was used by the program is OK for a package of this magnitude.

Suggestions for improving on the package:

1. Make the program executable at the end of the development
2. ...
3. ...

Name of the Specialist: Dr. Shafii M. Abdulhamid Area of Specialization: Computing

Rank: Senior Lecturer Institution/Establishment: F. U. T. Minna/SICT

Signature: [signature] Date: 24/09/2018

Thank you for validating the instrument

COMPUTER PROGRAMMER VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for teaching Physic at Senior Secondary School in Niger State, Nigeria. The validation of this Physics Contents is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of program language used: very approriate
2. Typography of the package: very good
3. Legibility of the package: it is legible
4. The navigation: very okay
5. The interface: very good and user friendly
6. The animation in the package: very good
7. Functionality of the package: very good
8. The storage capacity and durability: good.

Suggestions for improving on the package:

1. Text in the yellow colour should be change
2.
3.

Name of the Specialist: Dr. J. K. Alhassan Area of Specialization: Computer Scien.

Rank: Asso. Prof. Institution/Establishment: F.U.T, Minna

Signature: [signature] Date: 24/9/2018

Thank you for validating the instrument

APPENDIX F

Validation by Three (3) Physics Lecturers from FUT Minna

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics: Very appropriate for Classroom instruction for Physics at Senior Secondary Schools
2. Clarity and simplicity of the Physics content: The Clarity and Simplicity of the Physics Content is Satisfactory
3. Suitability for Senior Secondary School students: Very Suitable
4. The extent to which the contents cover the topics they are meant to cover: It Covers about 90% of the ~~[illegible]~~ topics
5. Possible errors in suggested answers: There is no error in the suggested answers except two questions with two Correct options and one question with no answer.
6. The structuring of the Questions: Satisfactory
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents): Minor Corrections needed ~~needed~~ in both the Contents and the questions.

Suggestions for improving on the Content

1. Endeavour to include the suggested sub-topics to cover the topics
2. Effect all the Corrections made in the instructional material

Name of the Specialists: Dr. Moses A.S. Area of Specialization: Physics

Rank: Senior Lecturer Institution/ Establishment: Federal university of Tech, Minna

Signature: [signature] Date: 31/10/2018

Thank you for validating this instrument

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics: The Content is appropriate for the chosen topics
2. Clarity and simplicity of the Physics content: The content is clearer enough and free of ambiguity
3. Suitability for Senior Secondary School students: It is very suitable
4. The extent to which the contents cover the topics they are meant to cover: The contents covers at least 75% of the chosen topics
5. Possible errors in suggested answers: Those possible errors has been indicated on the contents
6. The structuring of the Questions: Okay
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents): indicated in the contents

Suggestions for improving on the Content

1. Answers to the Multiple-Choice questions should be provided immediately
2. The Multiple choice questions must/should covered only those areas the content covered

Name of the Specialists: Dr. K. A. Salako Area of Specialization: Applied Geophysics

Rank: Senior Lecturer Institution/ Establishment: FUT Minna

Signature: [signature] Date: 02/10/2018

Thank you for validating this instrument

1

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics: Satisfactory
2. Clarity and simplicity of the Physics content: Satisfactory
3. Suitability for Senior Secondary School students: Satisfactory
4. The extent to which the contents cover the topics they are meant to cover: Very good
5. Possible errors in suggested answers: None
6. The structuring of the Questions: Satisfactory
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents): The few errors obseved have been noted on the research instrument

Suggestions for improving on the Content

1. I suggest the figures/illustrations be labelled for proper identification within the texts
2.

Name of the Specialists: Dada O. Michael Area of Specialization: Medical Physics

Rank: Senior Lecturer Institution/ Establishment: Fed. Univ of Technology, Minna

Signature: MDada Date: 02/10/2018

Thank you for validating this instrument

1

APPENDIX G

Validation by Three (3) Physics Teachers from Senior Secondary Schools Minna

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics: Very appropriate for the content it was chosen.
2. Clarity and simplicity of the Physics content: Okay, though some content required practical approach.
3. Suitability for Senior Secondary School students: The content is suitable for senior secondary school students.
4. The extent to which the contents cover the topics they are meant to cover: The content widely covered the topics it was meant to cover.
5. Possible errors in suggested answers: Errors identified in 16, 30, 31, and 41
6. The structuring of the Questions: The questions are well structured, few needs to be restructured.
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents): There were very few errors which were corrected.

Suggestions for improving on the Content

1. There should always be a link between the
2. objective(s) and the evaluation of the lesson.

Name of the Specialists: Daniel Yisa Loguma Area of Specialization: Physics

Rank: Chief Education officer (CEO) Institution/ Establishment: NSTPDC, Mararaban Dandaudu

Signature: [signature] Date: 03/10/2018

Thank you for validating this instrument

1

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics: The content is appro-priate but may be too much for 70min duration.
2. Clarity and simplicity of the Physics content: The diagrams are okay.
3. Suitability for Senior Secondary School students: The content is suitable but time is limited
4. The extent to which the contents cover the topics they are meant to cover: At secondary school level, the content is okay.
5. Possible errors in suggested answers: One option for definition of light should involve the nature of light.
6. The structuring of the Questions: At the secondary school level the structure of the questions are reasonable.
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents):

Suggestions for improving on the Content

1. The contents should be designed to accommodate the time frame
2. The content should include practical/experiment.

Name of the Specialists: Samuel Mamman Area of Specialization: Physics

Rank: Senior Assistant [illegible] Officer Institution/ Establishment: MBGSC Minna.

Signature: [signature] Date: 16/10/2018

Thank you for validating this instrument

1

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics: It's Good for The purpose it was designed for.
2. Clarity and simplicity of the Physics content: Okay
3. Suitability for Senior Secondary School students: The instrument is suitable for the targeted students.
4. The extent to which the contents cover the topics they are meant to cover: It covers most aspect of the chosen topic
5. Possible errors in suggested answers: 16, 30, and 31
6. The structuring of the Questions: needs little restructuring
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents): few of them needs correction

Suggestions for improving on the Content

1. Avoid the use of technical terms, when use
2. it should be explained; objective & evaluation should be noted

Name of the Specialists: Joseph Omaiye Area of Specialization: Physics

Rank: MECSC MINNA Institution/ Establishment: P.E.O

Signature: [signature] Date: 26/09/2018

Thank you for validating this instrument

1

Appendix H

Validation by Three (3) Physics Staff from NECO

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics: Based on the Curriculum and Syllabus, the Content chosen are appropriate
2. Clarity and simplicity of the Physics content: The content are clear and simple enough.
3. Suitability for Senior Secondary School students: It is suitable
4. The extent to which the contents cover the topics they are meant to cover: The extent it covers is suitable
5. Possible errors in suggested answers: Didn't solve most of the problems due to tight schedule
6. The structuring of the Questions: I have made some inputs in the material given.
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents): Shown in the material. An example to note when options are not much, is use of I, II, III and then to have options of I only, II only, III only, I & II only, I & III only / II and III only the case may be instead of using distracters that are plausible

Suggestions for Improving on the Content

1. There may be need to go with some of the devices/apparatus to aid understanding
2. Also if there are teaching aids with these topics it will help.

