UNIVERSITY OF EDUCATION, WINNEBA

EFFECTS OF ADVANCE ORGANISERS ON STUDENTS' PERFORMANCE IN INTEGRATED SCIENCE IN A COOPERATIVE LEARNING CLASSROOM

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DECLARATION

STUDENT'S DECLARATION

I, Shine Apeadido, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature:…………………………………..

Date:………………………………………..

SUPERVISORS' DECLARATION

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

Professor Mawuadem Koku Amedeker (Supervisor)

Signature:…………………………………..

Date:………………………………………..

DEDICATION

To my mother, Miss Christiana Vivian Alomenu and my sister, Gloria Apeadido.

ACKNOWLEDGEMENT

I owe a special debt of gratitude to my supervisor, Professor Mawuadem K. Amedeker for his unflinching support and suggestions.

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ABSTRACT

This study was aimed at investigating the effects of advance organisers on teaching and students' performance in Integrated Science in a cooperative learning classroom in Adugyama Senior High School in the Ashanti Region of Ghana. It sought to determine the science process skills that students would acquire when taught Integrated Science using advance organisers in a cooperative learning classroom and the effects of this strategy on students' academic performance and attitudes towards Integrated Science. This study used an action research design. Convenience sampling was employed and a sample of General Art Form Three class made up of 44 students was used for the study. Students' records in assessment and class observation checklists were utilised to collect data. Data collected were analysed qualitatively and quantitively. Findings of the study showed that the academic performance of students was enhanced when taught Integrated Science using advance organisers in a cooperative learning classroom. It was also revealed that this instructional strategy provided opportunity for the students to acquire science process skills and exhibit positive attitudes necessary for learning. The conclusion of this study revealed that this instructional approach has a positive impact on teaching and learning of Integrated Science which contributes to greater achievement of students. The study recommended that innovative, interactive and more effective learner-centered instructional strategies, such as use of advance organisers with cooperative learning activities should be used by Integrated Science teachers to promote easy acquisition of science process skills, better comprehension of concepts and development of positive attitudes.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background to the study, statement of the problem and purpose of the study. The structure of the chapter also includes the objectives, research questions and significance of the study. It also contains the limitations and delimitation of the study. This chapter ends with the organisation of the study.

1.1 Background to the Study

Designing a teaching strategy that enhances the understanding of scientific concept is key to academic achievement of learners (National Research Council, 2000). However, studies revealed that students are not taken through senior high school Integrated Science practical activities properly (Amoah, Eminah, Ngman-Wara & Azure, 2021; Azure, 2015). Also, it was reported that student-centered instructional strategies were not employed during Integrated Science lessons, hence limiting students' participation. (Sarfo-Adu, Ngman-Wara & Quansah, 2018; Sun, Wang, Xie & Boon, 2014). Consequently, students find the learning of Integrated Science difficult, boring, uninteresting and abstract (Winarno, Rusdiana, Riandi, Susilowati & Afifah, 2020) and perform poorly in examinations (West African Examinations Council, 2019; 2020).

The difficulties in teaching and learning of practical concepts calls for better and modern instructional approaches (Mehta, 2019) such as cooperative learning, which allows students to work together in small groups and use of advance organisers, which enhance their retention through presentation of information prior to teaching of any concept (Adebola, 2011).

Advance organiser is an instructional tool used by teachers to introduce the lesson topic and illustrate the relationship between what the students are about to learn and the information they have already learnt. This helps students understand, retain and remember the new learning material (Somashekhara & Dange, 2020). Advance organisers may take different forms such as descriptions with pictures, flowcharts, maps, questions, orals and visuals (Oyeniyi & Owolabi, 2021). Ausubel (2000) and Marzano (2001) classified advance organisers into four types namely narrative, expository, skimming, and graphic organisers. Narrative advance organiser utilises power of storytelling of which the teacher highlights the main ideas explained in the story. Expository advance organiser illustrates the new learning to be covered as the teacher gives the students key concepts and ideas to be learnt. Skimming gives chance to students to flick through content to be learnt and outline them. Graphic organisers help teachers and students to identify key concepts and ideas to be learnt and link them in visual format (Goodwin, 2020). Furthermore, cooperative learning is an instructional approach which enables students to work in small groups to accomplish a common learning goal under the guidance of the teacher (Rigacci, 2008). According to Mendo-Lazaro, Leon-del-Barco, Polo-del-Rio and Lopez-Ramos (2022), cooperative learning classroom enables students to develop skills and motivates them to participate more actively in the teaching and learning process.

Oyeniyi and Owolabi (2020) suggested that advance organisers positively impact students when used effectively with other innovative instructional strategies. Nonetheless, limited attention has focused on impacts of advance organisers on learners in cooperative learning classroom (Sunasuan, & Songserm, 2021). This therefore invites the need to explore the effects of this instructional approach on teaching and learning outcomes of students in Integrated Science.

1.2 Statement of the Problem

The Researcher has observed that most students at Adugyama Senior High School lack the required science process skills and cannot demonstrate them effectively during Integrated Science practical lessons, exhibit negative attitudes and consequently perform poorly in test of practical work assessments. It was further revealed that the students do not grasp practical concepts well possibly due to inadequate teaching aids and lack of innovative and student-centred instructional strategies during lessons. Chief examiners' reports of West African Examinations council (2019; 2020) affirmed this problem by revealing that most students are unable to answer Integrated Science test of practical work questions pertaining to measurement and linear graph correctly. This was attributed to lack of experience and science process skills (West African Examinations Council, 2019; 2020; Ministry of Education, 2010; Amoah et al. 2021) and negative attitudes (Amoah et al., 2021; Marcela & Mala, 2016). The persistent low performance of the students in practical activities which reflects in both internal and examinations informed the researcher's decision to embark on the research since Integrated Science is a core subject.

In line with this, the study sought to research into the extent to which advance organisers would influence teaching and enhance performance of students in Integrated Science test of practical work assessments.

1.3 Purpose of the Study

The study investigated the use of advance organisers in a cooperative learning classroom and their effects on the teaching and learning outcomes of students in Integrated Science.

1.4 Objectives of the Study

The study sought to determine:

1. the process skills that students would demonstrate when taught Integrated Science using advance organisers in a cooperative learning classroom.
2. the effects of advance organisers on students' attitudes towards Integrated Science in a cooperative learning classroom.
3. the effects of the use of advance organisers on students' academic performance when taught Integrated Science in a cooperative learning classroom.

1.5 Research Questions

The following research questions underpin the study:

1. What science process skills students acquire when taught Integrated Science using advance organisers in a cooperative learning classroom?
2. What effects does the use of advance organisers in a cooperative learning classroom have on students' attitudes towards Integrated Science?
3. What are the effects of the use of advance organisers in a cooperative learning classroom on the academic performance of students in Integrated Science?

1.6 Significance of the Study

The findings and recommendations of this study will serve as useful guidelines to teachers, students, educational researchers and curriculum developers.

With regard to the teachers, the outcome of the study could be used to improve their teaching strategies and technique. To students, it is hoped that the outcome of the study could be beneficial to them by enhancing their academic performances in Integrated Science towards West African Senior School Certificate Examination

(WASSCE) test of practical works. The findings of study could serve as reference for future studies in the use of advance organisers in cooperative learning environment.

1.7 Limitations

According to Marilyn and Jim (2013), limitations were described as matters and occurrences which arise in a study which are out of the control of the researcher. They place restriction on the validity of the study, limit the extensity to which a study can go, and sometimes affect the results and conclusions that can be drawn.

This study was intended to cover all the form three classes in Adugyama Senior High School in the Ashanti Region of Ghana but due to time and financial constraints, the study was limited to General Art 3 students only. It would even be ideal if this study was carried out in other senior high schools in Ghana but due to the confinement of the research in Adugyama Senior High School, generalisation of the results would be inappropriate. Another limitation of the study was absenteeism on the part of the students due to truancy at the time of intervention and this may affect the results of the study. In addition, a convenience sampling procedure used may likely affect the generalisability of the results.

1.8 Delimitation

According to Simon (2011), delimitation is the characteristics that limits the scope and define the boundaries of the study. Simon further stated that delimitations are in the control of the researcher. Delimiting factors include the choice of objectives, the research questions, variables of interest, theoretical perspectives the researcher adopted and the population chosen to investigate (Simon & Goes, 2013).

The study was restricted to Adugyama Senior High School in the Ashanti region of Ghana. This was due to closeness and accessibility of the research subjects. The study was also restricted to form three General Art students. In addition, the curriculum content was limited to some selected practical-oriented topics of Integrated Science.

1.9 Organisation of the study

The study has been organised into five chapters. The first chapter deals with introduction to the study. It includes background of the study, statement of the problem, purpose of the research, objectives of the research, research questions, significance of the study, limitation and delimitations. The second chapter deals with literature review. The third chapter covers methods and systematic measures that the researcher employed to get the needed data for the research work. The fourth chapter focuses on the data collected, their analysis and discussions of the results. The fifth chapter covers the summary, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter deals with the review of literature related to the study. Covered under this chapter is the theoretical framework. The topical issues under which literature was reviewed include cooperative learning classroom, the concept of advance organisers and their use to improve learning and retention of science concepts. Other areas looked at were innovative instructional strategies in teaching and learning of science, students' attitudes and science process skills acquisition.

2.1 Theoretical Framework

Theoretical framework is the structure that can hold or support the theory of a research study (Abend, 2008). It defines the key concepts in research, proposes relations between them, and discusses relevant theories based on a literature review (Vinz, 2020). According to Trochim (2006), theoretical framework connects the researcher to existing knowledge. Guided by a relevant theory, it gives a basis for the hypotheses and the choice of methods. Trochim further asserted that it specifies which key variables influence a phenomenon of interest and help examine how these key variables might differ and under what circumstances. A strong theoretical framework gives direction to research, allowing the researcher to convincingly interpret, explain and generalise from the findings (Vinz, 2020).

This study is anchored on the theory of Meaningful Learning formulated by Ausubel (2000). Meaningful Learning is a learning strategy which occurs when there is an interaction between potentially new knowledge and relevant ideas of the learner which results into the acquisition of new meanings in the cognitive structure of the learner (Ausubel, 2000). Hoffman, Bianchi and Durrani (2021) affirmed that Meaningful Learning is the study and explanation of how a learner learns by relating new ideas or information to previous known information. The theory primarily involves the acquisition of new meanings from presented material (Ausubel, 2000), and indicates longer retention than memorising and occurs when learners relate new concepts to pre-existing familiar concepts (Vallori, 2014).

The focal point of this theory is the understanding and integration of new meaning into cognitive structure of learners and that meaningful learning takes place when new ideas are subsumed under existing systems in cognitive structure (Ausubel, 2000). The main idea of Ausubel's approach involves the use of advance organisers, relevant introductory materials presented in advance to learners to help them learn at a higher level of abstraction, generality and inconclusiveness (Oyeniyi & Owolabi, 2020). Accordingly, the theory advocated that the most important factor in learning is what the learner already knows (Ausubel, 2000) and that meaningful learning occurs when the learner solves new problems after interpreting, relating and incorporating the new information into the existing knowledge (Gonzalez et al., 2008).

Awodun and Boris (2021) applied the meaningful learning theory to the study of second cycle school students' academic achievement in Basic science through the use of advance organiser teaching strategy. The study showed that students' achievement in the experimental group at post-test level was found to be significantly better than that of the control group. The findings indicated that advance organiser teaching strategy significantly influenced students' achievement (Awodun & Boris, 2021). The theory was also employed by Shihusa and Keraro (2009) to conduct a quasi-experimental study to show that second cycle students taught using advance organisers had a higher level of motivation than those taught using conventional teaching methods.

Meaningful Learning encourages teachers to use teaching aids such as advance organisers to assist in the learning process. As applied to the present study, this theory holds that the researcher would envisage the use of advance organiser to have an effect on performance of students in Integrated Science because advance organisers prepare learner's minds and activate specific prior knowledge that will be needed to understand and interpret the new information when they are used prior to a learning process (Hoffman et al., 2021). With this theory, the teacher aids learners to experience and take in new information by functioning primarily as a facilitator. This is achieved by creating an environment in which learners are encouraged (Hoffman et al., 2021). As such, the researcher expects learning environment like cooperative learning classroom to assist advance organisers have impacts on the students' performance in Integrated Science.

The Figure 1 shows how meaningful learning theory leads to use of advance organiser for this study.

It was centered on the Meaningful learning and use of Advance organiser in an innovative learning environment which is anticipated to enhance learners' achievement and positive attitude.

The Researcher designed a theoretical framework which is based on the Meaningful Learning theory. This theory is employed to guide the learners through learning activities so that they relate new information in the classroom to previously known information. An assertion by UzZaman et al. (2015) backed the Meaningful Learning theory that the usage of advance organisers can help enhance learning and retention among the learners. This affirmation serves as indirect policy guideline to the theory.

Through this, the Researcher expects the use of advance organisers in an innovative environment based on meaningful learning theory to have positive impact on students. The framework also consists of teaching strategy that assists learners to organise and interpret new information in an innovative instructional environment. Therefore, the framework makes use of advance organisers which could influence students' comprehension of new concepts. The advance organisers will be utilised at the beginning of the lessons to prepare the learners to structure new materials to be learnt. The framework will further make use of instructional techniques and activities such as cooperative learning, use of graphic organisers such as diagrams and charts, technology in the classroom and improvisation of learning resources with hands-on learning (Figure 1). Cooperative learning activities enable the learners to work in small groups or pairs to achieve a common goal. Use of graphic organisers will enable learners to utilise visual tools to organise concepts (Ayverdi et al., 2013). Technology in classroom make use of technological tools which will enables learners to be motivated and engaged longer (Cox, 2019) in interactive, active and cooperative-collaborative learning (Davis & Tearle, 2008). Improvisation and hands-on learning aids students to improvise and interact with learning resources via the teacher's guide to understand concepts.

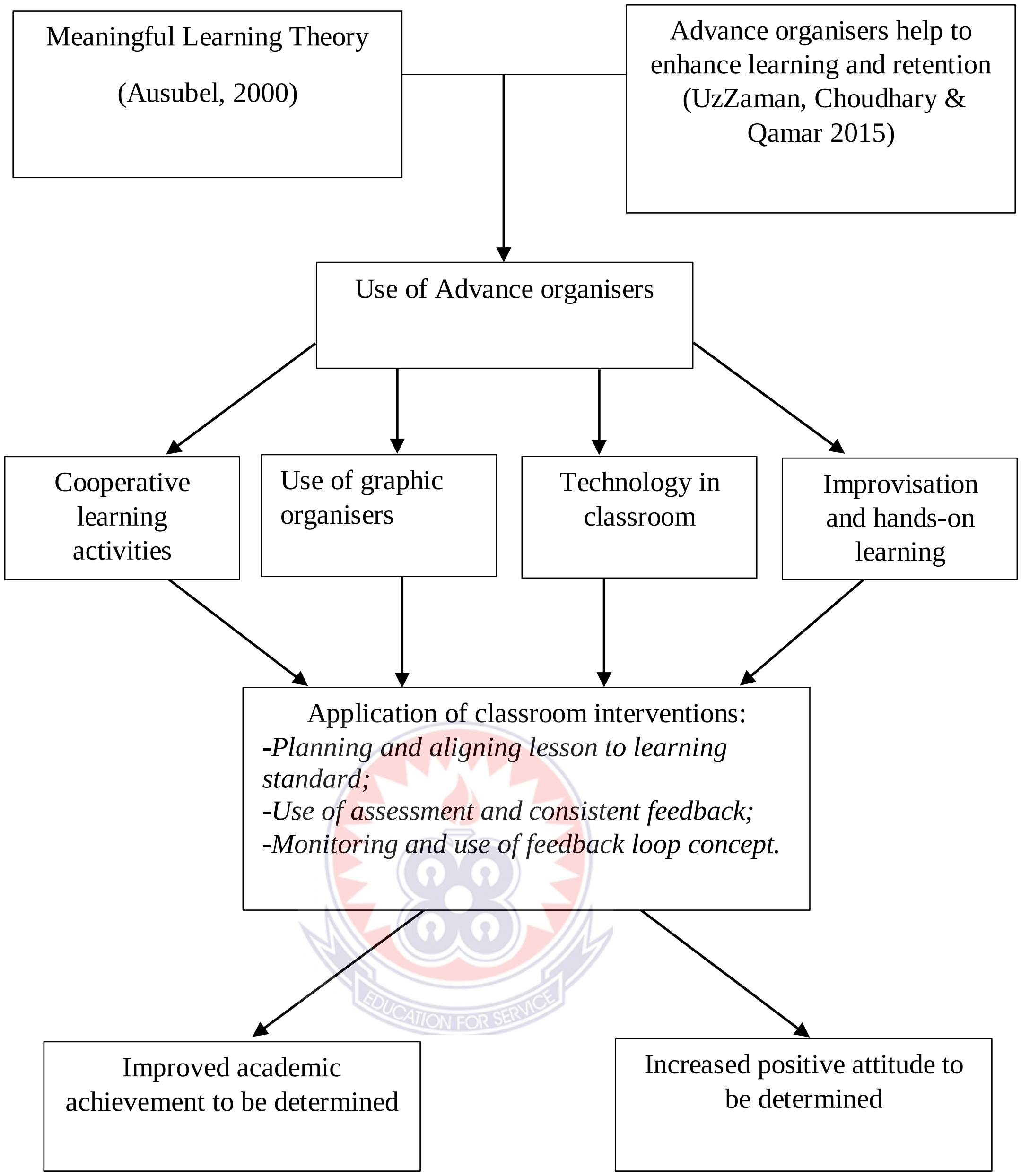


Figure 1: Theoretical framework of the study

These innovative techniques and activities will operate as a learning environment that will encourage learners and facilitates easier impact of the advance organisers on them. Hence the researcher will develop and employ these activities to teach Integrated Science concepts.

Accordingly, classroom interventions are employed through the use of the advance organisers and innovative interactive activities to monitor the progress of students for the attainment of improved achievement and increased positive attitudes of the students. Intervention strategies such as planning and aligning instruction to learning standard ensure that the lesson is effectively delivered and students have met the learning standard (TeacherReady, 2017). Formative assessment techniques such as assignments, group works and individual participation in lessons and consistent focused feedbacks are used to check progress of the students.

Finally, the Researcher expects positive outcomes of students' performance after implementation of these strategies, learning activities and classroom interventions.

The improved achievement to be determined is the positive assessment results that the Researcher expects to notice. The students' achievement will be assessed through frequent progress, checks and examinations.

Increased positive attitude is favourable attitude exhibited by learners that the Researcher expects to observe. The students' positive attitudes will be checked through class observations.

In summary, Figure 1 shows classroom strategies and activities which involve the thoughtful planning and organisation of teaching learning experiences causing students to have enhanced positive performance achieved by the use of advance organisers along with instructional strategies and activities and classroom intervention. Thus, improved academic performance by the students and increased positive attitudes of students depend on the use of advance organisers with innovative strategies, the learning activities, the teaching and learning material and assessment and feedback techniques.