Name of the Specialists: Clement Pepsrola Area of Specialization: Physics

Rank: Deputy Director Institution/ Establishment: NECO

Signature: [signature] Date: 11/10/2018

Thank you for validating this instrument

1

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics: the content is appropriate for teaching the chosen topics.
2. Clarity and simplicity of the Physics content: the physics content is clearly expressed
3. Suitability for Senior Secondary School students: the topics are suitable for ~~the~~ senior secondary school students
4. The extent to which the contents cover the topics they are meant to cover: the coverage of the topics is appropriate
5. Possible errors in suggested answers: All possible errors have been pointed out and correct answers are indicated
6. The structuring of the Questions: Some of the questions are open ended, but they have been ~~for adjustment~~.
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents):

Suggestions for improving on the Content

1. Some of the diagram need to be redrawn
2.

Name of the Specialists: Dr. M.B. Olomiyesan Area of Specialization: Physics Education

Rank: SEO Institution/ Establishment: NECO

Signature: [signature] Date: 15/10/2018

Thank you for validating this instrument

1

CONTENT EXPERT VALIDATION REPORT

Dear Sir/Ma,

I, Abolarinwa Lucy Folaranmi, a PhD student in the Department of Educational Technology, Federal University of Technology, Minna, do hereby humbly request your assistance in validating this research instrument. I have designed a flipped classroom instruction for Physics at Senior Secondary Schools in Niger State, Nigeria. The validation of the Physics concepts is to ascertain its suitability for classroom instructional standard. Your constructive criticism will be appreciated. Thank you.

Please, comment on the following:

1. Appropriateness of content for teaching the chose topics:......................................
2. Clarity and simplicity of the Physics content: It's ok
3. Suitability for Senior Secondary School students:......................................
4. The extent to which the contents cover the topics they are meant to cover......................................
5. Possible errors in suggested answers: Options not serially arranged
6. The structuring of the Questions: See correction as affected
7. Others (some sentence errors, spelling mistakes and misrepresentation of some symbols in the contents): See correction affected

Suggestions for improving on the Content

1. In your items try to make the stem one sentence as against two sentences in some. Options is not serially arranged.
2. The 70 minutes duration seem to be too short for the content delivery

Name of the Specialists D. A. Aibisala Area of Specialization: Educational Evaluator

Rank: Deputy Director Institution/ Establishment: NECO

Signature [signature] Date 16/10/18

Thank you for validating this instrument

1

APPENDIX I

FIELD TRIAL RELIABILITY RESULT

FIELD TRIAL RELIABILITY TABLE

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.971	17

PHYSICS ACHIEVEMENT TEST (PAT) RELIABILITY RESULT

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.841	50

STUDENTS' ATTITUDE TOWARDS PHYSICS QUESTIONNAIRE (SATPQ) RELIABILITY TEST RESULT

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.726	15

STUDENTS' ATTITUDE TOWARDS FLIPPED CLASSROOM QUESTIONNAIRE (SATFCQ) RELIABILITY TEST RESULT

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.807	14

APPENDIX J

ROLES OF TEACHERS\FACILITATORS DURING FLIPPED CLASSROOM INSTRUCTIONAL MODEL

Teachers' Roles

1. Facilitators help the students to learn by allowing them, in a safe environment, to work through the questions for the case. Facilitators are not tutorial group leaders and **do not** lecture or explain at length.
2. Facilitators allow the students to help each other and to explain the material and to challenge each other. Facilitators keep the environment safe by catching the students before they wander too far off track and waste too much time with wrong or misleading ideas.
3. Facilitators can answer questions, give explanations, and make suggestions all within these guidelines. It is important that the students themselves, as much as possible, struggle through the questions for the cases because this is how they will learn both the course content and how to function in teams.
4. Listen carefully to the discussion question. If they are getting off track find ways of hinting. If asked, answer a question with just enough of an explanation that they can get going on their own.
5. When they finish a question let them know if they got it right or even read out parts of the model answer for them.
6. When they have completed all the assigned questions and are ready to move on or time runs out hand out the Group Process Forms. These are to be completed individually first and then briefly shared in turn with the others in the small group.
7. When the Group Processing is complete, announce the individual "mystery" question. DO NOT let them know that this is the "mystery" question until this time. They will

then use the space provided to complete the answer to the best of their ability. They are not permitted to consult with others at this point; the response is to be done individually.

8. Please fill out the facilitator feedback form while the students are answering the mystery question and group processing information. This information is valuable for us to determine where we can make improvements to the content/questions or process.
9. Collect the forms with answers.
10. You are all free to go!
11. If you have any questions, please feel free to contact the researcher @ lucyfavour@gmail.com.

APPENDIX K

ROLES OF STUDENTS DURING FLIPPED CLASSROOM INSTRUCTIONAL MODELS

Student Roles and Group Process

Teacher assigns roles to students in each group. Each student has to rotate the roles every week. The rotation was to ensure that each student has equal chance to experience all the roles and to share different kinds of responsibility. In this study each student was given two roles, for example, leader and quiet captain; recorder and reporter; timer and checker.

Student Roles: (Role Assignments and Job Description)

Leader: The leader is the chairperson who hosts the group discussion and makes sure that each member is on task by participating in the discussion or any given task.

Quiet Captain: The quiet captain sees to it that the group does not disturb other groups.

Recorder: The recorder needs to take notes during the discussion. The written report will be given to the reporter.

Reporter: The reporter is responsible for reporting the summary of his/her group's discussion to the class on behalf of his/her team.

Timer: The timer controls the time given to their group and makes sure that the assigned task is completed in time. If time is not enough to complete the task, the timer has to request more time from the teacher.

Checker: The checker makes sure that each one in the group finishes the worksheet or assigned task in class. If someone in the group has problem completing the individual worksheet, the checker reports to the leader who decides what kind of help will be given to that member.

APPENDIX L

RULES AND REGULATIONS GUIDING STUDENTS DURING COLLABORATIVE LEARNING ACTIVITIES

A. The Ten Commitments

1. I promise to do my share of work with pleasure and delight.
2. I will be brave to express myself in my group. My opinions do count.
3. If I find any problem or difficulty, I will turn to my teammates for help immediately.
4. When my classmates are doing their presentation, I will encourage them with my big smile and attentive eyes.
5. I am willing to help my classmates and teammates when they need me.
6. I will write "thank-you" note to one of my classmates and teammates after each class.
7. I will learn how to show my appreciation in words and in deeds to anyone who helps me during class discussion.
8. I will develop more confidence in presenting my points before my teammates.
9. I will respect the individual differences among my teammates.
10. I promise to enjoy every minute of our Physics class by smiling happily all the time.

B. The Ten Commandments

1. I will not be late to turn in my homework.
2. I will not laugh at my teammates when they make mistakes.
3. I will not sleep in class.
4. I will not chat with teammates during group discussion.
5. I will not shout at my teammates when I am talking to them.
6. I will not take things from other teammates' desk without permission.
7. I will not kick others' feet under the table.
8. I will not eat or chewing gum or garlic when we have Physics class.
9. I will not stay up late the night before Physics class.
10. I will not swing my chair while seated.

NB: Students repeat the rules loudly before they started the Physics class. The purpose of repeating the rules and vows was for habit formation of self-control, discipline, and learner autonomy. When students got accustomed to this learning climate, the oral repetition of the rules was omitted.

APPENDIX M

FIELD TRIAL VALIDATION FORM

VALIDATION OF PHYSICS PACKAGE

Please use the experience acquired in the package to answer the questions as accurately as possible.

Name of school:

Gender: Male ☐ Female ☐

Please indicate your option by ticking (√) in respect of the following statement. The responses are categorized as follows:

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD)

Table 1: Content in the Package

S/No	STATEMENT	RESPONSE			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	The messages in the package are easy to understand				
2	The content of the package has been well organized (arranged in order)				
3	The diagrams/illustrations in the package are very clear to me.				
4	The examples used in the various sections of the lessons in the package are relevant.				
5	It was easy to understand the lesson because information was presented from simple to more difficult one.				
	Total				

Table 2: Feedback from the Package

S/No	STATEMENT	RESPONSE			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	This package provides immediate feedback after selecting the option.				
2	This package displays the correct or wrong answer chosen with some sound.				
	Total				

Table 3: Screen Design of the Package

S/No	STATEMENT	RESPONSE			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	The presentations of the information in the package attract my attention.				
2	The use of proper lettering (fonts) in terms of style and size make the information legible.				
3	The colours used for the various presentations are quite appealing.				
4	The quality of the text, images, graphics and video are interesting.				
5	The animations (moving picture) in the package assist in understanding the lessons better.				
	Total				

Table 4: Students' Preferences toward the Use of the Package Compared to Traditional
Methods of Learning

S/No	STATEMENT	RESPONSE			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	I prefer to learn Physics with an interactive package with a teacher acting as a facilitator.				
2	Learning Physics with an interactive package is more preferable than using text books.				
3	The activities provided in this package are more effective compared to normal classroom instruction.				
4	I will suggest to my friends to use computer package in learning Physics instead of textbooks.				
5	I prefer the use of this instructional method than normal classroom instruction.				
	Total				

APPENDIX N

STUDENTS ATTITUDE TEST

STUDENTS ATTITUDE QUESTIONNAIRE

Dear respondent,

I am a Post Graduate student (Ph.D) of Educational Technology in the Department of Educational Technology of Federal University of Technology, Minna. I am working on a research study, **"FLIPPED CLASSROOM COLLABORATIVE STRATEGIES ON SECONDARY SCHOOL PHYSICS STUDENTS' LEARNING OUTCOMES**". Please attempt the below questions as accurately as you can as your unbiased view is needed for the research. The researcher assures you that the answers gotten will be used confidentially and solely for the purpose of the research.

Thanks, in anticipation of your favorable response.

Yours faithfully

Abolarinwa Lucy F.

STUDENTS ATTITUDE TEST

STUDENTS ATTITUDE TOWARDS PHYSICS QUESTIONNAIRE (SATPQ)

Name of school:

Gender: Male ☐ Female ☐

Please indicate your option by ticking (√) in respect of the following statement. The responses are categorized as follows:

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD)

S/N	Items	SA	A	U	D	SD
1.	I find Physics as a simple subject					
2.	I only hate the calculation aspect of Physics					
3.	I usually get scared when Physics lesson is going on					
4.	Physics class is fun					
5.	I have better understanding of Physics concept					
6.	Physics is relevance subject to everyday life and society					
7.	We have enough Physics teacher					
8.	We learn interesting things in Physics					
9.	I look forward to Physics classes					
10.	I would like to have more Physics lessons in school					
11.	I like Physics lessons more than the others					
12.	I get good marks from Physics lessons					
13.	I only fail in Physics lessons					
14.	I feel helpless when doing Physics homework					
15.	I like Physics experiment because I cannot predict the result					

APPENDIX O

STUDENTS ATTITUDE TOWARDS FLIPPED CLASSROOM QUESTIONNAIRE (SATFCQ)

Name of school:

Gender: Male ☐ Female ☐

Please indicate your option by ticking (√) in respect of the following statement. The responses are categorized as follows:

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD)

S/N	Items	SA	A	U	D	SD
1.	I like using the flip instructional material					
2.	There is value in using the instructional video in learning Physics					
3.	The use of instructional video makes learning Physics more enjoyable					
4.	The instructional video help me learn at my own pace					
5.	I often take notes from the instructional video					
6.	There is value in using the instructional video in Physics					
7.	To the best of my knowledge, the instructional material has increased my level of Physics					
8.	My current overall attitude towards Physics is positive					
9.	The instructional material helps me learn Physics more					
10.	Generally, I watched the video when it was assigned					
11.	I watched the video in one sitting but I would pause and review certain sections					
12.	The time spent in class was helpful to my understanding of the concepts					
13.	I don’t have difficult time following this video content					
14.	I felt prepared to complete introductory problems in class after listening to the video content					

APPENDIX P

OPERATIONAL GUIDE FOR COLLABORATIVE INSTRUCTIONAL STRATEGIES

Selection and Training of Teachers for Collaborative Learning Activities

Teachers from each school were selected for the experiment. They were trained on Collaborative Learning strategies. The contents of the training package include:

- What is Collaborative Learning?
- Experience with Collaborative Learning Activities
- Class Climate
- Team-Building Techniques
- Strategies for Students - Centered Learning,
- Lesson Sharing
- Social Skills
- Implementation of Collaborative Learning strategies (Reciprocal Teaching (RT), Think –Aloud Paired Problem Solving (TAPPS) and Think Pair Share (TPS)).

The teachers were provided with training materials for practical teaching in the classroom on the following:

i. About Collaborative Learning
ii. Seating arrangement for Collaborative Learning activities
iii. About quiet signals
iv. Classroom rules
v. About schedules of (Reciprocal Teaching (RT), Think –Aloud Paired Problem Solving (TAPPS) and Think Pair Share (TPS)) activities.

APPENDIX Q

The Time Frame for Data Collection

S/NO	Steps	Activities	Duration
1	Consent from schools to be used	Visitation and consent from schools to be used	2 weeks
2	Production of FIP Video	Development of FIP by researcher and programmer	12 weeks
3	Validation of FIP	Validation of FIP by team of experts	3 weeks
4	Development of PAT	Development of PAT from Physics curriculum and lesson note by researcher	6 weeks
5	Validation of PAT	Validation of PAT by team of expert	3 weeks
6	Field trial validation of FIP	Field validation of FIP	3 weeks
7	Pilot test of PAT and questionnaire	Pilot test of PAT and Questionnaire	3 weeks
8	Visitation of schools and teachers orientation	Visitation of the four schools, inspection of the facilities, training of teachers on the use of FIP package and collaborative strategies	2 week
9	Student's orientation and sampling	Orientation and sampling for the students	2 weeks
10	Administration of pre-test	Administration of pretest to the four selected schools	1 week
11	Treatment	Treatment to students in each group	4 weeks
12	Post test	Administration of PAT and Questionnaire	1 week
13	Break	Break	2 weeks
14	Retention	Administration of PAT and attitude for retention test	1 week

APPENDIX R

The Flipped Classroom Instructional Model (FIP) Video Lesson Note

LESSON 1

SUBJECT: PHYSICS

TOPIC: LIGHT WAVES

SUB-TOPIC: INTRODUCTION TO LIGHT WAVES

DURATION: 70mins (Double Period)

SPECIFIC-OBJECTIVES: At the end of the lesson the students should be able to:

i) Define light and State different sources of light

ii) Differentiate a ray and beam of light

iii) Perform an activity to show rectilinear propagation of light

iv) Explain the phenomenon of shadow formation and how eclipse occur

v) Illustrate umbra and penumbra with the aid of diagrams

PREVIOUS-KNOWLEDGE: Students already learnt about the general characteristics of wave, light was cited as example of transverse waves.

INSTRUMENTAL MATERIALS: Text Books, Online Materials, pin-hole camera

PRESENTATION: - The lesson will be presented in the following steps: -

STEP 1:

INTRODUCTION

We already learnt about the general characteristics of waves. Light was one of the examples of transverse wave. Light is a form of energy which causes sensation of vision that enables us to see objects. It can be produced from different sources.