2.2 Cooperative Learning Classroom

Cooperative learning classroom focuses on shared knowledge among teachers and students because teachers work as mediators to facilitate the students to learn, while students work together to complete tasks using critical processes. These could provide effective communication among students and influence them to be successful learners (Ibrahim et al., 2015). Cooperative learning according to Rigacci (2008), is an instructional approach where students work in small groups to accomplish a common learning goal under the guidance of the teacher. Johnson, Johnson and Holubec (2008) described cooperative learning as the instructional use of small groups in such a way that students work together to maximise their own and each other's learning.

Cooperative learning can cultivate students' thinking skills, including creativity and information technology skills (Sunasuan & Songserm, 2021). It also encourages the learners to gain higher achievement, thinking skills, engagement with school, inter-ethnic relations and self-esteem because it allows learners to interact through the processes of brainstorming, discussing, explaining and persuading while they exchange information among themselves (Sunasuan & Songserm, 2021). Cooperative classrooms advocate focusing on teacher's facilitation, interpersonal skills among and within groups, effective communication, using appropriate materials, individual accountability, positive independence, real-time interaction, and group processing (Ibrahim et al., 2015; Riggaci, 2008; Johnson et al., 2008). This learning environment offers students the chance to learn by applying knowledge in an environment more similar to the one they will encounter in their future work life (Rigacci, 2008). Cooperative classroom can also increase motivation, enjoyment of school, attendance, time on task, and classes and independence among learners involved (Tsay & Brady, 2010).

There are numerous numbers of cooperative learning techniques. Some cooperative learning strategies employ small groups of four or five students as others utilise student pairing method. Among the strategies include Student Teams-Achievement Divisions (STAD), Think-Pair-Share, Think-Pair-Write, Jigsaw, Jigsaw II, Reverse Jigsaw, Reciprocal Teaching and Variations of Round Robin (Schul, 2012).

2.2.1 Elements of Cooperative Learning

Five essential elements are required in cooperative learning classroom for effective incorporation of cooperative learning in the classroom. The elements, according to Johnson, Johnson and Smith (2014) include positive interdependence, promotive interaction, accountability, appropriate use of social skills and group processing.

Positive interdependence occurs when individuals recognise that they can reach their goals if and only if the others in the group also reach their goals, thus individuals' goal achievements are positively correlated (Johnson et al., 2014). Positive interdependence exists when group members perceive that they are connected with each other in a way that one cannot succeed unless everyone succeeds (Johnson & Johnson, 2016). The second essential element of cooperative learning is individual and group accountability. Individual accountability occurs when the performance of each individual learner is assessed and the outcomes are given back to the individual and the group. Each group has a responsibility for completing one's share of work and aiding the work of other group members which enable the students in the groups to learn together so that they can subsequently perform higher as individual (Johnson et al., 2014). The group is held accountable for achieving its goals and each member is held accountable for contributing his or her share of work (Johnson & Johnson, 2016). The third essential element is promotive interaction, preferably face-to-face. Promotive interaction exists when members share resources and help, encourage, support and praise each other's efforts to learn (Johnson & Johnson, 2016). The fourth essential element of cooperative learning is teaching students to use the appropriate social skills. Social skills entail interpersonal and small group skills, skills for working together effectively and maintaining groups (Johnson et al., 2014). Students are expected to learn academic matter as well as learn interpersonal and small group skills. Group members must know how to provide effective leadership, decision-making, trust-building, communication, and conflict-management skills, and be motivated to use the prerequisite skills (Johnson & Johnson, 2016). The fifth essential element is group processing. Group processing is the practice of allowing group members discuss how well they are achieving their goals and maintaining effective work relationships. This can be done through careful analysis of how members are working together which results into continuous improvement of learning results (Johnson & Johnson, 2016).

Johnson et al. (2014) proclaimed that understanding how to implement these five essential elements enables teachers to: organise any lesson in any subject area with any set of curriculum materials cooperatively; modify cooperative learning to their specific circumstances, needs, and students; intervene to improve the effectiveness of any group that is not working. According to Johnson and Johnson (2016), these five elements are vital to all cooperative systems and hence must be carefully implemented and maintained.

Moreover, there are four essential characteristics of cooperative and collaborative classrooms that create meaningful learning in classrooms thus: shared knowledge among teachers and students; shared authority among teachers and students; teachers as mediators; heterogeneous groupings of students. For any cooperative learning strategy to influence students positively, adhering to these essential characteristics is pivotal (Sunasuan and Songserm, 2021).

2.2.2 Types of Cooperative Learning

Cooperative learning is grouped into two types, formal cooperative learning and informal cooperative learning (Johnson et al., 2008).

According to Johnson et al. (2008), formal cooperative learning consists of students working together to achieve shared learning goals and complete specific tasks and assignments in unison (examples include problem solving or decision making, writing a report, conducting an experiment, reading a chapter or reference book, learning vocabulary, or answering questions at the end of the chapter). Johnson et al. (2014) stated that teachers do the following in a cooperative learning classroom:

> 1. Instructors make a number of pre-instructional decisions. They specify the objectives for the lesson and determine the size of groups, the method of assigning students to groups, the roles students will be assigned, the materials needed to conduct the lesson, and the way the room will be arranged.
> 2. Instructors explain the task and the positive interdependence. They clearly define the assignment, teach the required concepts and strategies, indicate the positive interdependence and individual accountability, explain the expected social skills to be used and provide the criteria for success.
> 3. Instructors monitor students' learning and intervene within the groups to increase students' interpersonal and group skills or to provide task assistance. They systematically observe and collect data on each group as it works and intervene to assist students in completing the task accurately and in working together effectively when needed.
> 4. Instructors assess students' learning and help students process how well their groups functioned. They carefully assess and evaluate students' learning performance. The instructors allow members of the learning groups to discuss how effectively they worked together and how they can improve in the future. (p. 105)

Johnson et al. (2008) explained that informal cooperative learning is the way of allowing students work together to achieve a shared learning goal in temporary ad-hoc groups that last from a few minutes to one class period. Informal cooperative learning can be used to set a mood conducive to learning, help set expectations as to what will be covered in a class session, focus students' attention on the material to be learned, ensure that students cognitively process and rehearse the material being taught, summarise what was learned and pre-cue the next session, and deliver closure to an instructional session. The groups of informal cooperative learning are often structured so that students engage in focused discussions before and after a lesson for three to five minutes and turn-to-your-partner discussions for two to three minutes interspersed throughout a lesson (Johnson et al., 2014).

2.3 The Concept of Advance Organisers

According to Mayer (2003), an advance organiser is information that is presented prior to the learning that can be used by the learner to organise and interpret new incoming material. It is relevant introductory material (Ausubel, 2000) and a relatively short arrangement of material introduced to the learner before the lesson (Githua & Angela, 2008). It is designed to reveal the relevant prior knowledge of a learner and usually presented at a higher level of abstraction, generality and inconclusiveness than that of the planned lesson and enhances the learning of the students. Advance organisers link the previous knowledge to the newly learnt knowledge, hence known as linking agents (Oyeniyi & Owolabi, 2020).

According to Patel (2016), advance organisers are the result of a teacher's intended effort to preview and structure the new material to be learned and to connect it to content already existing in students pre-existing schemata. The use of advance organisers is not a teaching method on its own but a teaching strategy that is used to clarify the science concepts the students are trying to attain (Oyeniyi & Owolabi, 2020). David Ausubel developed and studied the theory of meaningful learning and advance organisers through the teachings of Jean Piaget (Rhalmi, 2011). Hence Ausubel's advance organiser can best be classified as a deductive method or reasoning, provides the rule to follow then the example leading to the correct answer or learning (Ifamuyiwa, 2011).

'Subsumers' are parts of the learner's existing cognitive structure that can provide for the interactions which may lead to meaningful learning. Hence, a subsumer is any concept, or principle that the learner already knows that can provide for association for the various components of the new knowledge. Introduced in the form of a topic which contains ideas with which the learner will have some familiarity, advance organisers are used in the absence of subsumers since new learning must be linked to existing knowledge for meaningfulness (Ifamuyiwa, 2011).

An advance organiser model (AOM) is a powerful instructional tool used by teachers to introduce the lesson topic and illustrate the relationship between what the students are about to learn and the information they have already learnt. This enables teachers to help students understand, retain and remember the new learning material (Somashekhara & Dange, 2020). Joyce, Weil and Calhoun, as cited in Gidena and Gebeyehu (2017) noted that there are three phases of AOM of teaching and that includes:

> Phase one: Presentation of the advance organiser – The teacher goes over the goals of the lesson and gets students ready to learn, introduces the topic, connects to previous learning, and refers to materials needed. Moreover, teacher presents the advance organiser, making sure that it provides a framework for later learning so that the content is connected to student's prior knowledge. The types of organisers that can be used are charts, photos, films,

> graphics, concept maps, and handouts. The teacher explains what the organiser is, but give detailed content in the next phase.
>
> Phase two: Presentations of the learning task or material – The teacher presents learning concepts and content, paying special attention to the logical ordering and meaningfulness to students and explain the content using the advance organiser as a framework connection. Students are required to explain the message presented by the advance organiser presented to the students. During the instructional process, students are actively engaged in a discussion in an effort to interpret the advance organiser.
>
> Phase three: Strengthening of cognitive organisation – The teacher asks questions and elicits student responses to the presentation to extend student thinking and encourage precise critical thinking either in large group, small group or individual activity. (p. 5)

In short, advance organisers are not a simple overview, reviewing of what was covered in the previous class, stating the objectives of the lesson, recalling what was done last week or last year, recalling a personal experience and relating it to what will be learned, or telling the students about tomorrow. But advance organisers are tools that help to connect the known to the unknown, organisational clues and frameworks for helping students understand study materials (Patel, 2016).

2.4 Types and Forms of Advance Organisers

There are two types of advance organisers namely expository and comparative organisers (Karthikeyan & Denisia, 2021; Woolfolk, 2001).

Expository organisers function to provide the learner a conceptual framework for unfamiliar and new information (Woolfolk, 2001). They are used when the new material is totally unfamiliar. They highlight context and link the essence of the new material to be learnt with some relevant previously acquired ideas (Curzon, as cited in Awodun, & Boris, 2021). According to Ausubel (2000), an expository organiser needs to be used on fairly unfamiliar materials to provide relevant near subsumers and this strategy advocates the method that involves presenting and ordering the subject matter sequence which enhances the clarity and stability of the cognitive structure (Patel, 2016).

Comparative organisers are used when the information to be acquired is relatively familiar to the learner (Woolfolk, 2001). They are used when the material to be learnt is not totally new. They are advance organisers intended to identify ways in which that material to be learnt is similar to and differs from that which is already known (Curzon, as cited in Awodun, & Boris, 2021), and they are designed to incorporate new concepts with basically similar concepts existing in the cognitive structure (Patel, 2016). Comparative organiser is used for fairly familiar learning materials to incorporate as well as distinguish between new ideas and existing ideas (Ausubel, 2000).

An advance organiser, whether expository or comparative, can take many forms thus text-based advance organisers and visual advance organisers (Dell'Olio & Donk, 2007).

Various visual materials known as graphic organisers may also act as advance organisers effectively. Graphic organisers, according to Odewumi, Gambari and Bada (2019) are unique tools of representation, illustration and demonstration of information in visuals or graphic form in instructions. Advance organisers that are presented graphically are also known as graphic advance organisers (Ayverdi et al., 2013). But not all graphic organisers utilised during lesson are necessarily advance organisers. Nakiboğlu at al., as cited in Ayverdi et al., (2013) explained that while advance organisers are being used in the beginning of the lesson, graphic organisers can be used in any processes of lesson with different intentions and that being visual is key to graphic organisers, but advance organisers can be visual or solely prose.

According to Ausubel, because advance organisers are presented at the same level of abstraction and generality as the rest of the material, they are different from overviews and summaries which simply highlight key ideas (Ifamuyiwa, 2011). They take different forms such as descriptions with pictures, flowcharts, cards, maps, story maps, Venn-diagrams and questions, orals and visuals (Owoeye, as cited in Oyeniyi & Owolabi, 2021). Shihusa and Keraro (2009) contended that advance organisers can take many shapes including a simple oral introduction by the teacher, outlines, student discussion, advance organisers timelines, concept maps, charts and diagrams. At the start of a lesson, presentation of the advance organisers can be used in the form of story, probing questions, or any other way that may help in connecting the new ideas with the previous concepts or ideas which must be learnt by the students (Mayer, 2003).

Patel (2016) asserted that the most effective advance organiser is the one which uses appropriate illustrations, analogies and concepts terms and proposition that are already familiar to the learner. According to Novak, as cited in Shihusa and Keraro (2009), advance organisers mostly include analogy, metaphor, model or capsule of knowledge as well as concept maps. Analogies and metaphors are frequently used as advance organisers (Karthikeyan & Denisia, 2021).

2.5 Construction of Advance Organisers

Constructing an advance organiser is the task of the teacher because the teacher determines the structure of the discipline, content, or subject to be mastered and then develops the organiser along with it (Dell'Olio & Donk, 2007). According to Patel

(2016), designing the exact form that of an advance organiser is dependent upon: the nature of the learning material; the age of the learner; the degree of prior familiarity with the learning material.

Mayer (2003) made suggestions on defined steps for constructing advance organisers in order to facilitate learning and retention. Mayer, as cited in Awodun and Boris (2021) advocated that advance organiser should:

1. be composed of a short set of verbal or visual information;
2. contain no specific content from the preceding learning task;
3. be presented prior to learning;
4. influence the learners' encoding process;
5. generate the logical relationships among the elements in the preceding learning task. (p. 17)

Based Ausubel's idea, Bricker, as cited in Chen (2007) suggested a modified series of procedures for constructing textual advance organisers. The procedures include:

1. Analyse learning materials to discover and list necessary prerequisite knowledge.
2. Map the cognitive structures of learners and find out if they know these prerequisite materials.
3. Summarise the major general ideas in the material to be learned.
4. Determine the characteristics of the advance organiser.
5. Write a paragraph of the advance organisers emphasizing the major general ideas and similarities across old and new topics. Examine the examples and use them as models.
6. The main subtopics of the lesson should be covered in the same arrangement as they are presented in the advance organiser. Estimate the readability of the organiser.
7. Check the understandability of the advance organiser.
8. Assess the study time of the advance organiser.
9. Evaluate the validity of the advance organiser.
10. Revise the advance organiser (p. 21)

The current study employed the ten steps in constructing the advance organisers recommended above.

2.6 Benefits of Advance Organisers to Teaching and Learning of Science

Studies have revealed that advance organisers increase retention abilities and higher achievement and ease the acquisition of more scientific concepts. Researchers have argued that the use of advance organisers provide a link to previous knowledge to the new learning (Oyeniyi & Owolabi, 2020). According to Patel (2016), the purpose of advance organisers is to explain, interrelate and integrate the material in the learning activity with previously learned material and also help the learners to discriminate new material from previously learned material. To other researches, advance organiser closes the gap between prior knowledge and new learning as students are able to understand better and retain more knowledge (Oyeniyi & Owolabi, 2020). Karthikeyan and Denisia (2021) affirmed that new information can be remembered easily if advance organiser is used to link the new information to old information because and it acts as a conceptual bridge from the old information to the new information and provides a structure for students thinking. Advance organisers such as analogies and metaphors, help student recognise that the topic they are beginning to learn is not totally new and that it relates to something they are already comfortable with. Consequently, it helps the students better understand the new concepts, and encourages and motivates them, as it makes them more confident about the material to come (Karthikeyan & Denisia, 2021).

Advance organisers may benefit slower learners and those that do not have a wide knowledge of topics available to them. They allow the learner to organise the material into a familiar structure because it becomes the student's prior knowledge before learning of the new material (Mayer, 2003). UzZaman, Choudhary and Qamar (2015) asserted that teachers can use the advance organiser to facilitate whole class discussion about upcoming information, getting students thinking and talking about what they already know. Advance organisers unambiguously inform students what they will be learning which reduces the likely stress of the unknown which can interfere with the student achievement. Due to flexible nature of advance organisers, they can be modified properly and easily for students with special needs which in turns lead to meaningful learning among these students. The use of advance organisers encourages students to directly participate in their learning and to be self-reflective throughout the lesson (UzZaman et al, 2015; Githua & Angela, 2008).

2.7 Innovative Instructional Strategies in Teaching and Learning of Science

Instructional strategies are innovative techniques teachers use to deliver their lessons. They involve any type of learning technique a teacher uses to help students learn or gain better comprehension of learning material (Persaud, 2021). They typically reflect the opposite of traditional teaching and training which focuses on transmissive, rote memorisation techniques which are ineffective (Brown, 2021). According to Persaud (2021), the main objective of using instructional strategies is to produce students who are independent strategic learners thus students who will be able to use appropriate strategies on their own and utilise them effectively to complete tasks.

Persaud (2021) established that effective instructional strategies: help students become actively involved in the learning process and support students in reaching their learning objectives; motivate students by capturing their attention, improving their engagement and encouraging them to focus, remember and understand course; allow teachers to make the learning experience more fun and practical to the students; allow teachers to be able to monitor and assess student performance through different methods of evaluation; offer an opportunity for students to demonstrate their knowledge on their own when needed; enable students to make meaningful connections between concepts learned during lesson and real-life situations (Persaud, 2021).

Instructional strategies include different teaching methods, procedures and plan that instructor use to teach students in their courses. There are several different types of instructional strategies, each with their own unique strengths and weaknesses. Teaching to peer, for example, enables students to gain familiarity with the material so that they can educate their peers about what they learned (Brown, 2021). Persaud (2021) also stated there are various instructional strategies that can be used effectively across all learning areas with wide range of learning styles. Hence, innovative strategies are necessary before, during and after instruction to improve upon the quality of learning of science among learners. Example of innovative instructional strategies employed in this study includes the cooperative learning, use of graphic organisers, improvisation and technology in the classroom.

2.7.1 Use of Graphic Organisers

It is the instructional strategy that involves the use of visual learning tools called graphic organisers to aid learners in learning. Graphic organisers are teaching and learning tools that show organisation of concepts and relationships between them into a visual format. They can be used as a tool throughout a lesson, or for review at a later time unlike advance organisers that can used only at the beginning of the lesson (Ayverdi, Nakiboglu, & Oz Aydin, 2013).

Salinger (2003) established that graphic organisers like comparison charts help many students to express ideas in a visible or noticeable way in order to process new information and that they have many uses in the classroom and can be used across the various curriculum and levels with increasing patterns of complexity (Moore, 2003).

The use of graphic organisers: enhances students' prior knowledge of the topic being discussed and assists students in connecting newly gained knowledge or concept to prior knowledge (Howard, 2005); gives students enough time to enhance his or her brain for the information he or she is about to learn when organisers are used to create a structure of prior knowledge (Zull, 2002). Howard (2005) further asserted that hierarchically organised graphics improve and assists in problem-solving recall and transfer of learning since they require examination, explanation and combination of content.

According to Velarde (2019), some examples of organisers are Circle Map, Spider Map, Idea Web, Concept Map, Venn Diagram, Tree Chart, Sequence of Events Chain, Cause and Effect Map, Brace Map, Analogy organisers, T-Chart and Timeline Chart.