SOURCES OF LIGHT

Light can be produced from different sources:

(a) Natural sources of light

They are self-luminous objects and give light by themselves. The sun, the stars, glow worm and fire fly are natural sources of light.

(b) Artificial sources of light

They are man-made sources of light. They reflect light from other sources. Candle-stick, electric lamps and torch light are example of artificial sources of light.

LUMINOUS AND NON-LUMINOUS SOURCES OF LIGHT

Light can still be grouped into luminous and non-luminous sources.

Luminous sources are those that gives light on their own. E.g. star, sun, candle, stick, electric bulbs, glow worm, etc.

Non-luminous sources depend on other sources like the natural sources or the artificial sources to illuminate them. The non-luminous objects are seen when they reflect light from other sources. E.g. car head lamp falling on road sign at night. Example of non-luminous are moon, sheet of paper, polished surfaces, mirror etc.

STEP 2:

TRANSMISSION OF LIGHT

Light is a wave and it is an electromagnetic wave in nature. Light waves travel in a straight line and it can pass through several material medium and vacuum. The nature of the medium determines the amount of light that can pass through it. A transparent medium will allow large percentage of light to pass through it. This makes it possible for object to be seen clearly through them. Examples are glass, water and water proof materials.

A translucent object on the other hand allows small percentage of light to pass through it. Objects are not seen clearly through them. Examples are frosted glass and tinted glass. An opaque object does not allow light to pass through them at all. Examples are wood and brick wall.

RAYS AND BEAMS OF LIGHT

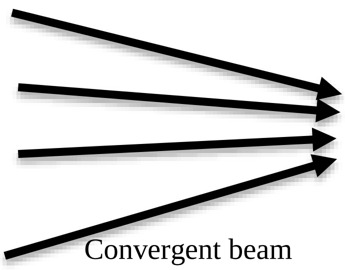
The direction or path along which light energy travels is called a ray of light. It is represented with a line and arrow which indicates the direction of flow of light energy.

A ray of light

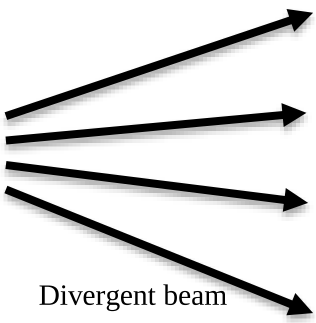
Parallel beam

A beam of light is a collection of many rays of light.

We have (a) parallel beam (b) convergent beam and (c) divergent bean



Convergent beam



Divergent beam

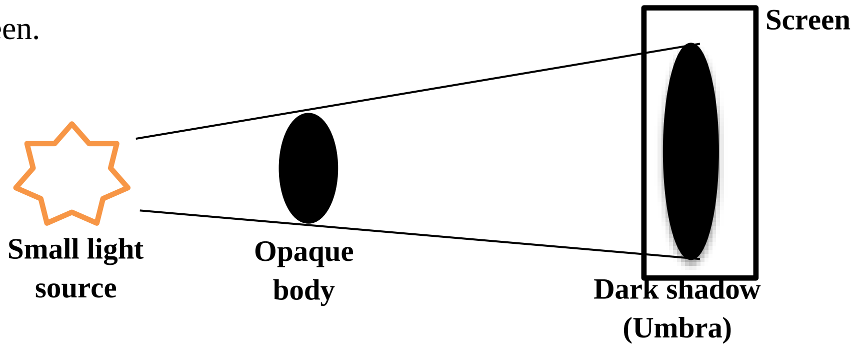
STEP 3:

THE RECTILINEAR PROPAGATION OF LIGHT

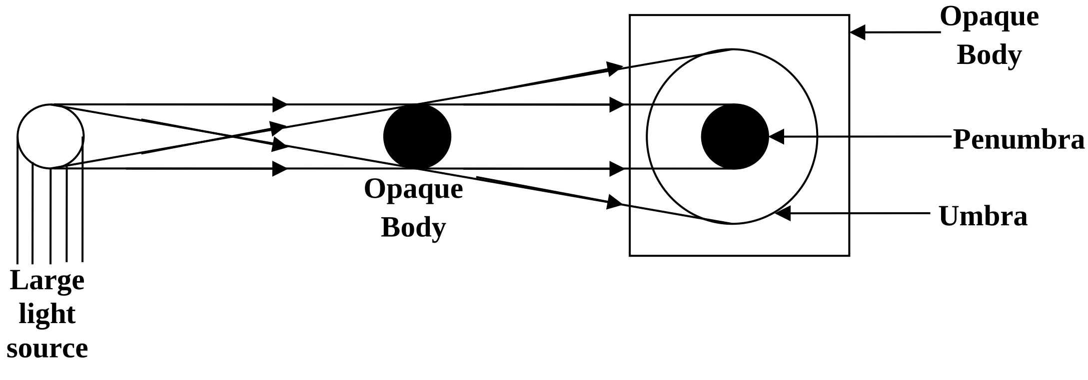
This explains the fact that light travels in a straight line: The shadow formation, eclipse and Pin -Hole camera are all evidence that light travels in a straight line.

SHADOW FORMATION

Shadow occurs because light travels in straight lines. Shadows are produced by the obstruction of light by opaque bodies which do not allow light to pass through them. If any opaque body is placed between a small light source and a screen, a dark shadow is cast on the screen.



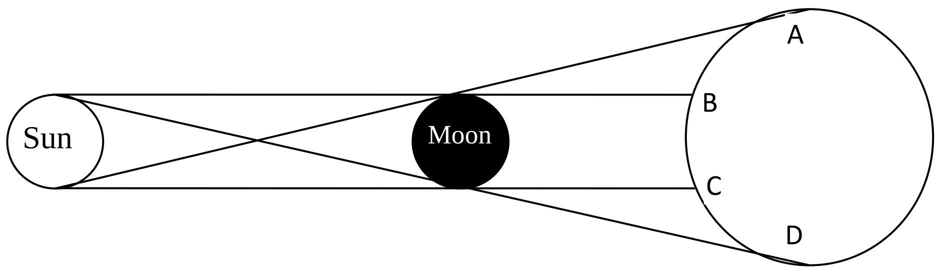
If light source is enlarged or extended, the resulting shadow will be of two parts, a completely dark area called umbra (total shadow) and on the outer light dark or grey area called penumbra (partial shadow) are obtained. The penumbra is formed because light is partially obstructed by the opaque body.