There are many kinds of graphic organisers. Accordingly, Struble (2007) grouped graphic organisers into four categories according to the interrelatedness of information or idea to be presented in a specific graphic organiser. The categories include conceptual, hierarchical, sequential and cyclical. A conceptual graphic organiser such as concept maps, Venn diagrams, and KWL presents a central idea with supporting information. Hierarchical graphic organisers such as classifying charts, branching diagrams, and topic/subtopic webs rank information according to such qualities as importance and have sublevels to show such. Sequential graphic organisers such as cause/effect chart shows in order how events occur in a sequence. Cyclical graphic organisers such as life cycle chart shows the natural cycle of various concepts (Struble, 2007).

Antoine (2013) conducted a study to determine whether graphic organisers foster better student achievement in science classrooms than guided note taking with PowerPoint presentations using 69 high school Biology I students. Two body systems were taught using graphic organisers and two other body systems were taught only using a guided notes lecture with PowerPoint and both pre-test and post-test were administered for each body system studied. The findings of the study showed that use of graphic organiser instruction was significantly better for student achievement when compared to the use of PowerPoint instruction and that there was much more interaction between student and teacher during the graphic organiser lessons.

In this study, graphic organisers like Concept Maps, K-W-L (‘Know’, ‘Want to Know’ and ‘Learned’) Chart, were utilised.

2.7.2 Improvisation of Teaching and Learning Materials

Another innovative instructional strategy is the improvisation of teaching and learning materials, which improves learning process of the learners. Improvisation is the way of effectively using relevant material obtained in a given environment, probably due to inadequacy or lack of original material to achieve a better goal. It is way of substituting a learning material or resource with whatever is available to improve learning (Eunice, Anumudu, & Yemi, 2021). Improvisation of teaching and learning materials is the ability of the teacher to produce relevant appropriate and adequate material resources (George & Amadi, 2016). Okori and Jerry (2017) sees improvisation as the act of creating something or using something in absence of the ideal tool.

Mapaderum (2002) indicated that inadequacy of resources affects the academic performance of students negatively whiles the availability of resources and adequacy of facilities promote effective teaching and learning activities in schools. Accordingly, Okori and Jerry (2017) stated that improvisation becomes necessary when there are scarce resources and facilities. Aina (2013) also asserted that due to unavailability of science teaching and learning instructional materials, there is the need for improvisation. Eriba (2011) affirmed that improvisation is the act of constructing instructional materials from locally available environment in replace of original material when the original material is very expensive or in short supply or unavailable. Hence there is need for improvisation when resources are inadequate or unavailable. Okori and Jerry (2017) highlighted that issues like technical and human factors must be taken into consideration for improvisation to be successful and that the degree of sophistication of the improvised materials must be determined by what is to taught and the objective of the lesson.

According to STAN 40th anniversary conference proceedings, as cited in Okori and Jerry (2017), improvisation influences teaching and learning process in the following ways: provides a cognitive bridge between abstraction and reality in students; saves cost; enables teachers and students to make positive effort towards effective instruction; enables teacher to think and research for cheaper, better and faster methods of making teaching and learning process easier for students.

A quasi-experimental study was conducted by Eunice, Anumudu and Yemi (2021) to examine the role of students' location on mathematics learning when learning material is improvised with 68 secondary school students. It was concluded from the study that improvisation of learning material enhances students' performance in mathematics and students' location does not affect performance in mathematics when instructional material is improvised. Aina (2013) also conducted a study to look at the availability, uses and improvisation of instructional materials and the implications on teaching and learning of physics in secondary schools. 23 physics teachers and 39 physics students were involved in the study. The findings showed that there are shortage of instructional materials and inadequate use of the available ones. The finding also showed that the improvised materials had positive influences on students' learning of physics due to teachers' use of local materials.

2.7.3 Technology in the Classroom

Another instructional strategy that is modern and very necessary is the use of information and communication technologies (ICTs) in a classroom. Yunus (2007) sees ICT as a complex varied set of goods, applications and services used for producing, processing, distributing and transforming information. They include hardware and software, computer services, television and radio broadcasting, electronic media and telecoms. ICT tools within the school environment include teaching and learning of ICT related skills for enhancing teaching/learning tasks and problem-solving skills, presentation of classroom work, stimulating creativity and imagination (Pennington, 2016).

Integrating technology into the classroom is a great way to empower students to stay connected in this technological period. Technology rich lessons have been found to keep students motivated and engaged longer. Some examples of utilising technology in the classroom are creating multimedia presentations such as a video, animation, or some type of graphic, utilising tablet or an iPad, taking the class to virtual trip or creating and utilising a e-class (Cox, 2019). Interactive whiteboards, projectors or mobile devices can be used to display images and videos, which help students to visualise new academic concepts or ideas. Mobile devices can be used in the classroom for students to record results, take videos or photos or simply as a behaviour management technique (Quizalize, 2018).

Eady and Lockyer (2013) argued that ICT interactive lessons allow teachers to process guided presentations using text, audio and graphics. Use of technology assists teachers to give wider coverage of topics and get access to authentic sources and materials, which in turns help the teachers to establish a sense of contact between the classroom and the wider world (Ruthven, Hennessy & Deaney, 2005). Use of technology in teaching and learning has the possibility to enhance the way teaching is done and improve students' understanding of basic concepts (Fine & Fleener, 2004). Papaioannou and Charalambous (2011) argued that students are able to access more information faster in an efficient way when ICT is integrated into classrooms.

Teaching using different learning strategies with the support of ICT tools helps teachers to reach each student during classroom lessons. Thus, teachers who make use of ICT during lesson in a classroom use various strategies in order to connect the learning style of each student (Kozma, 2015). Davis and Tearle (2008) further argued that ICT tools enhance learning when they engage students in interactive, active and collaborative learning. Harrison (2012) through his study indicated that the use of ICT in classroom activities has assisted in the development of learning processes, such as helping to support response mechanism applications during learning and gaining attention of students. His findings also revealed that ICT use facilitates knowledge comprehension and assists students to understand tasks in class effectively.

2.8 Attitudes of Students towards Science

Krah (2015) defines attitude as students' motivation (encouragement), interest (enjoyment), participation and their interpersonal relationship with science teachers in studying science. According to Ellington (2003), attitudes of students can be classified as positive or negative. Ellington explains that the positive attitude is a desirable positive emotional disposition in relation to the subject that influences an individual's behaviour, making one to achieve better in a subject. He further stated that the negative attitude is a negative emotional disposition. According to Ellington, positive attitude towards science enables the students to enjoy science instruction and learn effectively. According to Yara (2009), teacher's attitude and his method of teaching can significantly influence the students' attitude. Hence, every science teacher should consider the development of positive attitude of students towards science subjects as his or her core mandate.

Data from various researches has shown that the majority of students come to science classes with pre-instructional knowledge or beliefs about concepts to be taught and many students develop only a limited understanding of science concepts following instruction (Duit & Treagust, 2003). These pre-instructional knowledge or beliefs may result into misconceptions or misunderstandings which become integral part of students' cognitive structures. As a result, these students experience difficulty in integrating any new information into their cognitive structures which eventually affect learning. Hence, teachers are encouraged to use interactive learning strategies to elicit prior knowledge towards conceptual change and understanding (Carale & Campo, 2003).

2.9 Science Process Skills for Students

Science process skills are skills that an individual can use in each step of his or her daily life by being scientifically literate and increasing the quality and standard of life by understanding the nature of science (Aktamis & Ergin, 2008).

It is vital for students to be provided with science process skills at every educational institution because these skills form the foundation for scientific method (Colley, 2006). Aktamis and Ergin (2008) confirmed that process skills are used to define problems, to observe, to analyse, to hypothesise, to experiment, to conclude, to generalise, and to apply the information with necessary skills. Process skills are necessary tools used to produce and use scientific information, to perform scientific research and solve problems since the rationale of science education is to enable individuals to use scientific process skills (Aktamis & Ergin, 2008).

According to Saat (2004), science process skills consist of basic and integrated skills.

2.9.1 Basic Science Process Skills

The basic process skills are simple skills that provide a foundation for the learning of the integrated or complex process skills (Padilla, 2018). Saat (2004) affirmed that basic process skills enable one to order and describe natural events and objects by providing the intellectual foundation to scientific probe. Basic science process skills include observing, inferring, measuring, communicating, classifying and predicting (Padilla, 2018).

2.9.2 Integrated Science Process Skills

Integrated process skills, according to Saat (2004) are skills used for solving problems or doing science experiments. Integrated process skills include controlling variables, defining operationally, formulation of hypothesis, experimenting, collecting and transforming data, constructing tables and graphs of data, describing relationships between variables, interpreting data, drawing conclusions and formulating models (Saat, 2004; Padilla, 2018). According to Colley (2006), when scientists design and carry out experiments in everyday life, they integrate various basic skills together.

Huppert, Lomask and Lazarorcitz, in the work of Aktamis and Ergin (2008) argued that science process skills can be gained by students through certain science education activities and that students learn the process skills better if they are considered an important object of instruction and if proven teaching methods are used (Padilla, 2018). Science process skills require instructional approaches that place emphasis on active learning rather than passive learning, student-directed learning rather than teacher-directed learning and integration of content and process rather than separation of content and process (Colley, 2006).

Numerous researches conducted showed that the best teaching strategies for basic process skills are: applying a set of specific clues for predicting; using activities and pencil and paper simulations to teach graphing; using a combination of explaining, practice with objects, discussions and feedback with observing (Padilla, 2018). Padilla (2018) further argued that teachers cannot expect mastery of experimenting or complex skills from students after a few practice sessions instead students should be given multiple opportunities to work with these skills in different content areas and contexts.

2.10 Academic performance of students

Academic performance is the knowledge acquired which is assessed by marks by a teacher and or educational goals set by students and teachers to be achieved over a specific period of time (Narad & Abdullah, 2016). Continuous assessment or examination results are tools that can be used to measure these goals or academic achievement (Wikipedia, 2022; Narad & Abdullah, 2016). According to Barkley (2006), students' academic performance points towards their ability to demonstrate the knowledge they learnt in quizzes, presentations, tests and final examinations.

2.10.1 Effects of Advance Organisers on students' academic performance in a Cooperative Learning Classroom

Advance organiser is a cognitive instructional strategy used to promote learning and retention of new information (Ausubel, 2000). Studies have shown that use of advance organisers assists in acquisition and remembering of scientific concepts and enhances higher achievement scores in learners (Oyeniyi & Owolabi, 2020). Chen's study (2007) stated that advance organisers positively influence knowledge acquisition and applications in learners. Curzon in Awodun and Boris (2021) stated that advance organisers facilitate teaching and learning process by enhancing students to directly participate in their learning (UzZaman et al, 2015). Oyeniyi and Owolabi (2020) affirmed that performance and retention of students are enhanced when they are exposed to advance organiser teaching strategy. According to Nyabwa (2005), use of advance organisers provides suitable learning opportunities to students and motivating them to acquire various skills and knowledge. Also, advance organisers improve students' listening comprehension which enhances their skills demonstration (Jafari & Hashim, 2012). Adebola (2011) asserted that this instructional strategy is also capable of improving students' mastery of content at the comprehension level and achievement. In determining the academic achievement, students taught using advance organiser had higher scores in achievement test or work than those taught using conventional means (Gidena & Gebeyehu, 2017; Somashekhara & Dange, 2020; Karthikeyan & Denisia 2021).

Cooperative learning activities positively enhance students' academic achievement (Gull & Shehzad, 2015). Mendo-Lazaro et al. (2022) stated that cooperative learning enables students to develop skills and motivates them to participates more actively in the teaching and learning process.

According to these authors, cooperative learning techniques make a significant contribution to improving academic goals which influence students' behaviours leading to the achievement of learning objectives (Mendo-Lazaro et al., 2022).

In summary, the concept of academic performance includes gaining of relevant knowledge, acquiring skills and competencies, securing high grades and academic achievements among others (Kumar, Agarwal & Agarwal, 2021) shown through quizzes, presentations, assignments, tests and / or examinations.

From the discussion above, the effects of advance organisers on students' academic performance in a cooperative learning classroom can be classified as:

Students' performance in assessment; Students' learning and retention of concepts through tasks and presentations; Direct participation of students and students' involvement in learning activities; Skills development of students.

2.11 Relevant Studies on the use of Advance Organisers: The Empirical Review

Many researchers continue to test the effects of advance organisers on learning activities in the traditional classroom in different subjects at all levels by conducting studies on a variety of organisers, including textual and graphic organisers (Awodun & Boris, 2021). But it is mostly argued by researchers that advance organisers positively impact students when used effectively with other innovative instructional strategies (Oyeniyi & Owolabi, 2020).

Box and Little (2003) conducted a study to determine if cooperative small-group instruction in combination with advance organisers could positively impact the self-concept and academic achievement of elementary school students. After utilising approximately 125 third grades in four experimental classes and one control class, the researchers reported that a substantial improvement in all classes, including the experimental and control groups. Nyabwa (2005) has shown the effectiveness of using advance organisers in the teaching of mathematics in secondary schools in his study. Nyabwa reported that the use of advance organisers in teaching Biology can make significant impacts on learners by providing appropriate learning opportunities to them and motivating them to learn both inside and outside the school environment. Furthermore, a research on how using an advance organiser model can influence meaningful learning of new concepts for learners in collaborative classrooms was carried out by Sunasuan and Songserm in 2021**.** The study sample involved 20 students in a class of the Introduction to Skills for Leadership and Management at Mahidol University International Demonstration School, Thailand. The findings revealed that advance organiser model can influence meaningful learning of new concepts and improve academic achievements for ESL learners in collaborative classrooms (Sunasuan & Songserm, 2021). The studies of Kapri (2017) revealed that the teaching of science by the Advance Organiser Model is better than by the conventional methods of teaching of science. The results of the studies showed that Advance Organiser Model of teaching appealed to the students in experimental group very much and they felt encouraged to learn the subject matter with interest. The results of the experimental study confirm that Advance Organiser Model is of better-quality compared to the traditional method because the mean achievement score of the experimental groups were highly significant than the mean score of the controlled group.

Conclusively, there were some discrepancies about various researches over years pertaining to the effectiveness of organisers attributed possibly to insufficient instruction on how to use organisers, short duration of treatment, imprecise construction of organisers, and inadequate research control (Chen, 2007). Due to the discrepancies, Chen (2007) suggested that the following factors need to be considered:

1. Construction of advance organisers should follow the precise definition and procedures.
2. Students need appropriate instruction about how to use advance organisers.
3. Learners' ability level and prior knowledge should be closely examined.
4. Learners' characteristics need to be taken into consideration.
5. Short-term study lasting within 10 days should be avoided.
6. Objective methods are needed for qualifying and quantifying learning results.

(p. 46)

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter discusses the research methodology employed in the study which includes the research design, population, sample and sampling techniques. Pre-intervention stage, intervention stage and post intervention stage are part of this chapter. The structure of this chapter also includes instruments, validity and reliability of the instrument and intervention design. The chapter concludes with data collection procedure and methods employed to analyse the data collected.

3.1 Research design

Research design is a plan or strategy the researcher used to investigate a research problem (Johnson & Christensen, 2008). It deals with particular data analysis techniques or methods that the researcher used (Fraenkel & Wallen, 2000). According to Creswell (2012), research design is the precise techniques concerned with research process: data collection, data analysis, and report writing.

The choice of a particular research design must be appropriate to the subject under investigation for every research study and that the various designs in research have specific advantages and disadvantages. Some examples of research designs are Action, Experimental, Quasi-experimental, Survey and Case Study Research designs.

The type of research design chosen for this study is Action Research design. It aimed at finding immediate solution to students' inability to answer practical questions and improving students' learning and understanding of selected concepts in Integrated Science without disrupting the normal scheduled of the school.

3.1.1 Action Research

Action research is a systematic process of collecting, analysing, and interpreting information in order to increase an understanding of a phenomenon about which one is interested or concerned in the classroom (Leedy & Ormrod, 2010). Parsons and Brown (2002) also described action research as systematic observation and data collection which can then be used by the researcher in reflection, decision-making and the development of more effective classroom strategies. Ferrance (2000) sees action research as a disciplined inquiry done by a teacher with an intent of informing and changing his or her practices in the future. This research design deals with solving specific problems in the classroom, which improves teacher's classroom practice and enhances students learning (Leedy & Ormrod, 2010). In line with this idea, Parsons and Brown (2002) view action research as a form of investigation designed for use by teachers to attempt to solve problems and improve professional practices in their own classroom. Action research in education specifically is process of studying a school situation to understand and improve the quality of the educative process (Johnson, 2012). It offers teachers a systematic, collaborative and participatory process of inquiry that seeks to address areas of concern or redress actively (Hine, 2013).

To extent these notions, Pardede (2018) views action research as a systematic principled way of observing and reflecting upon one's teaching to increase its strength and reduce its weakness. Furthermore, Pardede explained that action research is different from an experimental study because whiles action research is integrated into regular learning and teaching process, experimental research implements different treatments to two or more groups isolated from the regular class. It does not interfere with the class learning schedule because the actions or interventions are added into the regular learning process and that the actions can be new learning or teaching strategy, innovation or any other changes intended to bring about improvement to the teaching and learning process (Pardede, 2018).

Sagor (2000) established that the primary reason for engaging in action research is to assist the actor (practitioner) in improving and or refining his or her actions and that action research always relevant to the participants thus the teacher and students because it helps educators to be more effective at what they care most about.

Action research is beneficial to the researcher or practitioner because it: bridges the gap between research and practice (Johnson, 2012); enable participants to examine their own educational practice systematically and carefully (Ferrance, 2000); enhances teacher motivation and efficacy (Sagor, 2000); provides practitioners with new knowledge and understanding about how to improve educational practices or resolve significant problems in classrooms and schools (Mills, 2011); meets the need of a diverse student body (Sagor, 2000); encourages teachers to become continuous learners within their classrooms and schools (Mills, 2011).

According to Hensen, as cited in Hine (2013), action research:

> (a) helps teachers develop new knowledge directly related their classrooms, (b) promotes reflective thinking and learning, (c) expands teachers' pedagogical repertoire, (d) puts teachers in charge of craft, (e) reinforces the link between practice and student achievement, (f) fosters an openness toward new ideas and learning new things, and (g) gives teachers ownership of effective practices. (Hine, 2013, p. 152)

Generally, action research enables researchers or practitioners to develop a systematic, inquiring approach towards their own practices which enable them to effect positive change in this practice or within a larger community (Hine, 2013).

The core of action research in an educational setting is systematic reflection of one's professional practices which leads to increase teaching effectiveness.

In order to undertake systematic reflection, it is required of a teacher to undertake a five-step process namely: planning, collecting data, analysing the data, data reflection and an action (implementing action based on findings) (Smith, 2010). In the same vein, Sagor (2000) explained that action research always involves seven-step process. Sagor stated that the seven steps which are uninterrupted cycle for inquiring teacher includes: selecting a focus, clarifying theories, identifying research questions, collection of data, analysis of data, reporting results and taking informed action.

Action research is usually described as a cyclical process termed as 'action research cycle' (Hine, 2013), because it becomes an endless cycle for the inquiry teacher (Sagor, 2000) as the researcher faces real-life issues that are seldom direct and linear (Whitehead, as cited in Pardede, 2018). Although different authors described action research cycle differently, there is consensus that action research combines theory and practice, repeating certain stages or steps (Kaye & Harris, 2017).

Based on procedures of action research, many guidelines and models of action research were devised to be available to teachers who wish to engage in this research design (Hine, 2013). However, in this study, the Researcher employed Burns (2015) model of action research cycle which is similar to Dickens and Watkins (1999) and Nelson (2014) models. According to Burns (2015), action research approach goes through four stages including Planning, Action, Observation and Reflection in a cyclical nature.

These four stages in the cycle of the research (Figure 2) may become continuing or spiral of cycles which recur until the researcher conducting the action research achieved a satisfactory outcome (Burns, as cited in Pardede, 2018). The four-stage cyclical process above indicates the process of Action Research.

Action research cycle begins with the planning stage where the researcher determines the specific problem and study focus, interventions to be taken and then makes a decision on the intended improvement. The researcher then devises a plan to observe and record their classroom activities. During the action stage, the interventions devised consisting of classroom activities and innovative strategies are then applied. At the observation stage, relevant observations are noticed and recorded as the interventions are applied during the action phase. During the reflection stage, the recorded observations are then critically reflected upon by the researcher to determine whether the intended improvement has been achievement. If the intended improvement is not yet achieved, revised and modified classroom activities are then designed by the researcher based on the results of observations. These modified activities are then incorporated into the next planning stage as the researcher begins second action research cycle consisting of the same four stages. Also, if the intended improvement is also not achieved, the modified intervention of second cycle is used to conduct the third cycle, and so on. Accordingly, this cycle is continually repeated until the intended improvement has been achieved.

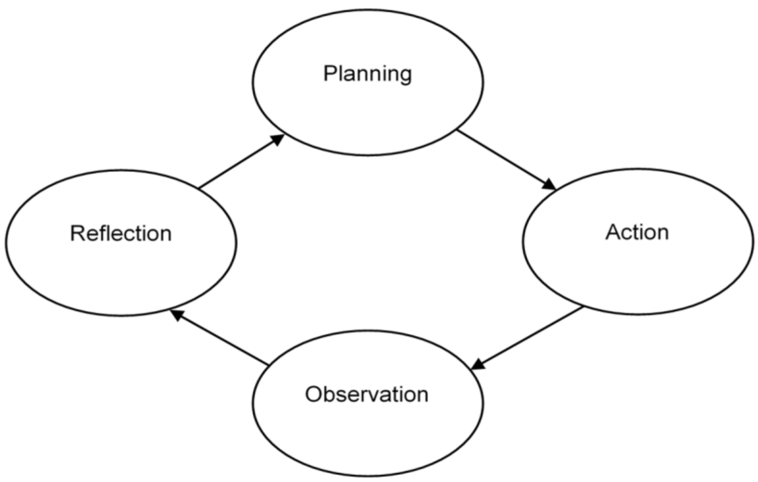


Figure 2: Action research cycle (Adapted from Burns, 2015, p. 189)

The four-stage cycle (Plan, Action, Observe and Reflect) is just the general process of action research and in practice, each stage consists of various steps (Pardede, 2018). Based on this notion, the research design was carried out in three phases with each phase consisting of at least one stage of four-stage cycle of action research.

This study was in three major phases: pre-intervention phase, intervention phase, and post-intervention phase.

3.1.2 Pre-intervention phase

This is a pre-stage of the research process that focuses on the establishment of the research context which is necessary for the intervention stage (Ismail & Wahat, 2010). In this study, the Researcher interacted with form three General Art students of Adugyama Senior High School to ascertain their level of understanding in practical concepts. Five lesson notes representing five lessons were prepared by the Researcher. A scheme of work or weekly forecast for the semester was prepared and each student was given a copy to follow. The form three General Art students were placed into groups of two and four for cooperative learning activities. This phase also included manipulation and setting up of practical apparatus/equipment and gathering required teaching aids and materials for the lessons. This stage of the study lasted for three weeks.

3.1.3 Intervention phase

This phase had to do with the implementation of the intervention strategies. According to Ismail and Wahat (2010), intervention is the process of taking action on the strategies that have been planned during the planning stage of action research cycle. It involves aligning instruction to learning standard, use of formative and continuous feedback and monitoring the instructional procedures over time (TeacherReady, 2017).

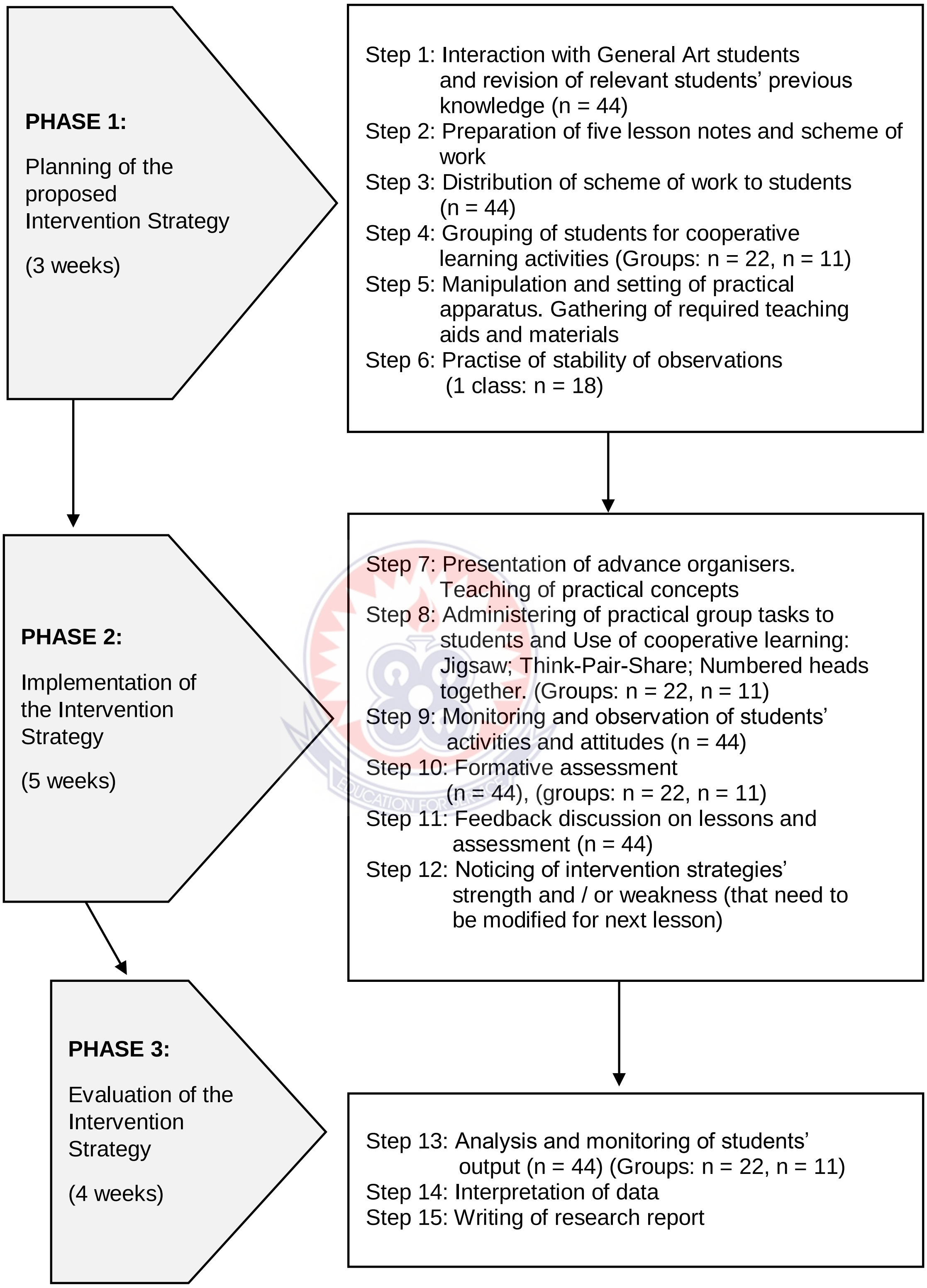
In this study, the Researcher delivered the five intervention lessons with the aid of the advance organisers with innovative instructional strategies. The form three General Art students performed practical activities at this stage in groups. The Researcher monitored students' activities, intervened when necessary and assessed them with feedbacks. The Researcher also monitored the students' attitude and science process skills exhibited during the five intervention lessons with the observational checklists by indicating the number of observational behaviour and checking for the presence of various process skills respectively. The findings from these observations and documents analysis of earlier lessons were used to modify the intervention strategies for subsequent lessons towards the attainment of the anticipated learning outcomes thus enhanced positive attitudes and achievement among the subjects. Five lessons were utilised and analysed during this phase in the study. This stage lasted for five weeks.

3.1.4 Post-intervention phase

This was the final phase which was mainly used to determine if the intervention was effective. This phase is also known as evaluation phase because it offers the opportunity to focus on the outcomes of the intervention (Ismail & Wahat, 2010).

In this study, the evaluation was done through the monitoring of form three General Art students' work outputs at the end of each week. The students' outputs were monitored by the researcher based on their individual participation in the lessons during the class and group practical activities and tasks. At the end of the five weeks of intervention, the findings of the analysed data were utilised in writing a report. This stage lasted for four weeks.

Figure 3 below shows a diagrammatic representation of the procedures of the research design.



TOTAL DURATION: 3 MONTHS

Figure 3: ***Research design of the study***

Figure 3 shows the specific procedures involved in the research process.

In phase one, the study began with interaction with 44 students for data to be collected on students' relevant previous knowledge and revision of these previous concepts learnt by students. This was followed by preparation of five lesson notes for five lessons, and the study environment (design of intervention procedures). The students were then grouped into two groups for cooperative learning activities thus each student was given two groups. The two kinds group were: (i) group of two students equaling a total of 22 groups; (ii) group of four students equaling a total of 11 groups. Teaching aids and practical apparatus needed in the study during the data collection phase were gathered and set-up. Also, the researcher practiced stability of observations where the observational checklists were piloted twice on another class of 18 students to ascertain their reliability.

In phase two, there was implementation of intervention strategies and the administering of practical group tasks to the 44 students in groups of four or two depending on the activities. During this activities and tasks, the 44 students were monitored and observed with the observational checklists. During this phase, continuous formative assessments were administered: to the students individually involving 44 students; to the groups involving 22 groups; and /or to the groups involving 11 groups. With regards to the formative assessments, documents analysis was used to analyse data on students' performances. Subsequently, the researcher engaged the students on feedback discussion among the students based on the data collected during lessons. In phase three, the evaluation of the intervention strategy was done through the monitoring and collation of the general data students' output using document analysis and observational checklist. This was followed by analysis, interpretation of data collated and writing of research report.

3.2 Research Population

A population is the characteristics of object, people, humans, objects, groups, organisation, cases or elements from which generalisation can be made from its study (Cohen, Manion & Morrison, 2007). According to Creswell (2012), population is a group of individuals or objects who have the same characteristics. It defines the limits within which research findings are applicable and that a population could be large or small (Creswell, 2012). In this study, the population was all students of Adugyama Senior High School in the Ashanti Region of Ghana.

3.2.1 Types of research population

There are two main types of research population namely target population and accessible population (Explorable, 2009). According to Explorable (2009), target population is to the entire group of individuals or objects which the researchers are interested in and would like to generalise their conclusions. Also known as theoretical population, it usually has varying characteristics. On the other hand, accessible population is the population that is available to the researcher for a study from which the study sample can be drawn. It is population which the researchers can readily access, work with, and apply their conclusions. It is also known as the study population and a subset of the target population (Explorable, 2009).

In this study, the target population was all form three students of Adugyama Senior High School in the Ashanti Region of Ghana and accessible population was form three General Art students in Adugyama Senior High School. The form three classes were targeted because they are group of students who are unable to answer WASSCE Integrated Science test of practical questions properly hence the researcher followed the normal time table of the school to conduct the research without disrupting classes. Also, General Arts students were chosen because they show lack of interest in the subject with negative attitude towards its learning and habitually perceived the subject to very difficult because of its practical nature.

3.3 Sample

A sample is a subset of a population which arises due to the inability of the researchers to test all the individuals in a given population (Explorable, 2009). It is a smaller group which is drawn from a larger population and studied (Punch, 2006). The use of sample allows the researcher to conduct the study to individuals from the population so that the results of his or her study can be used to draw conclusions that will apply to the entire population (Explorable, 2009). In this study, out of all form three General Art students, only form three General Art class, 3A2A of Adugyama Senior High School was chosen to serve as the sample. The sample size of this class was 44 students and out of these, 27 of them were boys and the remaining 17 were girls. The choice of General Art class, 3A2A, was made because that was the class allocated to the researcher.

3.4 Sampling Technique

Sampling is the process of selecting units from a population of interest so that by studying the sample the researcher may fairly generalise the results back to the population from where they were chosen (Trochim, 2002). Explorable (2009) also sees sampling as the process of taking a subset of subjects that is representative of the entire population. The purpose of sampling, according to Cohen et al. (2007), is to obtain a group of subjects that will provide specific information needed. Explorable further affirmed that sampling is done to save time, money and effort since it is impossible to test every single individual in the population.

Trochim (2002) highlighted that there are two main types of sampling procedures: probability and non-probability sampling. According to Explorable (2009), probability sampling is the type of sampling where every individual of the population has equal chance of being selected as a subject for the research. Probability sampling procedures include simple random sampling, systematic sampling, stratified sampling and cluster sampling. Non-probability sampling is the type of sampling where members of the population do not have equal chance being selected into the sample. Non-probability sampling procedures include convenience sampling, purposive or judgmental sampling, snowball sampling and quota sampling (Cohen et al., 2007; Explorable, 2009).

In this study, the Researcher employed convenience sampling. Convenience sampling involves choosing the nearest individuals to serve as respondents until the required sample size has been achieved or those who happen to be available and accessible at the time. This sampling procedure enables researchers to choose sample from those whom they have easy access to (Cohen et al., 2007).

In this study, convenience sampling technique was used to select a sample of 44 form three General Art students for the study because the Researcher was teaching that class.

The students in 3A2A class were further put into 11 groups of four students at times or 22 groups of two students at other times using simple random sampling technique to ensure maximum interactions and participation among group members involved in the study. Simple random sampling is technique where each member of the population has an equal and independent chance of being selected (Explorable, 2009). The instructor placed the students into groups of mixed abilities in two ways including Instructor-assigned groups and Randomly-assigned groups.

3.5 Research instruments

Research instruments are the tools that researchers use to collect data (Sathiyaseelan, 2015). To extend this notion, Discoverphds (2020) established that research instruments are tools that researcher use to collect or obtain, measure and analyse data that is relevant to the subject of research. A good research instrument must be able to assist the researcher in answering the questions, aims and objectives. Sathiyaseelan (2015) affirms that instruments are selected based on the research question and the credibility of an instrument depends on the validity and reliability.

In this study, two main instruments were used to collect data from the research subjects and they were: (i) document analysis; (ii) class observations checklist.

3.5.1 Document analysis

Document analysis is a method of data collection which involves content analysis from written documents in order to make specified deductions based on the study parameters (Kenpro, 2012). It is a form of research usually qualitative where documents are interpreted by researcher to give meaning to an assessment topic (Bowen, 2009). Dalglish, Khalid and McMahon (2020) stated that depending on one's research questions, documents review can be used in combination with interviews, observations and quantitative analyses, among other common methods. Examples of documents researchers usually examined during document analysis in school setting are archival documents like student records and standardised test scores, journals, maps, videotapes, audiotapes, and artifacts (Gay, Mills, & Airasian, 2012).

In this study, the documents analysed were students' class works. The Researcher used documents analysis to analyse and check the progress of the students through the students' performance in class works during the five lessons. The documents analysis was used to effectively measure objectives 1 and 3 and draw valid conclusions on effects of intervention strategy on students' performance in Integrated Science.

3.5.2 Class Observation

Observation is the process of gathering open-ended, firsthand information by observing people and places at a research site (Creswell, 2012). Observation offers the researcher the opportunity to gather live data from naturally occurring situations (Cohen et al., 2007). According to Creswell (2012), observation gives an opportunity to the researcher to study actual behaviour, to study individuals who have difficulty verbalising their ideas and to record information as it occurs in a setting. It requires careful attention to visual details and good listening skills in a setting (Creswell, 2012). In a classroom setting, observation can focus on facts like number of students in a class, on events as they occur in the classroom, on behaviours or qualities of the teacher and students (Cohen et al., 2007). According to Essuman-Johnson (2015), observational research approach can be classified into systematic and unsystematic observation. According to this author, systematics observation is a structured approach that involves the researcher detailing in advance, precisely what is to be observed, how the observations will be recorded and even possibly how the observations will be analysed and interpreted. On the other hand, unsystematic observation is an unstructured type that involves the researcher monitoring or observing all aspects that might be related to the problem under study (Essuman-Johnson, 2015).

In this study, the Researcher used the observational checklists to gather in-depth data on research objectives 1, 2 and 3. An observational checklist is a set of questions or statements that assist an observer evaluate behaviour and performance of an individual's skills. In teaching and learning environment, classroom observation helps the observer to identify skill gaps and problems areas to help improve teaching strategies, classroom settings, and student learning development (Andales, 2022).

Two different types of observational checklists thus checklist on science process skills and checklist on student's attitudes, were developed and used by the Researcher during lessons to take record of the science process skills and attitudes exhibited by the students. The science process skills intended to be observed during lessons include observation, measuring, inferencing, drawing and labelling, experimentation, manipulation, interpreting data (constructing tables, constructing graph of data, describing relationship between variables and drawing of conclusion). The students' attitudes intended to be observed during lessons include activeness, attendances, social interactions, following and working with instructions, contributions in class, working with class tasks and teaching aids.

3.6 Validity and Reliability of Instrument

3.6.1 Reliability of Instrument

According to Howell et al. (2022), reliability is the extent to which any measuring procedure yields the same results on repeated trials. Reliability for qualitative data represents neutrality, credibility, dependability, confirmability, applicability, trustworthiness and transferability. In quantitative research, it represents consistency, accuracy and precision, dependability, applicability over time, applicability over instrument and applicability over group of respondents (Cohen et al., 2007).

The types of reliability researchers should consider in quantitative research include equivalence, stability and internal consistency (Cohen et al., 2007; Howell et al, 2022). Also, the types of reliability in qualitative researchers accepts the possibility of replication thus if the same methods are used with the same sample resulting into the same results (Cohen et al., 2007) and hence include stability of observations, parallel forms and interrater (Denzin and Lincoln as cited in Cohen et al., 2007).

In this study, stability of observations was employed by the Researcher for the classroom observation checklists, where the observations were repeated on the same subjects at different time and the same results were obtained.

3.6.2 Validity of Instrument

According to Howell et al. (2022), validity is the degree to which a study accurately reflects the specific concept measured by the researcher. Validity in qualitative research represents honesty, depth, richness and scope of data, participates approached, extent of triangulation and objectivity of the researcher. On the other hand, validity in quantitative research is about careful sampling, appropriate instrumentation, and appropriate statistical treatment of data. The types of validity researchers should consider include content validity, criterion related validity (predictive or concurrent), construct, internal validity and external validity (Cohen et al., 2007).