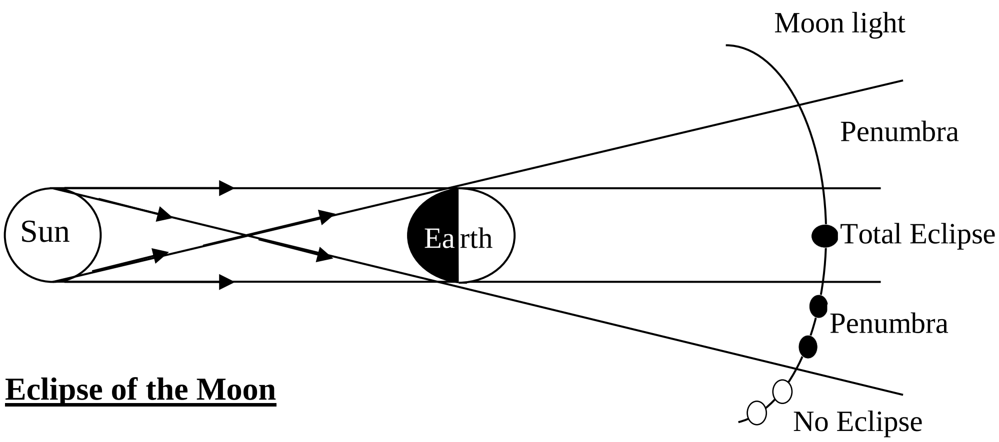
Umbra and Penumbra shadow

ECLIPSE

The formation of umbra and penumbra types of shadow is the principle in which eclipse is formed. Eclipse is formed when the sun, moon and the earth are in a straight line. This is because the moon and the earth are both non-luminous objects while the sun is a luminous object that produces the light. When the moon is in between the earth and the sun during revolution, the shadow of the moon is cast on the surface of the earth. In effect, some parts of the earth, where the shadow of the moon is cast is cut off from the view of the sun and will experience TOTAL darkness. This is called the eclipse of the sun or SOLAR eclipse. Therefore, for those living in the umbra region it is total eclipse and for those living in the penumbra region, it is partial eclipse. On the other hand, when the earth lies between the sun and the moon, being an opaque body, the shadow of the earth is cast on the moon resulting in LUNAR Eclipse of the moon. It can also be total or partial.



Eclipse of the Sun



Eclipse of the Moon

STEP 4:

PIN-HOLE CAMERA

The image on a pin-hole camera is formed based on the principle of formation of eclipse. Pin-hole camera is made of a box whose inner region is made of a light proof material and is painted black. A small pin hole is made in front of the box while the back is made of oiled paper which acts as the screen. Any object AB placed in front of the pinhole forms an inverted image on the screen.

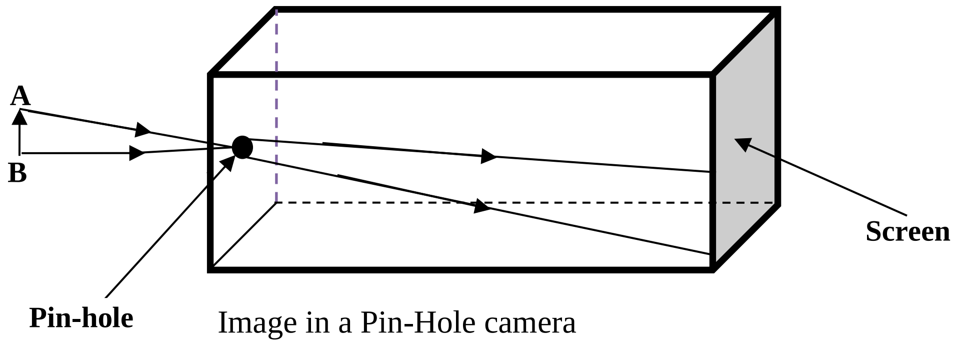


Image in a Pin-Hole camera

When the object distance is greater than the image distance, the image is diminished. But when the object distance is less than the image distance, the image enlarges. The image of a pinhole camera is actually formed by range of light passing through the pinhole where it intersects to form the image on the screen. This is why the image in a pin-hole camera is inverted and diminished if the pin-hole is made smaller, the image is sharper. Where the pin-hole is made wider, the image becomes blurred due to overlapping of image as a result of several pin-hole which form different images. A pinhole can be used to take the picture of an object but does not require focusing.

MAGNIFICATION

In a pin-hole camera, magnification can be determined. Magnification can be defined as the ratio of height of image to that of the object.

Magnification (m) $= \frac{height\ of\ image}{height\ of\ object}$

It could also be the ratio of image distance to that of object distance

i.e. Magnification (m) $= \frac{image\ distance}{object\ distance}$

Hence, $m = \frac{height\ of\ image}{height\ of\ object} = \frac{image\ distance}{object\ distance}$

Worked Examples:

An object of height 30cm is placed at a distance of 120cm from the hole of a pinhole camera. If the length of the camera is 20 cm, determine the magnification produced by the camera and the height of the image.

Solution

Magnification (m) $=\frac{Image\ distance}{Object\ distance} = \frac{lenght\ of\ camera}{distance\ of\ object\ from\ pin-hole}$

$$= \frac{20}{120} = \frac{1}{6}$$

Also, $m = \frac{height\ of\ image}{height\ of\ object}$

Hence, $\frac{1}{6} = \frac{height\ of\ image}{30}$

$$height\ of\ image = \frac{30 \times 1}{6}$$

$$= 5cm$$

SUMMARY

The teacher summarizes the lesson by running through the entire steps.

EVALUATION

1) Light causes a sensation and vision that enable us to___________
    a) talk
    b) read
    c) see
    d) work
    e) walk
2) Which of the following materials is translucent?
    a) Frosted glass

b) Mirror

c) Galvanized iron

d) Wall

e) Water

3) An object in which no light rays can pass through is said to be:

a. Opaque

b. Translucent

c. Transparent

d. Pigment

e. Convex

4) Rectilinear propagation of light explains the idea that light

a. Travel in a random pattern

b. Travels in a straight line.

c. Is reflected from a shining surface.

d. Can be refracted.

e. Is a form of wave

5) A frosted window would be....

a. Opaque.

b. Translucent.

c. Transmission.

d. Transparent.

e. Invisible

6) The height of the image produced from an object placed before a pin hole camera is two times the object height. If the object is placed at a distance of 7.5cm from the pinhole, calculate the length of the pinhole camera.

a. 30.00 cm

b. 15.0 cm

c. 7.5 cm

d. 3.75 cm

e. 1.88 cm

7) The bending of light rays when they pass from one transparent material to another is called.

a. Interference

b. Polarization

c. Reflection

d. Refraction

e. Diffraction

8) What does a lens do?

a. Refracts light

b. Magnifies light

c. Takes pictures

d. Diminish light

e. Colours light

LESSON 2

SUBJECT: PHYSICS

TOPIC: LIGHT WAVES

SUB-TOPIC: REFLECTION OF LIGHT

DURATION: 70mins (Double Period)

LEARNING OBJECTIVES: At the end of the lesson, the students should be able to;

i. Define regular and diffused reflection
ii. State the law of reflection and verify them
iii. Use diagram to explain the formation of images in a plane mirror and in an inclined mirror
iv. Explain reflection of light waves in mirror
v. Solve simple problems involving focal length F, radius of curvature r, image distance I, object distance O and magnification M

PREVIOUS-KNOWLEDGE: Students already learnt about reflection of light, shadow formation and pin-hole camera.

INSTRUMENTAL MATERIALS: Text Books, Online materials, mirror, optical pins, a light source.