In this study, the types of the validity the Researcher considered were internal validity, concurrent validity, and content validity. Internal validity was considered because the research design and procedures used in the study relates to the appropriate inferences made (Creswell, 2012). The Researcher further used two different data collecting instruments thus observation and documentation and the results from these instruments all agreed – concurred. Triangulation is a powerful way of demonstrating concurrent validity, particularly in qualitative research (Cohen et al., 2007). Since the triangulation reveals concurrent results, then it is prudent to conclude that concurrent validity has been practiced by the researcher. Moreover, content validity, which is how an instrument fairly and comprehensively covers the domain or items that it aims to cover (Cohen et al., 2007), was utilised by the researcher. For this reason, the content validity of the instruments was determined by subjecting them to experts including the researcher's supervisor, a lecturer at the University of Education, Winneba, and two SHS Integrated Science teachers who had more than five years of teaching experience for their suggestions and corrections.

3.7 Intervention Strategy

The Researcher designed five lessons using advance organisers along with innovative instructional technique to teach some selected practical Integrated Science concepts. The interventions were carried out for five weeks, taking place on Wednesday each week within the normal hours of classes which lasted for 90 minutes.

Using the 1 period allocated for lessons each day per week, a total of five lessons of five periods were taught during the period of intervention.

The first 15 minutes of each lesson was used to introduce each lesson through the use of advanced organisers. 50 minutes of each lesson was used by taking the students through the learning activities. Also, 10 minutes was used for group works or tests. The rest of the 15 minutes was used for whole class discussion, feedbacks of cooperative class works and evaluation of stated objectives of the lesson.

Lesson one was based on measurement of length. Lesson two was based on measurement of time, mass and weight. Lesson three was based on measurement of volume. Lesson four was based on measurement of density. Lesson five was based on plotting of simple linear graph and determination of slopes of graph.

At the end of each lesson, practical tests or group tasks were conducted on the taught selected concepts in Integrated Science for the students. The feedback from previous lesson(s) was incorporated into the teaching of the next concept. The final lesson was used to determine: how well the students demonstrated their understanding of the taught concept; mastering of their process skills; expected positive attitudes particularly enhanced activeness, attendance and positive interactions from them.

The intervention implementation commenced on Wednesday 18th of May, 2022 and ended on Wednesday 15th of June, 2022. The implementation of the intervention strategy and lesson structure involves five stages. The stages are explained below:

3.7.1 Introduction and use of advance organisers

The researcher introduced the lesson by reviewing the students' relevant previous knowledge. This stage is necessary to remind students of what they've learned and connect their previous knowledge to incoming materials which assist the students in subsequent learnings. The researcher used advance organisers, learning aid to introduce the lesson. This was done by: giving the students broad idea of lesson's goals before the lesson begins; presenting to the students graphic organisers like concept maps, visual information of terms and concepts before the lesson; guiding the students to use KWL ("What I Know", "What I Want to Know", "What I Learned") charts where students were aided to divide a page into three columns, then use one column to write what they think they know, use second column for what they want to know and use the third column for what they've learned.

3.7.2 Use of cooperative learning and other innovative instructional strategies

The researcher presented the main lesson in a cooperative learning environment. The cooperative learning activities utilised in the five lessons were Think-pair-share, Jigsaw method, numbered-heads together, cooperative problem solving, cooperative group tasks. Cooperative problem solving and group task is the way of giving assignments, tasks or exercises to students in groups to work on. Jigsaw method allows students to learn on aspects of topics or tasks and teach each other or help to put together a team product by contributing a piece of the puzzle (Colorin Colorado, 2018). Rigacci (2020) explains Think-pair-share as strategy that enable students to think about a topic or question individually and pair up and share their responses. Numbered-heads together according to Alfayed (2018) is a strategy that allows students to work in groups to gain a mutual understanding of a topic taught through the questions. Each student is assigned a number as identity and whose number is mentioned must answer the questions asked by the teacher (Alfayed, 2018).

In addition, the researcher presented the practical lesson with use of graphic organisers, technological tools and improvised learning materials in the cooperative environment. The whole class was then taken through some practical concepts in measurements. The researcher then allowed the students to perform some practical activities and class works in groups by using instructional guides. For each week, students were taught using advance organisers and allowed to work and learn in groups.

3.7.3 Monitoring and Intervening

The researcher moved round and observed each individual performance of students in groups and the group tasks as the students were working on the given practical task. The researcher intervened when an individual or group asked for a clarification to be made while working on the task. As the cooperative learning is ongoing, the researcher asked questions which stimulate the students in the groups to think and work well.

3.7.4 Assessment

Assessment was done at the end of each of the five intervention lessons and the students' performance was analysed. The researcher evaluated the student individually and in groups using students' worksheet task and checklist. The researcher made checklists to keep track of individual points and performance. Students' adaptation to the instructional strategies and advance organisers were checked through their level of participations in the lesson. Students' attitudes to the lesson were also assessed through students' opinions and expressions, way they ask of questions and their contributions during the lessons. In addition, science process skills of the students exhibited during the lesson were assessed. The students were given formative assessment through various assignments and practical tests presented on worksheet and in exercise books in groups. The work assessments were given to the students in groups of four, groups of two and individually depending on the concept and type of assessment.

Students were not permitted to help one another or copy from each other during the evaluation exercises. The assignments, tests and exercises were marked, scored and collected for the students for analysis. The researcher recorded the findings of the students.

3.7.5 Feedback

The researcher also observed and gave possible feedbacks that students need to progress in the lessons. General discussions on the feedback on the practical activities were done after each lesson. In addition, the researcher identified above average, average and below average students through individual participation in the various lessons and group works. Student's weaknesses on use of advance organisers, misrepresentation of scientific process skills, misconceptions of topics and comprehension problems were identified and addressed. Above average and average students or groups were award or praised. Students and groups who have improved over the previous exercise and assignments were also awarded or praise. This is to acknowledge the individual and group achievements which encourage the individual students to learn vehemently and group of students to work cooperatively.

3.8 Data collection procedure

Data collection is the process of collecting and measuring information on variable of interest, in an established systematic way that enables one to answer stated research questions, test hypothesis, and evaluate outcomes (Rosalina & Jayanto, 2018).

Data collection, according to Creswell (2012), is the process that involves more than simply gathering information. The procedure involves determining the participants to study and sites, considering what types of data to collect from several sources available to the research, selecting instruments that will be useful for the study and administering the data collection process to collect data (Creswell, 2012).

In this study, data collection was done with the aid of the research instruments, document analysis and observation. The data collection was done in three phases:

The first phase consisted of collection of pre-intervention data based on relevant previous knowledge of the students. This was done through researcher's interaction with the students. Teaching and learning record forms were used to collect data from these activities.

The second phase involved collection of data on the five intervention lessons designed by the researcher. During this phase, the researcher taught some selected practical concepts in Integrated Science for five weeks using the intervention strategy. After each lesson, the students were assessed in groups and individually through individual participation in lesson, group tasks, assignments and practical tests. The exercises and worksheets were marked and record. In addition, the students' attitudes, motivational levels and science process skills shown were also observed and recorded during the five intervention lessons. The analysed data from each of lesson enabled the researcher to check the students' progress and provide feedback to the them.

Students' performances documents such as combined register and record book, and observational checklist were used to collect the data.

The third phase was collection of post-intervention data based on effects of the intervention strategy. The researcher during this phase monitored the students' output, collated the outputs and analysed them for reports.

3.9 Data analysis procedure

Data analysis is the process of systematically applying statistical and/or logical techniques to condense and recap, describe and illustrate, and evaluate data (Begum & Ahmed, 2015). According to Vapulus (2018), whiles data analysis in quantitative research is a structured way of anyalsing data through the use of computational, statistical, and mathematical tools to derive results, data analysis in qualitative research is primarily exploratory and can include statistical procedures where data is continuously collected and analysed almost simultaneously (Begum & Ahmed, 2015). Data analysis in qualitative research is used to gain understanding of underlying reasons, provides insights into the problem or helps to develop hypotheses for potential quantitative research (Vapulus, 2018).

In this study, qualitative data methods were mainly employed and the data were analysed based on the progress made in each lesson by the students. This analysis procedure was chosen to determine the effects of the intervention strategy on students at every stage since it is intended to improve learning process in students. Observations, document reviews and findings made from the five lessons in data format were analysed. The analysis and discussions of the findings were also based on the five intervention lessons and the research questions respectively. Reports were presented on each lesson taught. The reports also included activities carried out, science process and positive attitudes shown by students, level of students' participations and progress of the lessons. From the analysis, conclusions and recommendations were made.

Table 1 demonstrates data-planning matrix of the study based on the research questions, data collection and analysis techniques. It further shows that document analysis and observation data served as the primary data collection methods in this study. Accordingly, a cycle of comprehensive and careful documents reviews and class observations were carried out on each participant involved in the study over the intervention strategy duration. In order to answer the research questions, specific sources of data, data collection techniques and data analysis techniques were devised by the researcher to guide the study (Table 1).

Table 1: Relationships between research questions, data source, data collection techniques and data analysis technique

Research Questions	**Data Source**	**Data collection Techniques**	**Data Analysis Technique**
1. What science process skills will students acquire when taught Integrated Science in a cooperative learning classroom? (Q1)	Students, Students' workbook, Students' record book	Document analysis, Class observation	Content analysis, Frequency analysis, Descriptive statistics
2. What effects does the use of advance organisers in a cooperative learning classroom have on students' attitudes towards Integrated Science? (Q2)	Students, Students' workbook, Students' record book	Class Observation	Frequency analysis Descriptive statistics
3. What are the effects of the use of advance organisers in a cooperative learning classroom have on the academic performance of students in Integrated Science? (Q3)	Students, Students' workbook	Document analysis, Class observation, Achievement test	Content analysis, Frequency analysis, Descriptive statistics

CHAPTER FOUR

FINDINGS AND DISCUSSION

4.0 Overview

This chapter dealt with the findings of the five lessons. Each lesson report was based on the teaching and learning activities that went on in the classroom, the procedures used as well as the observations made during the lessons. Data collected from students' weekly intervention exercises after lessons were analysed for easy presentation and analysis of data. The chapter ends with discussion of the findings in line with the research questions.

4.1 Report on Lesson One

Topic: Measurement of length.

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

1. Identify length measuring instruments;

2. Describe length measuring instruments;

2. Use length measuring instruments accurately.

Resources: Metre rule, Vernier calliper, Micrometer screw gauge, measuring tape, diagrams on the length measuring instruments and their parts.

Advance organisers: Brief description with skimming, KWL ("What I Know", "What I Want to Know", "What I Learned") chart

Cooperative learning strategy: Numbered heads together, Cooperative group tasks

4.1.1 Learners' Activities

Phase One: Introduction

1. The students were asked to state some instruments used to measure length.

Students' responses: *Metre rule, vernier calliper, measuring tape and pair of callipers.*

Presentation of Advance Organisers

2. **Brief description**: The topic was introduced and the students were briefed on objectives and goals to be determined by them after the lessons; The students were made to skim through handout and weekly forecast and write the subheadings under measurement of length on the board as a numbered list of agenda items to cover.

Students' responses: *Explanation of length, examples of length measuring instruments, use of metre rule, use of Vernier calliper and use of Micrometer screw gauge.*

3. **KWL chart**: Sheets of paper were distributed to the students and they were made to split the papers into three columns (Know (K) section, Want to Know (W) section, Learned (L) section); The students were allowed to independently complete the "K" section of the chart and then share individual answers and discuss responses;

The students were allowed to independently complete the "W" section and then share and discuss responses among themselves.

Table 2: Students' responses as indicated in KWL chart

K – Know	**W – Want to Know**	**L – Learned**
-Instruments like metre rule and measuring tape are used to measure length. *-The units of length include centimetre, millimetre, metre and kilometre*	*- How to take the readings of micrometer screw gauge and vernier calliper* *-What is the main use of vernier calliper and micrometer screw gauge?*	*-Taking readings of metre rule, vernier calliper and micrometer screw gauge.* *-Vernier calliper is used to determine diameter of small objects. Micrometer is used to measure extremely short lengths like diameter of wire*

Phase Two: Main lesson

1. A metre rule was placed along straight edges (door, marker board and table) and various readings were taken. The readings of the width of classroom door, the length of marker board and the length of student's table were taken for students to observe.

Cooperative Learning Activities

2. **Cooperative group tasks**: The students were allowed to practise the use of metre rule and measuring tape in groups by placing them along the length of exercise books, the height of student's table and size of classroom windows.

3. Through discussions with students, the researcher identified the parts of vernier calliper as shown in Figure 4

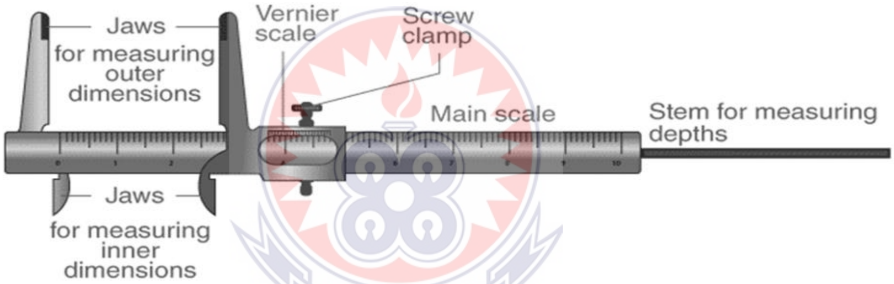


Figure 4: A diagram of Vernier calliper (Byjus, 2021)

4. The students were shown how to use and read vernier calliper: The students in groups practiced the use of vernier calliper by using glass marbles and pendulum bobs.

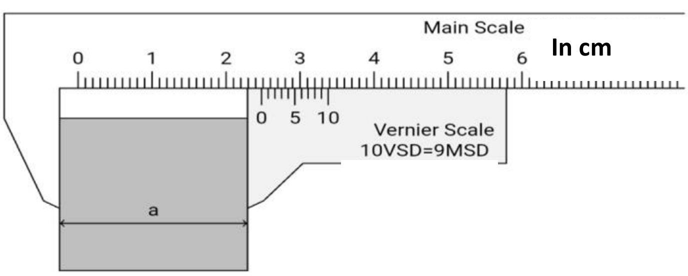


Figure 5: A diagram showing the reading of Vernier calliper (Singh, 2017)

Based on Figure 5, the students were made to read the main scale where it lines up with vernier scale's zero; The students read the vernier scale by identifying the first mark that lines up perfectly with a line on the main scale and multiplied the reading with the least count thus 0.01; The students added the readings to determine total reading.

Students' responses: *Main scale reading = 2.4 cm, Vernier scale reading = 8 x 0.01= 0.08, Total reading = 2.4 + 0.08 = 2.48 cm.*

5. **Numbered heads together**: The students were allowed to teach each other about how to read the vernier calliper in groups based on Figure 6. The researcher called on a number representing a student of a group to present the findings to the whole class.

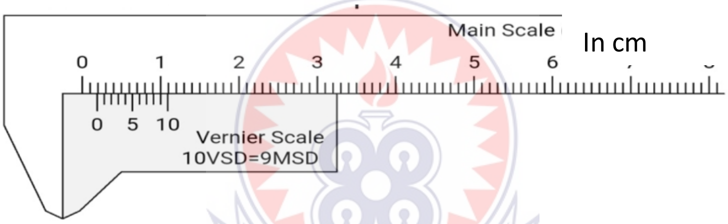


Figure 6: A diagram showing the reading of Vernier calliper in cm (Singh, 2017)

Student's response: *Main scale reading = 0.1 cm, Vernier scale reading = 9 x 0.09 = 0.09, Total reading = 0.1 + 0.09 = 0.19 cm.*

6. Through discussions, parts of micrometer were identified based on Figure 7.

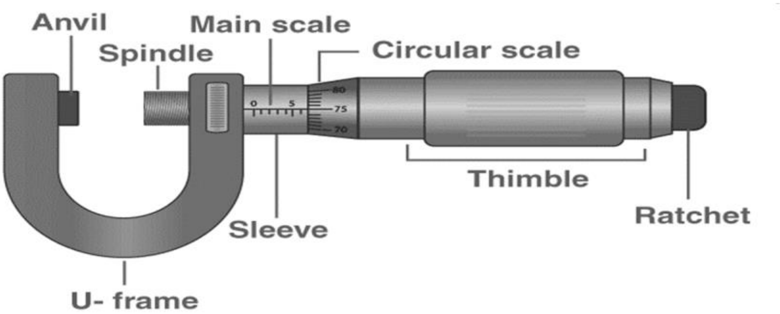


Figure 7: A diagram of Micrometer screw gauge (Byjus, 2021)

7. The researcher illustrated to students how to use micrometre screw gauge: The students were guided to practice use of the micrometer by placing small objects (a

paper, cloth and wire) to be measured between the jaws (anvil and spindle) whiles using the ratchet.

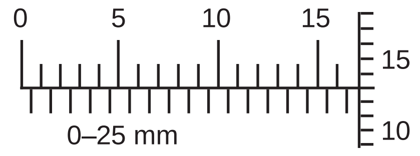


Figure 8: A diagram with the reading of Micrometer screw gauge (OSBC, 2017)

Based on Figure 8, the students were allowed to read the upper main scale by identifying the mark above the centre line close to the thimble scale; The students read the lower main scale by identifying mark below the data line using a count of 0.5; The students read the thimble scale by identifying mark on the thimble scale that lines up exactly with or little below the datum line of the main scale and multiplied the reading with its least count thus 0.01; Both readings were added to determine total reading.

Students' response: *Sleeve Upper scale reading = 16 mm, Sleeve Lower scale reading = 0.5 mm, Thimble scale reading:13 x 0.01 = 0.13 mm, Total reading: Sleeve reading + Thimble reading = 16 + 0.5 + 0.13 = 16.63 mm.*

8. **Numbered heads together**: The students were allowed to teach each other about how to use and read micrometer screw gauge in groups based on Figure 9. A number representing a student of a group was called to present the findings to the whole class.

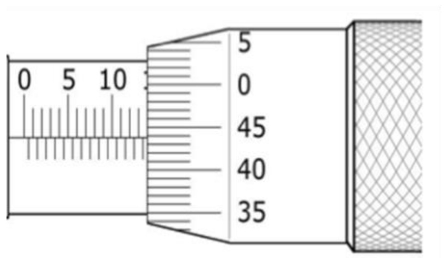


Figure 9: A diagram with the reading of Micrometer screw gauge (OSBC, 2017)

Student's response: *A. Sleeve reading: -Upper scale: 13 mm -Lower scale: 0.5 mm*

Thimble reading: 44 x 0.01 = 0.44 mm, Total reading: 13 + 0.5 + 0.44 = 13.94 mm.

Phase Three: Reflections

1. A group was asked to volunteer and summarise what happened in the day's lesson.

Student's response: *Length is measured in metres (m). Other smaller units of length are centimetre (cm) or millimetre (mm). Length can be measured by using and reading of metre rule, vernier calliper and micrometer screw gauge.*

Vernier calliper is used to measure round objects of small length. Micrometer screw gauge is used to measure objects of extremely short length.

2. The students were made to complete the "L" section of KWL chart independently. The students were allowed to share and discus their responses.

The students' responses under the L section were indicated in Table 2.

Findings from learners' activities:

1. The students used metre rule to determine the length of exercise books, the height of student's table and size of classroom windows. The students recorded the readings.

2. The students observed and identified parts of vernier calliper as main scale, vernier scale, external jaws and internal jaws. The students made individual drawings and labelled the parts as indicated in Figure 5. Also, the students used vernier calliper to determine the diameter of glass marbles and pendulum bobs. The students read vernier calliper accurately and recorded the readings.

3. The students observed and identified parts of micrometer screw gauge as sleeve scale, thimble scale, spindle, anvil and ratchet. The students made individual drawings and labelled the parts as indicated in Figure 7. Also, the students used micrometer screw gauge to determine the thickness (length) of paper, cloth and wire. The students read micrometer screw gauge effectively and recorded the readings accurately.

4. The skills acquired by the students were observing, measuring, drawing and labelling, communication, experimentation, manipulation, interpretation of data.

4.1.2 Evaluation questions

1. The diagram below shows a length measuring instrument. Study the diagram carefully and answer the following questions.

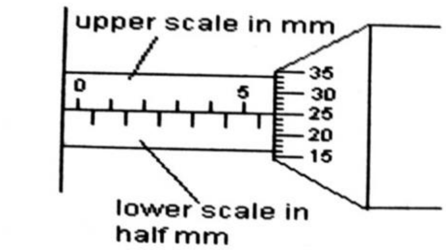


Figure 10: A diagram with reading of Micrometer screw gauge (Asiedu, 2017)

a. Identify the measuring instrument illustrated above
b. Name any two objects that the instrument illustrated can effectively measure.
c. What's the reading of the instrument?

2. The figure below shows lengths of wire used during an experiment. Measure and record the length L = L_1, L_2, L_3, and L_4

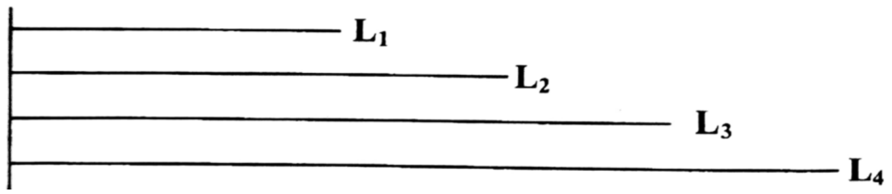


Figure 11: A diagram of lengths of wire

Expected responses:

1. (a) The instruments illustrated above is micrometer screw gauge. (b) Objects that can be measured: a piece of wire, thickness of cloth, thickness of a paper and a leaf.

c. Sleeve reading = 5.5 mm, Thimble reading: 25 x 0.01 = 0.25, Total reading = 5.5 + 0.25 = 5.75 mm

2. This question requires measuring the lengths of wire in cm using metre rule.

L_1 = 4.1 cm, L_2 = 6.2 cm, L_3 = 8.2 cm, and L_4 = 10.3 cm.

Depending on the correctness of the answers to the questions, students' responses to evaluation questions were classified as "correct" and "incorrect". The responses given by the students to the evaluation questions were analysed and presented in Table 3 in terms of number and percentage of students.

Table 3: Students' responses to evaluation questions in lesson one

Task	N	Correct	Incorrect
Identification of instrument	44	40 (90.9)	4 (9)
Examples of objects	44	41 (93.1)	3 (6.8)
Reading of instrument	44	36 (81.8)	8 (18.1)
Measurement of length	44	43 (97.7)	1 (2.2)

Note: Figures in brackets are percentages

Data from Table 3 showed that most of the students' responses were correct. 40 students (90.9 %) identified the length measuring instrument thus micrometer screw gauge correctly. As many as 41 students (93.1%) were able to give examples of objects that micrometer screw gauge can measure and 36 students (81.8%) were able to read the instrument well. Also, 43 students (97.7%) measured the length of wires accurately. On the other hand, only 4 students (9%) failed to identify the micrometer screw gauge whilst 3 students could not give examples of objects that the instrument can measure. Also, 8 students representing 18.1% were not able to read the instrument well and only 1 student (2.2%) failed to measure length of wires effectively.

4.1.3 Summary of Findings from Lesson One

1. Majority of the students identified vernier calliper, micrometer screw gauge and metre rule as length measuring instruments.

Most of the students were able to describe: Metre rule as a simple instrument used to measure short straight edges; Vernier calliper as instrument used to measure external and diameter of small spherical objects; Micrometer screw gauge as instrument used to measure objects of extremely short lengths.

2. Most of the students were able to effectively use the metre rule, vernier caliper and micrometer screw gauge to determine the length of objects. About 81.8 % of the students were able to read these instruments (micrometer screw gauge and metre rule) effectively and recorded their readings accurately.

3. The skills acquired by the students in the lesson were: observation through looking at the metre rule, vernier calliper and micrometer screw and identifying their parts; drawing and labelling skills; manipulation skills through the handling of the vernier calliper and micrometer screw gauge, measuring skill through placing the length instruments on objects to be measured and taking their readings; communication skills in answering questions and group activities and recording skill by noting and or tabulating the values of reading.

4.2 Report on Lesson Two

Topic: Measurement of Volume

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

1. Identify volume measuring instruments;

2. Use volume measuring instruments accurately;

3. Perform simple calculations relating to volume of regular objects.

Resources: Measuring cylinder, burette, pipette, volumetric flask, rectangular box, charts and diagrams on the volume measuring instruments and their parts.

Advance organisers: Concept mapping, Brief description with outline

Cooperative learning strategies: Jigsaw method, Think-Pair-Share, Cooperative problem solving, Cooperative group tasks.

4.2.1 Learners' Activities

Phase One: Introduction

1. The students were asked to state some instruments used to measure volume.

Students' responses: *Burette, Pipette, Measuring cylinder, Volumetric flask*

Presentation of Advance Organisers

2. **Concept mapping**: The concept "Volume" was introduced to the students by writing and circling it on the board; Using probing questions, the students were asked to give words or ideas that comes into their minds when presented with the concept;

Students' responses: *Regular objects, Irregular objects, Liquids, Solids, Measuring cylinder, Volumetric flask, Burette, Pipette, Total space occupied, Metre rule,* cm^3, *ml,* m^3, *Stone, A piece of rock, Leaf, Water, Petrol, Box, Book, Volume's formulae.*

The researcher wrote the ideas around the main concept as the students give their ideas; The researcher circled key words that are in the lesson to be treated; The students were asked how two words are linked and the students were involved to make links between words using arrow and ways the words are connected; The researcher wrote the links between the words on the marker board and make them into a concept map as shown in Figure 12.

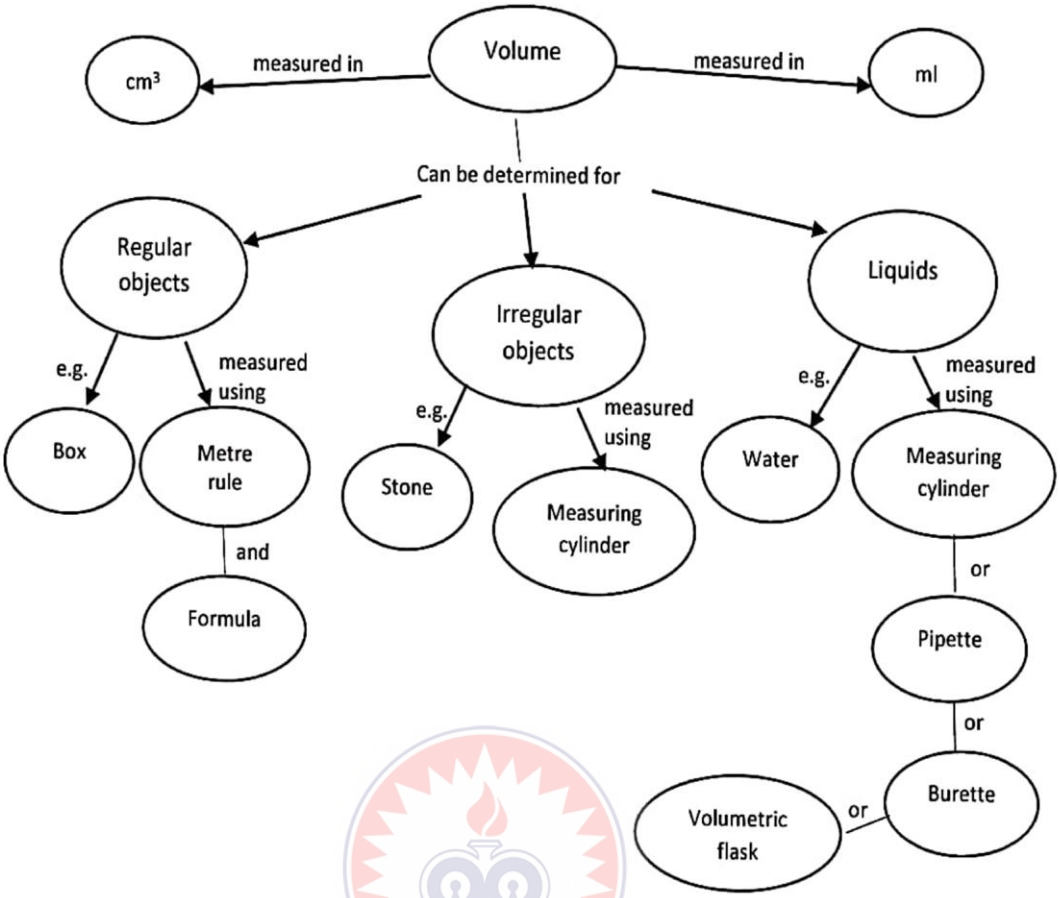


Figure 12: A determination of volume's Concept map

3. **Brief description with outline**: The topic was introduced and the students were briefed on objectives and goals to be determined by them after the lessons; The day's activities were presented to the students and item list was given to them and the students were made to cross out the item and move to the next one as they complete activity.

List of the day's activities presented to the students were: Use of measuring cylinder and volumetric flask; Reading of measuring cylinder; Use of pipette and burette; Regular objects and determination of volume of regular objects; Irregular objects and determination of volume of irregular objects.

Phase Two: Main lesson

Cooperative Learning Activities

1. Through discussion, the students were guided on how to use measuring cylinder and volumetric flask: In groups, the students were allowed to fill measuring cylinder with water to a certain level and then the reading was taken; The students were made to fill a 250cm^3 volumetric flask with water to its mark and the reading was taken.

2. **Cooperative problem solving**: The students were allowed in groups to solve a question that involves reading of various measuring cylinders containing liquids based on Figure 13.

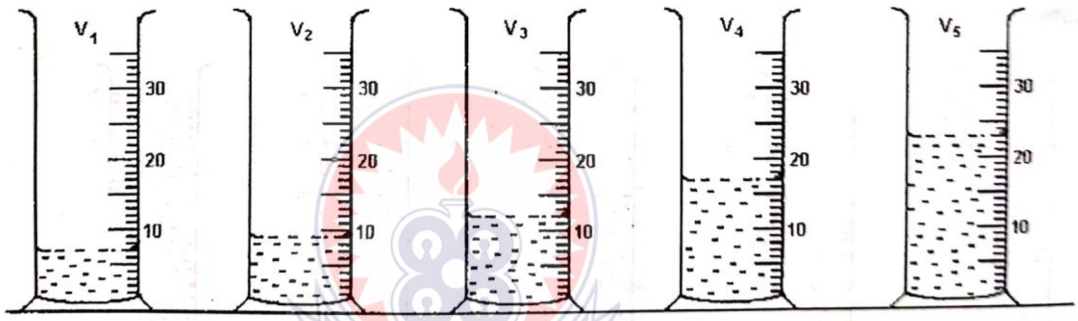


Figure 13: A diagram showing volume of liquid of measuring cylinders in cm^3 (Adams, 2020)

Students' responses: V_1 =7cm^3, V_2 =9 cm^3, V_3 = 12 cm^3, V_4 =17 cm^3, V_5 = 23 cm^3.

3. **Group tasks**: The students were guided on how to use pipette and burette: The students were allowed to observe the filling of 25 ml volumetric pipette with water to it mark using rubber bulb; The students were made to practice the filling of the pipette to the mark with water using rubber bulb in groups; The students were allowed to observe the filling of burette with water using beaker and funnel and reading of the burette; The students practiced the filling of burette with water using beaker and funnel in groups;

4. **Using Jigsaw method**, the students were allowed to teach each other the uses of pipette, burette, volumetric flask and measuring cylinder.

Students' responses: *Burette, pipette, volumetric flask and measuring cylinder are used to measure specific volume of liquids. Measuring cylinder can also be used to determine the volume of irregular objects. Volumetric flask is also used to prepare standard solution. Burette is also used for titration.*

5. The researcher demonstrated to students how to find the volume of rectangular box: Measure the length, the breadth and height of the box; Use the formula of "volume = length x breadth x height" to find the volume of the rectangular box.

6. **Think-Pair-Share:** The students were allowed to find the volume of Figure 14 using the formula of volume of rectangular object individually, as they show each other steps used to arrive to the answer. In pairs, they assessed each other's answers.

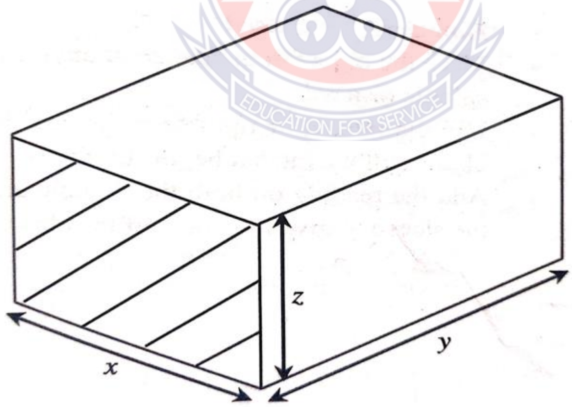


Figure 14: A diagram of rectangular block of metal (Adams, 2020)

Students' responses: *x = 3.2 cm, y = 4.1 cm, z = 2.0 cm. Volume (V) = length (y) x breadth (x) x height (y), V = 4.1 cm x 3.2. cm x 2.0 cm, V = 26.24 cm*^{3}

7. Through discussion, the students were made to give examples of irregular objects.

Students' responses*: Irregular objects include stone, leaf, a piece of broken glass, bean.*

8.Video clip: The students were showed a video clip of how to determine the volume of irregular object.

9. **Cooperative problem solving:** In groups, the students practiced and described how to determine the volume of irregular objects like rock based on Figure 15

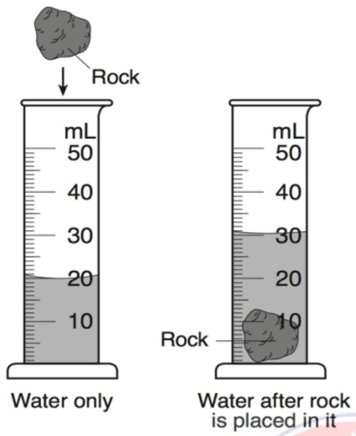


Figure 15: A diagram of rock placed in a graduated cylinder containing water causing the water level to rise (Brainly, 2017)

Students' response: *Initial volume of water in the measuring cylinder (V_1) is 20 mL, the final volume of water after the rock was immersed in the water (V_2) is 30 mL, the volume of the rock is determined the by using the relation $V_2 – V_1$. Hence volume of rock = 30 mL – 20 mL = 10 mL.*

Phase Three: Reflections

1. A group was allowed to summarise how to "determine of volume of objects''.

Students' responses: *Determination of volume can be done for regular objects, irregular objects and liquids. For regular objects like rectangular box, a metre rule is used to determine the length, breadth and height and then the appropriate formula is applied to determine the volume. For the irregular objects like stone, immersed the objects into liquid and determine the volume of displaced liquid. For liquids, pour the* *liquid into measuring cylinder and take reading as the volume. Other instruments like pipette, burette and volumetric flask can be used to determine the volume of liquids.*

2. The researcher ended the lesson by alerting the students' issues to be considered in the next lesson. As such, the researcher informed the students that "measurement of time and mass" will be treated in the next lesson.

Findings from learners' activities:

1. The students used measuring cylinder to determine volume of water. The students observed and recorded the readings of measuring cylinder. The students made individual drawings as indicated in Figure 13.

2. The students used volumetric flask to determine volume of water by filling it to its 250 cm^3 mark, observing and taking the readings.

3. The students used pipette to determine volume of water by filling it to its 25 ml mark, observing and taking the readings. Few students struggled with the use of the pipette.

4. The students used burette to determine volume of water. The students observed and recorded the readings of burette.

5. The students determined the volume of rectangular box by using the relation "length x breadth x height".

6. The students exhibited how to determine the volume of rocks using measuring cylinder. The students made individual drawings and labelled the parts as indicated in Figure 15.

7. The skills acquired by the students were observing, measuring, drawing, prediction, communication, inference, formulation of hypothesis, experimentation, manipulation and interpretation of data.

4.2.2 Evaluation question

1. a. State three instruments that can be used to measure a specific volume of kerosene.

   b. Explain briefly how to determine the volume of kerosene.

2. The figure below is an illustration of rectangular object. Study the figure carefully and answer the question that follows and determine the volume of Figure 16

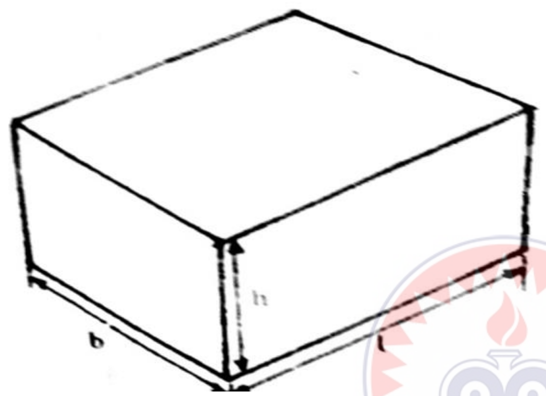


Figure 16: A diagram of rectangular box (Adams, 2020)

Expected responses:

1. (a) Measuring cylinder, pipette, burette, graduated beaker and volumetric flask.

   (b) Pour the volume of kerosene into measuring cylinder and note the reading.

2. Length, l = 4.0 cm, Height, h = 1.8 cm, Breadth, b = 2.8 cm. Since the object is the rectangular object, the formular of volume, l x b x h will be used. Volume of Figure 16 = 4.0 x 1.8 x 2.8 = 20.16 cm^3.

Depending on the correctness of the answers to the questions, students' responses to evaluation questions were classified as "correct" and "incorrect". The responses given by the students to the evaluation questions were analysed and presented in Table 4 in terms of number and percentage of students.