PRESENTATION: The lesson will be presented in the following steps: -

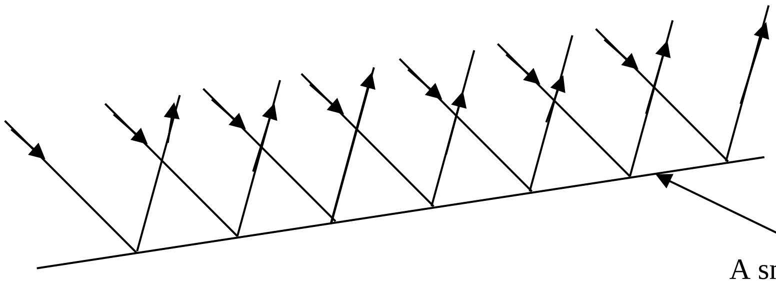
STEP 1:

REFLECTION

Reflection of light is thrown back of light from a non-luminous object whenever light fall on them. Whenever light falls on a non-luminous surface, it absorbs, transmit, or reflect it. There are two types of reflections: - (i) Regular reflection and (ii) Irregular or diffuse reflection

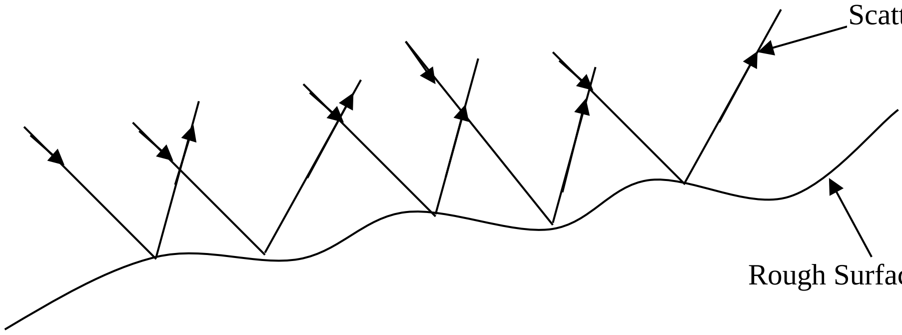
REGULAR AND DIFFUSED REFLECTION

A regular reflection occurs when parallel rays of light incident on a smooth or polished surface reflects in one direction.



A regular reflection

A diffused or irregular reflection occurs when parallel rays of light are incident on a rough surface and are reflected in various directions.

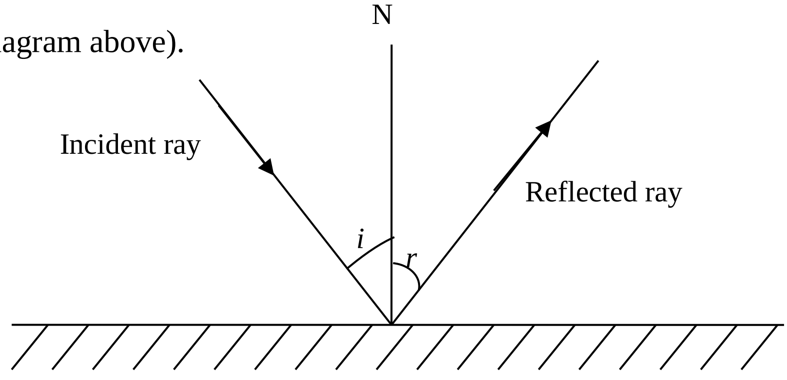


Diffuse reflection

LAWS OF REFLECTION

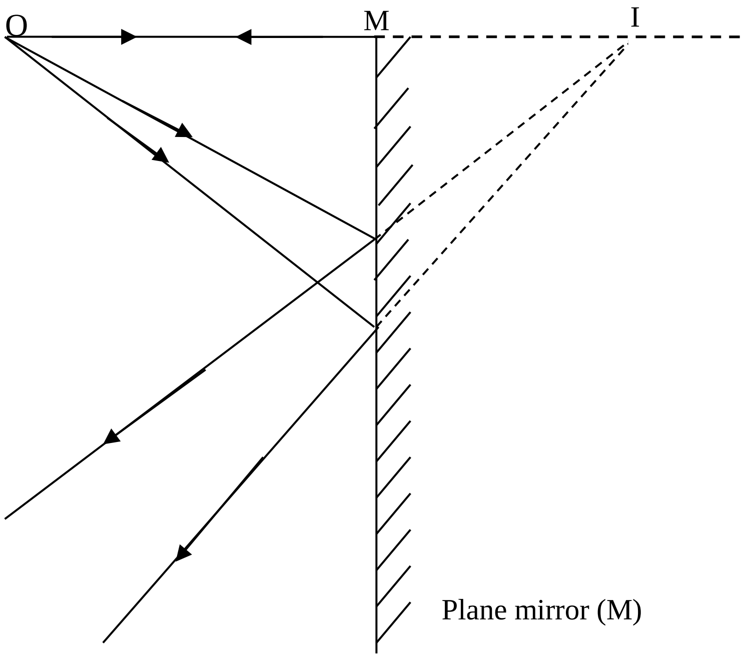
The first law of reflection states that, the incident ray, the reflected ray and the normal at the point of incidence all lie on the same plane.

The **second** law of reflection states that the angle of incidence is equal to the angle of reflection. i.e. $i = r$ (from the diagram above).



FORMATION OF IMAGES IN PLANE MIRROR

Whenever an object is placed in front of a plane mirror, the image formed at the back is not a real image but virtual and upright or erect.



- The object distance in front of the mirror is always equal to the image distance. That is $OM = IM$
- The image appears to be a reverse of the object laterally inverted i.e. your right hand appear to be like left hand in the mirror.
- The image is of the same size as the object.

Summarily, it can be said that image in a plane mirror are: -

Same size as object, upright, Laterally inverted and Virtual (cannot be produced on the screen).

FORMATION OF IMAGES IN AN INCLINED MIRROR

When two mirrors are placed at an angle to each other, it is said to be inclined. Many images of an object will be seen (by an observer) placed in front of the inclined mirrors. The number of images that are formed depends on the angle between the two mirrors.

This relationship is given in the formula:

$$n = \frac{360}{\theta} - 1$$

where n is the number of images and θ is the angle between the two mirrors.

e.g. when the two mirrors are placed in angle 60^0 to each other, we have

$$n = \frac{360}{60} - 1$$

$$n = 6 - 1$$

$n = 5$ i.e. five (5) images are formed.

STEP2:

REFLECTION OF LIGHT WAVES IN SPHERICAL MIRROR

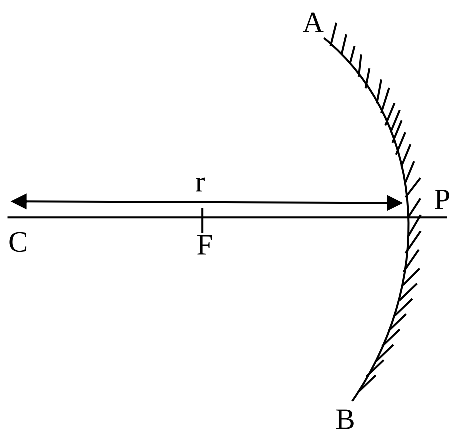
Spherical mirrors are curved mirrors which form parts of the surface of spheres. There are two major types of curved mirrors namely;

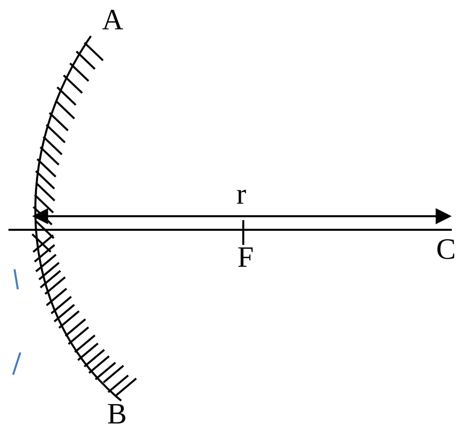
i) The concave mirror (Shaving mirror)

ii) The convex mirror (Driving mirror)

These mirrors are produced by coating a glass surface which is part of a sphere. When the outer surface of the spherical mirror is silver-coated, and the inner surface serves as the reflecting part, the resulting mirror is referred to as CONCAVE mirror while when the inside of the spherical mirror is silver coated, the resulting mirror is referred to as CONVEX mirror.