Table 4: Students' responses to evaluation questions in lesson two

Task	N	Correct	Incorrect
Identification of instrument	44	41 (93.1)	3 (6.8)
Determination of volume	44	35 (79.5)	9 (20.4)
Reading of instrument	44	39 (88.6)	5 (11.3)
Performing of volume calculation	44	36 (81.8)	8 (18.1)

Note: Figures in brackets are percentages

Data from Table 4 showed that most of the students' responses were correct. 41 students (93.1%) identified the volume measuring instruments thus instruments used to measure volume of kerosene. 35 students (79.5%) were able to show how to determine the volume of substances by explaining how to determine the volume of liquids. Also, 39 students (88.6%) were able to read volume measuring instruments particularly reading of measuring cylinder and 36 students (81.8%) performed calculation related to determination of volume of regular objects.

On the other hand, only 3 students (6.8%) were not able to list instruments used to determine volume of liquids and 9 students (20.4%) failed to show how to determine the volume of liquids. Moreover, 5 students (11.3%) were not able to read measuring cylinder properly and 8 students representing 18.1% failed to perform calculation pertaining to volume of regular objects.

4.2.3 Summary of Findings from Lesson Two

1. Majority of the students (93.1%) identified measuring cylinder, pipette, burette and volumetric flask as instruments used to measure the volume of liquids.

2. Most students were able to effectively use measuring cylinder, burette and volumetric to determine volume of liquid. Few of the students struggled with the use

of the pipette. About 88.6 % of the students were able to read the measuring cylinder well.

3. Most students (81.8 %) were able to perform the calculation related to determination of volume of regular objects like rectangular box.

4. The skills acquired by the students in this lesson were: observation through looking at the volume measuring instruments; drawing and labelling skills; measuring skills by taking the readings of liquid in measuring cylinders; manipulating skills by handling the metre rule, measuring cylinder, burette and pipette; communication skills in answering questions and group activities and recording skill by noting and or tabulating the values of reading.

4.3 Report on Lesson Three

Topic: Measurement of Time, Mass and Weight

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

1. Read time measuring instruments accurately;
2. Use mass measuring instruments accurately;
3. Use weight measuring instruments accurately;
4. State at least two differences between mass and weight.

Resources: Stop watch, stop clock, electronic balance, charts on volume measuring instruments and their parts, charts and diagrams on weighing scale and spring balance

Advance organisers: Brief description with skimming, KWL chart

Cooperative learning strategy: Cooperative group tasks, Numbered heads together

4.3.1 Learners' Activities

Phase One: Introduction

1. The students were asked to state some instruments used to measure time.

Students' responses: *Stop clock, Stop watch*

Presentation of Advance Organisers

2. **Brief descriptions:** The topic was introduced and students were briefed on objectives and goals to be determined by them after the lessons; The students skimmed through handout and weekly forecast and wrote the subheadings under measurement of time, mass and weight on the board as a numbered list of agenda items to cover.

Students' responses: *Example of time measuring instruments, Reading of stop clocks, Explanation of mass and weight, Mass measuring instruments, Use of electronic balance, Reading of weighing scale, Spring balance and how it works, Mass and weight: The relation and differences.*

3. **KWL chart**: Sheets of paper were distributed to the students and they were allowed to split the papers into three columns (K section, W section, L section);

The students independently completed the "K" section of the chart and then shared individual answers and discussed responses; The students independently completed the "W" section and then shared and discussed responses among themselves.

Table 5: Students' responses as indicated in KWL chart

K – Know	**W – Want to Know**	**L – Learned**
Stop clocks and watches are time measuring instruments. The unit of time is second. The unit of mass is kilogramme. Spring balance is used to measure weight. Beam balance is used to measure mass	*How to read stop clocks How to read weighing scales and spring balance What is the difference between mass and weight?*	*Reading of stop clocks, weighing scale and balance. Weight and mass are related by the relation weight = mass x gravity. Mass is amount of matter in a body and weight is force of gravity on a body. Spring balance works by extension of a spring in it.*

Phase Two: Main lesson

1. Through discussion, the students stated time measuring instruments and units of time.

Students' responses: *Stop clock, stop watch. The unit of time is second, minute.*

Cooperative Learning Activities

2. **Cooperative problem solving**: The students were assisted to read stop clocks in groups: Stop clock and chart of stop clocks were displayed in the classroom; The students read the stop clocks in seconds based on Figure 17.

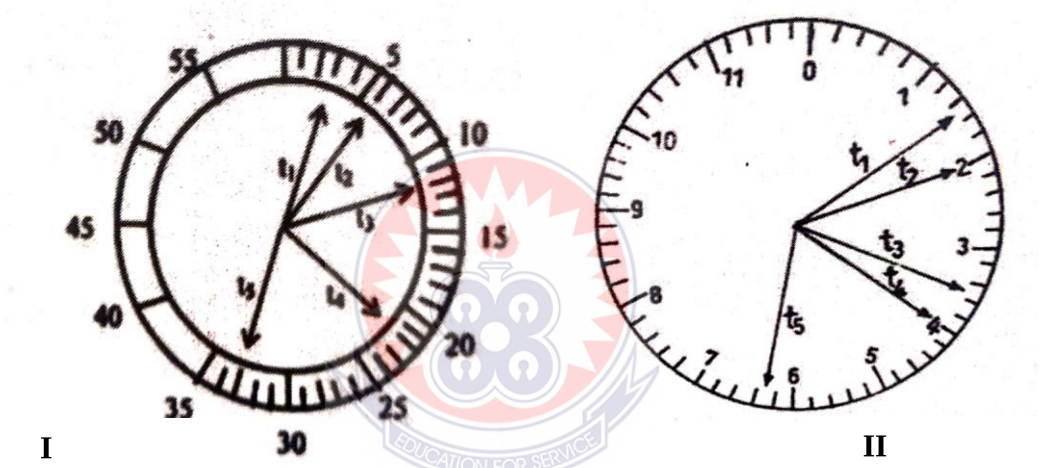


Figure 17: A diagram of stop clocks in seconds (Adams, 2020)

Students' responses: *For I:* $t_1 = 3s$, $t_2 = 6s$, $t_3 = 12s$, $t_4 = 22s$ *and* $t_5 = 33s$.

For II: $t_1 = 1.5s$, $t_2 = 3.5s$, $t_3 = 12s$, $t_4 = 4.0s$ *and* $t_5 = 6.3s$

3. **Through group discussion**, students stated the units of mass and weight.

Students' responses: *Unit of mass is kilogramme (kg), unit of weight is Newton (N).*

4. Students were made to list mass measuring instruments.

Students' responses: *Beam balance, Electronic balance, Weighing scale, Lever balance.*

5. **Group tasks:** The students were guided to use electronic balance: Electronic balance was displayed in the classroom; The students placed objects like marker, pen, stone and exercise book on the balance and observed the readings in groups.

6. A chart of weighing scale with object was presented to students and they were made to take the reading based on Figure 18.

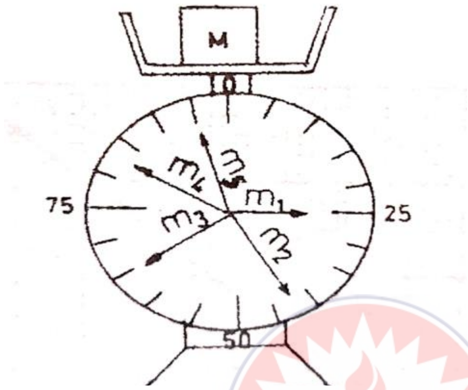


Figure 18: A diagram of readings showing masses of cubes in g (Adams, 2020)

Students' responses: m_1 = *25.0g*, m_2 = *42.5g*, m_3 = *65.0g*, m_4 = *82.5g*, m_5 = *95.0g*

7. The students were allowed to state weight measuring instrument.

Students' responses: *Spring balance*

8. Video: The students were showed a YouTube video of how the spring balance works

9. Through discussion, the researcher explained the relationship between mass and weight using the formula "weight (w) = mass (m) x acceleration due to gravity (g)"; The students were made to be aware that mass can be derived by rearranging the formula making the m the subject, giving m = w/g.

10. **Numbered heads together**: In small groups, students practiced the reading of stop clock and weighing scale; The students discussed the differences between mass

and weight; The researcher called on any number of any group to present the findings from his or her group to the whole class.

Student's response: *Reading of stop clocks in done in seconds and the reading of weighing scale is done in kilogrammes. Mass is the amount of matter a body contains measured in kg whiles is the force of gravity acting on a body measured in N.*

Phase Three: Reflections

1. The researcher asked a group to summarise what happened in the day's lesson.

Students' responses: *The instruments used to measure time include stop clocks and stop watches. The instruments used to measure mass include electronic balance and weighing scale. The weight measuring instrument is spring balance.*

2. Students completed the "L" section of KWL chart independently. Students were made to share their responses and discuss about the responses.

The students' responses under the L section were indicated in Table 5 above.

Findings from learners' activities:

1. The students observed, read and recorded the readings of stop clocks. The students made individual drawings as indicated in Figure 17.

2. The students used electronic balance to determine the mass of marker, pen, stone and exercise book. The students observed and recorded the readings of the balance.

3. The students observed, read and recorded the readings of weighing scale. The students made individual drawings as indicated in Figure 18.

4. The students described the spring balance as the instrument used to determine the weight of objects and that it is made up of spring, hook, hanger, scale and pointer.

5. The students explained the difference between mass and weight by indicating that mass is the amount of matter a body contains measured in kilogramme and weight is the force of gravity acting on a body measured in newton.

6. The skills acquired by the students were observing, measuring, drawing, communication, experimentation, manipulation and interpretation of data.

4.3.2 Evaluation question

1. If the mass of a block is 120 kg, calculate the weight. (Take g = 9.8 m/s^2)

2. Tabulate two difference between mass and weight.

3. A car travelling at a certain velocity begins to accelerate continuously for a period of time with corresponding times t = t_1, t_2, t_3, t_4 and t_5 as illustrated below (t in seconds).

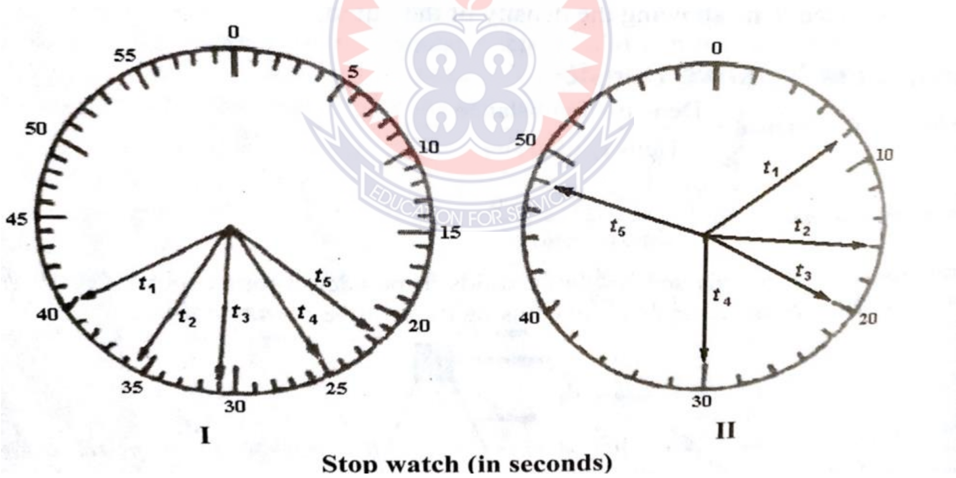


Figure 19: A diagram of stop clocks in seconds (Adams, 2020)

Read and record the times t = t_1, t_2, t_3, t_4 and t_5 for figure I and II

Expected response:

1. Weight (w) = mass (m) x acceleration due to gravity (g), where m is 120 kg and g is 9.8 m/s^2. W = 120 x 9.8 = 1176 N. Hence the weight of the block is 1176 N.

2. Mass: i. The quantity of matter in a body ii. A scalar quantity iii. Always constant everywhere iv. Measured by using top pan balance v. Unit is kilogramme

Weight: i. Force of gravity acting on a body ii. A vector quantity iii. Varies from one place to another iv. Measured by using spring balance v. Unit is Newton

3. I. $t_1 = 40.0$ s, $t_2 = 35.5$ s, $t_3 = 31.0$ s, $t_4 = 25.0$ s, $t_5 = 21.5$ s.

II. $t_1 = 8$ s, $t_2 = 16$ s, $t_3 = 20$ s, $t_4 = 30$ s, $t_5 = 48$ s.

Depending on the correctness of the answers to the questions, students' responses to evaluation questions were classified as "correct" and "incorrect". The responses given by the students to the evaluation questions were analysed and presented in Table 6 in terms of number and percentage of students.

Table 6: Students' responses to evaluation questions in lesson three

Task	N	Correct	Incorrect
Reading of weighing scale	44	36 (81.8)	8 (18.1)
Relating mass and weight	44	35 (79.5)	9 (20.4)
Identifying differences	44	40 (90.9)	4 (9)
Reading of stop clock	44	41(93.1)	3 (6.8)

Note: Figures in brackets are percentages

Data from Table 6 showed that most of the students' responses were correct. 36 students (81.8%) were able to read mass measuring instrument thus weighing scale effectively. Also, 35 students (79.5%) were able to relate mass and weight through their relations by performing simple calculations and 40 students (90.9%) identified the differences between mass and weight. Moreover, 41 students (93.1%) were able to read stop clocks effectively.

On the other hand, 8 students (18.1%) were not able to read the weighing scale. 9 students (20.4%) failed to show the relationship between mass and weight through calculation and 4 students could not identify the differences between mass and weight. Moreover, 3 students (6.8%) were not able to read stop clocks.

4.3.3 Summary of Findings from Lesson Three

1. Majority of the students identified stop clock as a time measuring instrument and most (93.1%) students were able to read stop clocks accurately.

2. Most students were able to effectively use electronic balance.

About 81.8% of the students were able to read the weighing scale.

3. Most students (79.5 %) were able to perform the calculation related to relationship between mass and weight and 90.9% students identified the differences between mass and weight.

4. The skills acquired by the students in this lesson were: observation through looking at the time, mass and weight measuring instruments; manipulating skills by handling the weighing scale and spring balance; drawing skills; measuring skills by taking the readings of liquid in stop clocks and weighing scale; communication skills in answering questions and group activities and recording skill by tabulating the values of reading.

4.4 Report on Lesson Four

Topic: Measurement of Density

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

1. Explain density;

2. Demonstrate how to determine the density of substances;

3. Perform basic calculations related to density.

Resources: Measuring cylinder, thread, stone, weighing scale, charts and diagrams on the measurement of density.

Advance organisers: Concept mapping, Brief description with skimming

Cooperative learning strategies: Numbered heads together, Think-Pair-Share, Cooperative group tasks

4.4.1 Learners' Activities

Phase One: Presentation of Advance Organisers

1. **Concept mapping**: The concept "Density" was introduced to the students by writing and circling it on the board; Using probing questions, the students were asked to give words or ideas that comes into their minds when presented with the concept; The researcher wrote the ideas around the main concept as the students give their ideas;

Students' responses: *Liquids, Solids, Regular objects, Irregular objects, kg/m^3, g/cm^3, Weighing scale, Measuring cylinder, Displacement, Mass per unit volume, mass.*

The researcher circled key words that are in the lesson to be treated; The students were asked about how two words are linked and the students were allowed to give link between words using arrow and ways the words are connected; The researcher wrote the links between the words on the marker board and made them into a concept map as shown in Figure 20.

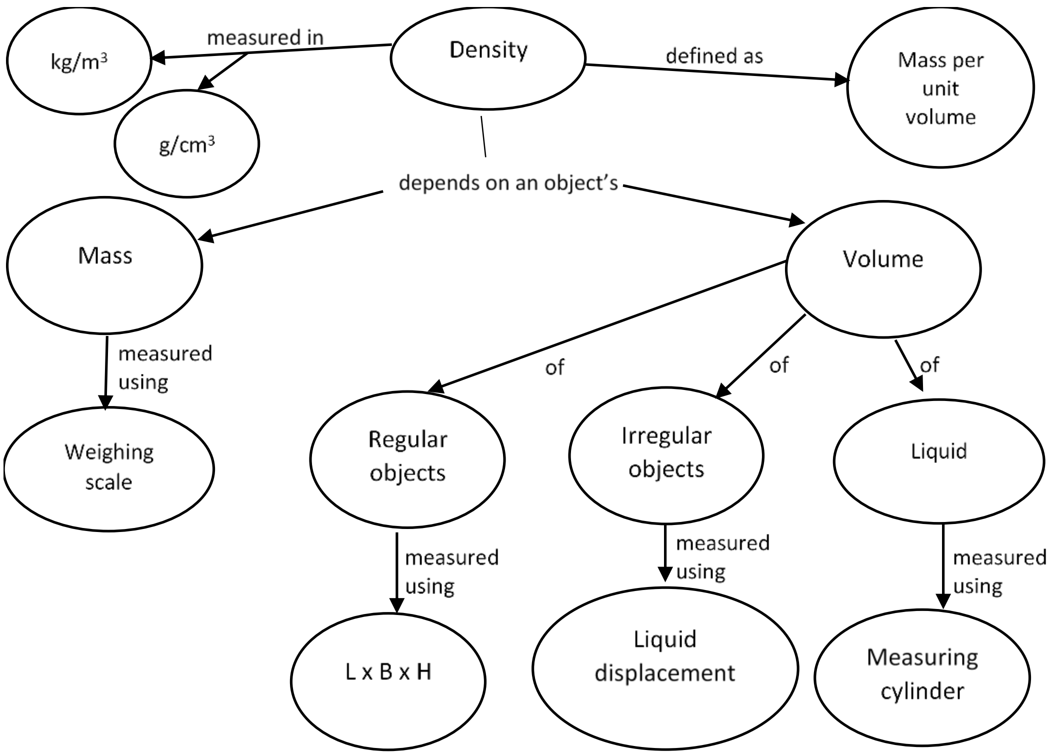


Figure 20: A determination of density's Concept map

2. **Brief descriptions**: The topic was introduced and students were briefed on objectives and goals to be determined by them after the lessons; The students were made to skim through handout and weekly forecast and write the subheadings under measurement of density on the board as a numbered list of agenda items to cover; The questions that will be answered in the given lesson were presented.

Students' responses: *Explanation of density, the formula and units, Determination of density of regular objects, Determination of irregular objects, Determination of density of liquids, Calculations related to density.*

Phase Two: Main lesson

1. The students brainstorm to bring out the meaning of density.

Students' response: *Density of a substance is the mass per unit volume of the substance.*

2. Through discussion, the researcher presented the formula of density (Density = mass/ volume) to the students and the students were allowed to bring out the units of density.

Students' response: *kilogramme per metre (kg/m^3), gramme per centimetre cube (g/cm^3)*

3. Video clips: The researcher showed the students video clips that illustrated the determination of density of regular objects and irregular objects

Cooperative Learning Activities

4. **Group tasks**: The students were guided to determine the density of an irregular object like a stone; The researcher placed a stone on weighing scale and the students observed and read the its mass; The students filled measuring cylinder with water and the level of water was noted; The students tied thread to the stone and gently immersed the stone into the measuring cylinder containing the water; The students took notice of the new volume. The students determined the volume of the stone by subtracting initial volume from final volume; The students were made to determine the density of the stone using the formula Density = mass of the stone ÷ volume of the stone.