(i) A Concave Mirror (ii) A Convex Mirror





Main part of spherical mirror:

- The pole (P): This is the center of the mirror (P). That is the mid-point of the mirror.
- The aperture: This is the width of the mirror AB
- The center of curvature (R): It is the center C of the sphere of which the mirror is part
- The radius of curvature (r): It is the distance CP which is the radius of the sphere of which the mirror is part.
- The focal length (f): Is the half of radius of curvature (r) (i.e. f = r/2). The focal length which is the distance from the principal focus to the pole is half the size of radius of curvature (i.e. f = r/2).
- The principal axis: This is the line PC – an imaginary line drawn to run through the centre of curvature (C), the focus (F), and the Pole (P). it is also known as primary axis.

THE PRINCIPAL FOCUS

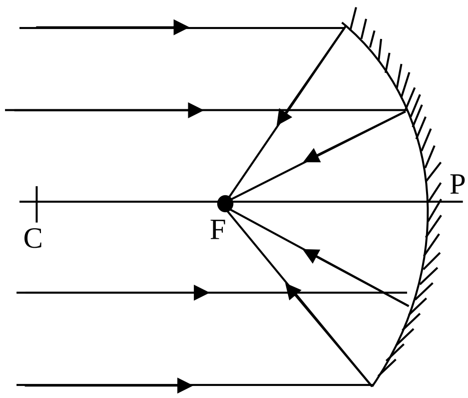
The principal focus of curved mirror (F): Is a point on the principal axis at which incident rays which are close and parallel to the principal axis CONVERGE or appear to DIVERGE from after reflection.

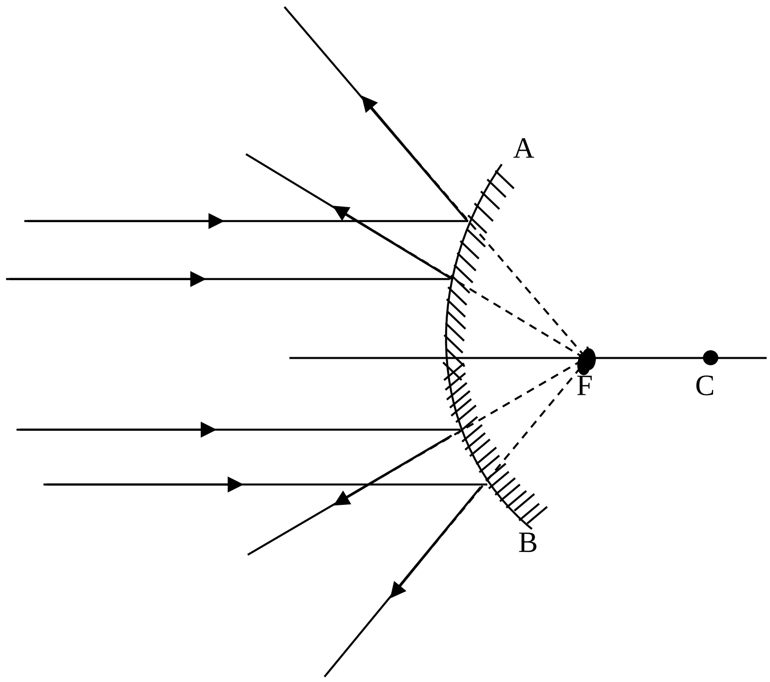
For a concave mirror: Principal focus is a point (F) on the principal axis where parallel rays of light that are close and parallel to the principal axis CONVERGE at a point (F). The principal focus of a concave mirror is REAL and positive because the rays actually pass through and the point of convergence can be located on the screen.

For a convex mirror: Principal focus is a point (F) on the principal axis where parallel rays of light that are close and parallel to the principal axis DIVERGE at a point (F). The principal focus of a convex mirror is virtual and negative because the reflected ray does not actually pass through the focus. It cannot be detected or seen on a screen. It is VIRTUAL

Focus of a convex mirror

Focus of concave mirror





STEP3:

IMAGE FORMATION IN CURVED MIRROR

Images formed depend on the distance of the image from the pole of the mirror. The size, nature and the position of the images in curved mirror are determined by the position of the object in front of the reflecting surface.

Diagrams to Illustrate Possible Images Formed from Curved Mirrors:

(a) CONCAVE MIRROR:

(i) For object beyond C

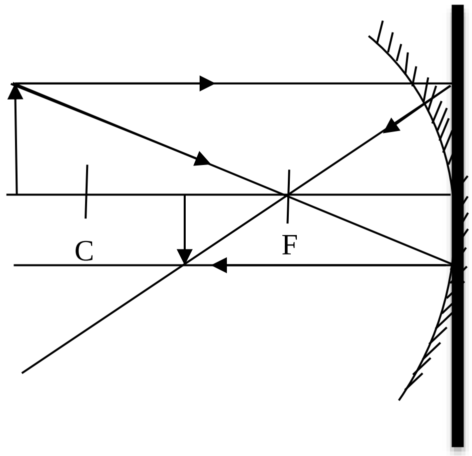
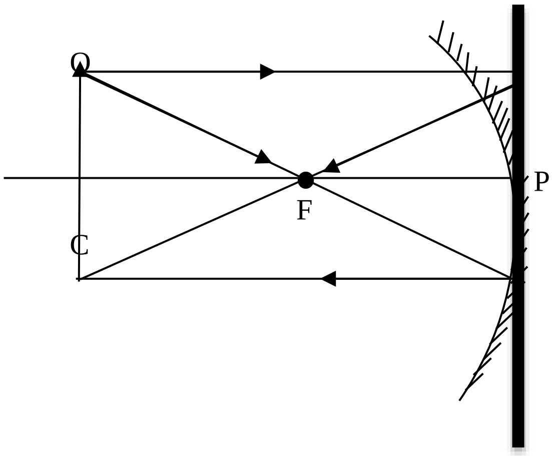


Image is

- Inverted
- Real
- Diminished
- Between C and F

(ii) For object at C



- Same size as object
- Inverted
- At C
- Real

(iii) Object in between C and F

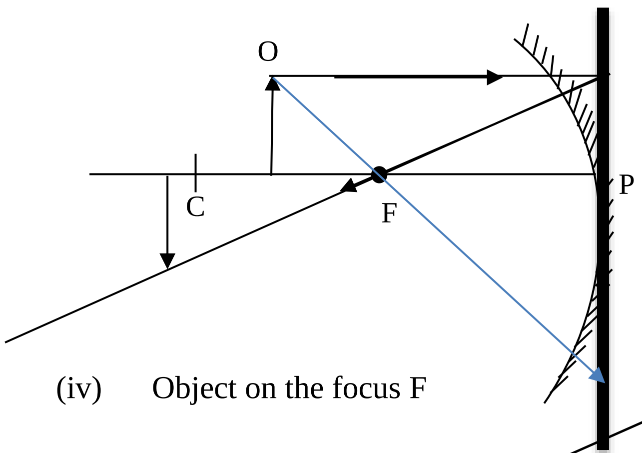


Image is

- Magnified
- Inverted
- Real
- Beyond C

(iv) Object on the focus F

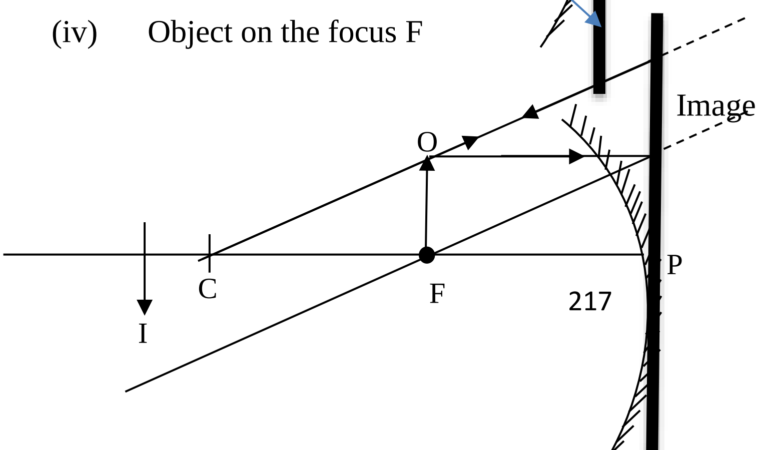


Image is at infinity

CONVEX MIRROR

No matter the position of the object in front of the convex mirror, the image is always Diminished, upright and Formed behind the mirror (Virtual).

STEP4:

APPLICATION AND USES OF CURVED MIRRORS

- Concave mirrors are used as shaving mirrors because the image formed is magnified, vertical and erect especially when the object is located within the focal length of the mirror.
- Concave mirrors can be used as reflectors in search light and car headlamps. When the point source of light is at principal focus of a concave mirrors, the reflected beam is parallel. The beam of light travels far. For wide parallel beam to be obtained, the mirrors must be parabolic.

Worked Examples:

An object is placed 40cm from a concave mirror of radius of curvature of 60cm, calculate the image position and magnification.

Solution:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

For a concave mirror the focal length $f = +30$, the object hence is real

U= $40cm$

Substituting for u in equation (1), we have

$$\frac{1}{+40}+\frac{1}{v}=\frac{1}{+30}$$

$$\frac{1}{v}=\frac{1}{30}-\frac{1}{40}=\frac{4-3}{120}=\frac{1}{120}$$

$$\therefore v=120cm$$

Since v is positive, the image is real and it is 120cm from the mirror

$$Magnification=\frac{Image\ distance}{\text{Object distance}}$$

Magnification $\frac{v}{u}=\frac{120}{40}=3$

This means that the image is three time the size of the object

Exercise 2

An object is placed 20cm from a convex mirror of focal length 30cm, determine the image distance and magnification.

Solution

For a convex mirror, the focal length = -30cm

Using the equation of convex mirror, we have

$$\frac{1}{u}+\frac{1}{(-)v}=\frac{1}{-f}$$

$$\frac{1}{20}+\frac{1}{v}=\frac{1}{30}$$

$$\frac{1}{v}=\frac{1}{20}+\frac{1}{30}$$

$$\frac{1}{v}=\frac{3+2}{60}$$

$$\frac{1}{v}=\frac{5}{60}$$

$$v=\frac{60}{5}$$

$$v = -12cm$$

Magnification $m = \frac{v}{u}$

$$m = \frac{12cm}{20cm}$$

$$m = 0.6$$

m = 0.6 which is less than 1 means that the image is smaller than the object i.e. diminished.

SUMMARY: The teacher summarises the lesson by going through the whole lesson briefly.

EVALUATION:

1. An object is placed 40cm from a convex mirror of focal length 60cm, determine the image distance.
   a) 20 cm
   b) 24 cm
   c) 40 cm
   d) 120 cm
   e) 60 cm
2. Determine the magnification in (1) above.
   a) 1.2
   b) 0.2
   c) 0.6
   d) 0.5
   e) 1.5
3. The center of a mirror is known as
   a) Pole

b) Focal point

c) Center of curvature

d) Principal axis

e) Radius of curvature

4. A man stands 1.8 m from a plane mirror. How far is the man from his image?

a) 4.5 m

b) 0.9 m

c) 1.8 m

d) 2.7 m

e) 3.6 m

5. The focal length of a diverging mirror is 12 cm. An object is placed 5.0 cm away from the mirror. The image will be

a) Smaller and real

b) Larger and real

c) The same size and real

d) Smaller and virtual

e) Larger and virtual

APPENDIX S

RESULTS OF FIELD TRIAL VALIDATION

Table 1: Frequency and percentage results of the respondents on the content in the Package

S/No	STATEMENT	RESPONSE (%)			
		Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
1	The messages in the package are easy to understand	12(43.3%)	20 (57.1%)	3 (8.6%)	0 (0%)
2	The content of the package has been well organized (arranged in order)	9 (25.7%)	26 (74.3%)	0 (0%)	0 (0%)
3	The diagrams/illustrations in the package are very clear to me.	10 (28.6%)	23 (65.7%)	2 (5.7%)	0 (0%)
4	The examples used in the various sections of the lessons in the package are relevant.	10 (28.6%)	23 (65.7%)	2 (5.7%)	0 (0%)
5	It was easy to understand the lesson because information was presented from simple to more difficult one.	21 (60.0%)	9 (25.7%)	5 (14.3%)	0 (0%)
Total		**37%**	**57%**	**6%**	**0 (0%)**
Summary of Agree and Disagree		**94 (0%)**		**6%**	

Table 2: Feedback from the Package

S/No	STATEMENT	RESPONSE			
		Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
1	This package provides immediate feedback after selecting the option.	7 (20%)	28 (80%)	0 (0%)	0 (0%)
2	This package displays the correct or wrong answer chosen.	8 (22.9%)	6 (17.1%)	20 (57.1%)	1 (2.9%)
Total		**21.45%**	**48.55%**	**28.55%**	**(1.45%)**
Summary of Agree and Disagree		**70.0%**		**30.0%**	

Table 3: Screen Design of the Package

S/No	STATEMENT	RESPONSE			
		Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
1	The presentations of the information in the package attract my attention.	10 (28.6%)	24 (68.6%)	1 (2.9%)	0 (0%)
2	The use of proper lettering (fonts) in terms of style and size make the information legible.	11 (31.4%)	24 (68.6%)	0 (0%)	0 (0%)
3	The colours used for the various presentations are quite appealing.	5 (14.3%)	26 (74.3%)	4 (11.4%)	0 (0%)
4	The quality of the text, images, graphics and video are interesting.	21 (60%)	14 (40%)	0 (0%)	0 (0%)
5	The animations (moving picture) in the package assist in understanding the lessons better.	19 (54.3%)	14 (40%)	2 (5.7%)	0 (0%)
Total		**37.70%**	**58.3%**	**4%**	
Summary of Agree and Disagree		**96%**		**4%**	

Table 4: Students' Preferences toward the Use of the Package Compared to Traditional Methods of Learning

S/No	STATEMENT	RESPONSE			
		Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
1	I prefer to learn Physics with an interactive package with a teacher acting as a facilitator.	23 (65.7%)	8 (22.9%)	4 (11.4%)	0 (0%)
2	Learning Physics with an interactive package is more preferable than using text books.	21 (60%)	10 (28.6%)	2 (5.7%)	2 (5.7%)
3	The activities provided in this package are more effective compared to normal classroom instruction.	8 (22.9%)	14 (40%)	8 (22.9%)	5 (14.3%)
4	I will suggest to my friends to use computer package in learning Physics instead of textbooks.	4 (11.4%)	20 (57.1%)	11 (31.4%)	0 (0%)
5	I prefer the use of this instructional method than normal classroom instruction.	10 (28.6%)	10 (28.6%)	8 (22.9%)	7 (20%)
Total		**37.70%**	**35.44%**	**18.86%**	**8%**
Summary of Agree and Disagree		**73.14%**		**26.86%**	