5. **Numbered heads together**: The students were made to write on the method used in determining the density of irregular objects. The researcher called on any number of students of any group to present the findings from his or her group to the whole class.

Students' response: *Weigh the irregular object and record it (M). Fill a measuring cylinder with water and record it (V_1). Tie a thread to the object, gently put it into the water in the measuring cylinder and record it (V_2). Determine the volume of the* *object by using the relation $V_2 - V_1$. Determine the density of the object by using the relation Density = mass / volume.*

6. **Discussions and group tasks**: The researcher illustrated to students how to determine the density of liquid (fruit juice) using measuring cylinder and weighing scale: The researcher placed an empty measuring cylinder on weighing scale and the students read and recorded the mass; The students filled the measuring cylinder with the fruit juice and read and recorded the new mass; The students were allowed to get the mass of the liquid by subtracting initial mass from the final mass; The students filled measuring cylinder with the liquid (fruit juice) and the read and recorded the volume; The students were made to determine the density of the liquid using the relation, mass/ volume (of the liquid).

7. Through discussions, the researcher recapped the formula and units of densities; The researcher explained to students how the two main units of density are related.

The formula for density (ρ) = $\frac{mass\ (m)}{volume\ \ (V)}$ and the units of density can either be in kilogramme per metre (kg/m^3) or gramme per centimetre cube (g/cm^3).

The units are related by the relation, 1 g/cm^3 = 1000 kg/m^3.

8. **Using Think-Pair-Share**, the students solved a sample of density-related question.

Phase Three: Reflections

1. The researcher asked a volunteer group to present a summary on density.

Students' response: *Density is mass per unit volume and it is measured is kg/m^3 or g/cm^3. The density can be determined for regular and irregular objects and liquids.*

2. The students were allowed to indicate areas of weakness.

Students' response: *How to change value in kg/m^3 to g/cm^3.*

3. The researcher clarified the areas of weakness of the students by explaining to them that, to change a value in kg/m^3 to g/cm^3, divide value in kg/m^3 by 1000.

Findings from learners' activities:

1. The students explained density as the mass per unit volume of a substance measured in kilogramme per cubic metre or gramme per cubic centimetre.

2. The students observed, demonstrated and described how to determine the density of stone. Weigh the stone and record it (M). Fill a measuring cylinder with water and record it (V_1). Tie a thread to the stone, gently put it into the water in the measuring cylinder and record it (V_2). Determine the volume of the stone by using the relation $V_2 – V_1$. Determine the density of the stone by using the relation "Density = mass of stone/ volume of stone". The students made individual drawings.

3. The students observed and demonstrated how to determine the density of fruit juice by using weighing scale and measuring cylinder.

4.The students solved a sample of density related question correctly using the relation density = mass ÷ volume

5. The skills acquired by the students were observing, measuring, drawing, prediction, communication, inference, experimentation, manipulation.

4.4.2 Evaluation question

1. What is the density of a substance?

2. A piece of iron has a volume of 15 cm^3 and a mass of 27 g. Calculate the density of the iron in: (a) g/cm^3 (b) kg/m^3

3. A piece of metal weighs 90 g. When it is put into a measuring cylinder containing water, the water level rose from 45 cm^3 to the 85 cm^3 mark. Find the density of the metal.

Expected responses:

1. Density is a mass per unit volume of a substance.

2. Density = mass/volume. In g/cm^3, density = 27/15 = 1.8 g/cm^3. In kg/m^3, 1 g/cm^3 = 1000 kg/m^3, hence 1000 x 1.8 = 1800 kg/m^3

3. Density = mass/volume. Density = 90 g / 85 – 45 (cm^3), Density = 90 g / 40 cm^3. Hence density of the metal = 2.25 g/cm^3.

Depending on the correctness of the answers to the questions, students' responses to evaluation questions were classified as "correct" and "incorrect". The responses given by the students to the evaluation questions were analysed and presented in Table 7 in terms of number and percentage of students.

Table 7: Students' responses to evaluation questions in lesson four

Task	N	Correct	Incorrect
Explanation of density	44	42 (95.4)	2 (4.5)
Calculation on density	44	37 (84.0)	7 (15.9)
Demonstration of density	44	39 (88.6)	5 (11.3)

Note: Figures in brackets are percentages

Data from Table 7 showed that most of the students' responses were correct. As many as 42 students (95.4 %) explained density. 37 students (84%) were able to perform calculations related to density accurately and 39 students (88.6%) were able to demonstrate how to determine the density of objects particularly of irregular object. On the other hand, only 2 students failed to explain the meaning of density. Also, 7 students representing 15.9% were not able to perform the density related calculations well and only 5 students (11.3%) failed to demonstrate how to determine the density of irregular objects.

4.4.3 Summary of Findings from Lesson Four

1. Majority (95.4%) of the students explained density and gave the units of density. Most of the students (84%) were able to effectively perform density related calculations.

2. Most of the students were able to demonstrate how to determine the density of liquids and irregular objects. About 88. 6% of students showed how to determine the density of irregular object, metal.

3. The skills acquired by the students in the lesson were: observation through looking at the density instruments; drawing and labelling skills; manipulation skills through the handling of the measuring cylinder, weighing scale and Eureka can; experimentation skills through density related experiments; communication skills in answering questions and group activities and recording skill by noting and or tabulating the values of reading.

4.5 Report on Lesson Five

Topic: Plotting of linear graph and Determination of slope

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

1. Correctly record data;

2. Plot simple linear graphs;

3. Determine slope of the graph.

Resources: Metre ruler, graph sheets, charts and diagrams of stop clock and distances

Advance organisers: Brief description with outline, KWL chart

Cooperative learning strategies: Think-Pair-Share, Numbered heads together, Group tasks, Cooperative problem solving

4.5.1 Learners' Activities

Phase One: Introduction

1. The students were made to state parts of graph.

Students' responses: *Vertical axis, horizontal axis, points plotted, title of graph, names of axes and line of best fits, intercepts.*

Presentation of Advance Organisers

2. **Brief description with outline**: The researcher introduced the topic and briefed students on objectives and goals to be determined by them after the lessons; The researcher presented the day's activities to the students and gave them the item list and let the students cross out the item and move to the next one as they complete activity;

List of the day's activities presented to the students were: Explanation of linear graph, Reading and recording of data; Plotting of points on graph; Drawing of line of best fit; Determination of slope.

3. **KWL chart**: The researcher distributed sheets of paper to the students and let them split the papers into three columns (K section, W section, L section); The students were allowed to independently complete the "K" section of the chart and then share individual answers and discuss responses; The students were allowed to independently complete the "W" section and then share and discuss responses among themselves.

Table 8: **Students' responses as indicated in KWL chart**

K – Know	W – Want to Know	L – Learned
-Reading of stop clock is done in seconds and metre rule is done in centimetres. *-X-axis is horizontal and Y-axis is vertical.*	*How to plot points accurately on a graph.* *How to draw the best line of best fit.* *Determination of slope of graph.*	*Points plotting depends on type of scale. The best numbers for determining scale are 1, 2 and 5. The line of best fit must pass through at least 3 points.* *Determination of slope is done using y_2-y_1 / x_2-x_1*

Phase Two: Main lesson

1. With the help of charts, the researcher explained what linear graph is.

Researcher's response*: Linear graph is graph of straight line. Parts of linear graph include axes (X and Y axes), units, intervals or scales, data points and title.*

Cooperative Learning Activities

2. **Discussions and group tasks**: The students were made to read and record the data: The students measured the various distances of lines, read stop clocks and tabulated the results in groups.

3. **Cooperative problem solving:** The students were allowed to plot linear graph by using the tabulated values: The students identified which set of values represent vertical (Y) axis values and those that represent horizontal (X) axis values; The students used the values to plot points on graph sheets; The students drew line of best fit through the points; The students were made to select two best points that the line of best fit passes through accurately and then connect the two points with triangle.

4. Through discussions, the researcher explained the formula for determining slope of graph and how to determine the units of slope.

Researcher response: *From the graph, slope and intercept can be determined. The slope can be found using the formula* = $\frac{y2-y1}{x2-x1}$ *.The intercept is the point where the straight-line crosses X or Y axis.*

4. **Think-pair-share method:** The students were made to find slope of the graph by using the two best points of the graph and the formula, slope = $\frac{y2-y1}{x2-x1}$

5. **Numbered heads together:** Based on Table 9, the students were allowed to discuss and plot a linear graph of Actual distance (D/m) on the vertical axis against Time (t/s) on the horizontal axis. Also, the students were allowed to determine slope of the graph. The Researcher called on any number of any group to present the findings of discussion to the whole class.

Table 9: **The distances covered by a man and corresponding times**

Time (t/s)	t_1 = 0.29	t_2 = 0.48	t_3 =0.58	t_4 =0.77	t_5 = 1.06
Raw distances (d/cm)	d_1 = 2.30	d_2 = 3.70	d_3 = 4.40	d_4 = 5.80	d_5 = 7.20
Actual distances (D/m)	D_1 = 23	D_2 = 37	D_3 = 44	D_4 = 58	D_5 = 72

Student's response: *It is a graph of actual value of distance (D/m) against time (t/s). The values of raw distances (d/cm) were not used because they were not needed. The graph is a positive graph because as distances increases, the time also increases. The slope of the graph is 69.01 m/s and it signifies the speed of sound in air.*

Phase Three: Reflections

1. The researcher asked a group to present the findings on the linear graph's lesson.

Students' response: *A metre rule is used to determine the distance of the straight lines and the various values tabulated. The tabulated values are used to plot five points and line of best fit is drawn. The line of best fit must pass through at least three points.*

2. The students were allowed to indicate areas of weakness.

Students' response: *How to use the right scale and plot exact points on the graph sheet.*

3. The researcher clarified the areas of weakness of the students by demonstrating to the students that 1, 2 and 5 are the best numbers for scales and that a graph should cover more than half of the graph sheet.

4. The students completed the "L" section of KWL chart independently. The students shared their responses and discussed about the responses.

The students' responses under the L section were indicated in Table 8 above.

Findings from learners' activities:

1. The students explained linear graph as a graph of straight line. The components of linear graph are vertical axis, horizontal axis, points plotted, title of graph, names of axes and line of best fits, intercepts.

2. The students read stop clocks and tabulated the readings. Also, the students measured various distances with metre rule and tabulated the readings.

3. The students drew horizontal axis and vertical axis on a graph sheet and label them as D/m and t/s respectively.

4. The students used the tabulated values as indicated in Table 9 to plot points on the graph. The students further drew line of best fit to pass through at least the three plotted points.

5. The students determined slope of a graph and the implication of the slope by using the relation "differences in y-axis $(y_2 - y_1)$ / differences in x-axis $(x_2 - x_1)$".

6. The students determined the intercepts of graph correctly by indicating on the graph where line of best fit crosses the x-axis and / or y-axis.

7. The skills acquired by the students were observing, measuring, drawing, prediction, communication, inference, formulation of hypothesis, experimentation, manipulation and interpretation of data.

4.5.2 Evaluation question

The table below illustrates distances covered by vehicle with corresponding times.

Table 10: **The distances covered by vehicle with corresponding time**

Raw distances of d/cm	3.3	5.4	8.2	12.3	14.4
Actual distances of D/m					
Time of t/s	6.0	10.0	16.0	25.0	30.0

a. Convert the raw distance, d into actual distances, D using the scale 1 cm = 10 m.

b. Plot a graph of D on the vertical axis against t on the horizontal axis

c. Determine the slope of the graph you have drawn

Expected response:

The demands of this question require science process skills like presenting table of values; drawing and labelling the axes correctly, plotting the points correctly; drawing a straight line passing through at least three of the plotted points; determining the slope.

Table 11: Distances and time values as expected answer to evaluation question 5

Raw distances of d/cm	3.3	5.4	8.2	12.3	14.4
Actual distances of D/m	33.0	54.0	82.0	123.0	144.0
Time of t/s	6.0	10.0	16.0	25.0	30.0

From the Table 11 values, a graph of actual value of distance (D/m) against time (t/s) is expected to be determined. The scale of the vertical axis was 20 units to 2 cm whiles that of horizontal axis was 5 units to 2 cm. The graph should be a positive type because as distances increases, the time also increases. Based on the line of best fit, the intercept on the vertical axis is 10 m/s and the slope is 4.5 m/s (velocity of a moving body).

The responses given by the students to the evaluation questions were analysed and presented in Table 12 in terms of number and percentage of students.

Table 12: Students' responses to evaluation questions in lesson five

Task	N	Correct	Incorrect
Recording of data	44	44 (100)	0 (0)
Drawing and labelling axes	44	43 (97.7)	1 (2.2)
Plotting of points	44	38 (86.3)	6 (13.6)
Drawing of line of best fit	44	37 (84.0)	7 (15.9)
Determination of slope	44	36 (81.8)	8 (18.1)
Significance of slope	44	36 (81.8)	8 (18.1)

Note: Figures in brackets are percentages

Data from Table 12 showed that most of the students' responses were correct. All students (100%) exhibited correct usage of skills for recording data. As many as 43 students (97.7 %) were able to draw and label the two main axes. Also 38 students (86.3%) plotted the values correctly and 37 of them (84%) were able to draw the line of best fit. 36 students (81.8%) determined the slope of the graph and same number of students (81.8%) indicated its significance.

On the other hand, only few students were not able to were not able to plot points (13.6%) and draw line of best fit (15.9%). Also, some 8 students (18.1%) were not able to determine the slope of the graph and state its significance.

4.5.3 Summary of Findings from Lesson Five

1. All students (100%) collected data and record them accurately and as many as 43 students (97.7%) were able to draw and label the axes.

2. Majority of the students were able to plot the linear graph. About 38 students (86.3%) were able to plot the points and 37 students (84%) were able to draw the line of best fit.

3. Most students (81.8%) were able to determine the slope and indicates its significance.

4. The skills acquired by the students in this lesson were: measuring skills by taking the readings of metre rule and stop clocks, collection of data and recording skill by noting and tabulating the values of reading; drawing and labelling skills; constructing graph of data skill; describing relationship between variables by noting relationship between D/m and t/s; communication skills in answering questions and group activities.

In general, the intervention lessons enabled the students to exhibit certain science process skills and positive attitudes as shown as in Table 13, Table 14 and Table 15.

Table 13: Science process skills exhibited by students during the five lessons

N	Science process skills	Lesson (L)					Total
		L1	L2	L3	L4	L5	
1	Observation	/	/	/	/	/	5
2	Measuring	/	/	/	/	/	5
3	Drawing and Labelling	/	/	/	/	/	5
4	Prediction	*O*	/	*O*	/	/	3
5	Communication	/	/	/	/	/	5
6	Inference	*O*	/	*O*	/	/	3
7	Formulation of hypothesis	*O*	/	*O*	*O*	/	2
8	Experimentation	/	/	/	/	/	5
9	Manipulation: Controlling variables	/	/	/	/	/	5
10	Interpreting data	*O*	/	/	*O*	/	3
Total		**6**	**10**	**7**	**8**	**10**	

"/ " indicates science process skill , "*O*" indicates no science process skill

Table 13 showed the science process skills that were demonstrated by the students in the five Integrated Science practical lessons. A tick (/) means science process skill was observed and a zero (*O*) means science process skill was not observed. A total of 10 science process skills (observation, measuring, drawing and labelling, prediction, communication, drawing of conclusion, formulation of hypothesis, experimentation, manipulation, interpreting data) were expected to be observed.

Data from Table 13 showed that in lesson one, 6 science process skills were observed. Also, lesson three and four showed that 7 and 8 science process skills were observed respectively. All science process skills were observed in lessons two and five.

Science process skills such as observation, measuring, drawing and labelling, communication, experimentation and manipulation, were observed in all the five lessons. Prediction, drawing of conclusion and interpreting of data were exhibited in three lessons whiles hypothesis formulation was exhibited in two lessons.

In summary, the basic science process skills such as measuring, observing and communication were observed most often compared to integrated science process skills like formulation of hypothesis and interpreting of data which were observed less frequently in the five lessons.

Table 14: Acquisition of science process skills after the five intervention lessons

Science process skills	Number of students (N)	Percentage (%)
1. Observation	42	95.4
2. Measuring	40	90.9
3. Drawing and Labelling	33	75.0
4. Prediction	27	61.3
5. Communication	36	81.8
6. Inferring	31	70.4
7. Formulation of hypothesis	26	59.0
8. Experimentation	39	88.6
9. Manipulation: Controlling variables	34	77.2
10. Interpreting data	30	68.1

Table 14 shows the percentage of the students who were certain that they had acquired the vital science process skills investigated as a result of performing practical work via the use of advance organisers with cooperative activities during the five lessons.

Results of findings in Table 14 indicate that 42 out of 44 (95.4%) students acquired the skill of observing, 40 (90.9%) students acquired the skill of measuring, 33 (75%) students acquired the skill of drawing, 27 (61.3%) students acquired the skill of prediction and 36 (81.8%) students acquired the skill of communication. In addition, 31 (70.4%) students acquired the skill of inference, 26 (59%) students acquired hypothesis formulation skill, 39 (88.6%) students acquired experimental skill, 34 (77.2%) students acquired manipulation skill and 30 (68.1%) students acquired data interpretation skill. From this result, it is noticed that the science process skills stated above were acquired by the majority of the students through demonstration.

Table 15: Attitudes exhibited by students during the five lessons

Observed students' attitudes	**Lesson (L) and Percentage (%) of attitude shown by the students.**				
	L1	**L2**	**L3**	**L4**	**L5**
1. Regular in class	79.5	97.7	100	100	100
2. Sleeping in class	0	0	0	0	0
3. Working well with teaching aids	65.9	88.6	95.4	95.4	100
4. Exhibition of disruptive behaviours	0	0	0	0	0
5. Working independently	81.8	86.3	95.4	95.4	100
6. Complete task and working on time	52.2	86.3	97.7	100	100
7. Following along with instruction	90.9	97.7	100	100	100
8. Constructive contributions in class	56.8	68.1	72.7	79.5	81.8
9. Interacting appropriately in class	88.6	90.9	97.7	100	100
10. Showing interest in topic	79.5	84	90.9	90.9	100

Note: Figures are percentages. Number of students = 44 students

Table 15 showed attitudes of the students exhibited during the five Integrated Science practical lessons. Data from Table 15 showed that no students exhibited negative attitudes such as exhibition of disruptive behaviours (0%) and sleeping in class (0%) in all lessons. Majority of the students exhibited positive attitudes (Regular in class, following along with instruction, working independently, working well with teaching aids, complete task and working on time, interacting appropriately in class and showing interest in topic) in lesson one (above 50%) and subsequently all students in lesson five (100%). Moreover, attitudes such as constructive contributions of students (responses to questions, asking of questions and making suggestions) in class were demonstrated by majority of the students throughout the five lessons (from 56.8% in lesson one to 81.8% in lesson five)

Based on the observations made and documents review of students' records in assessment, the summary of the positive effects of advance organisers on the academic performance of students in Integrated Science in a cooperative learning classroom has been compiled in Table 16.

Table 16: Effects of Advance organisers on academic performance of students in a cooperative learning classroom

Academic performance enhanced	Justification of the effects with finding(s)
1. Improved students' performance in academic achievement through evaluation questions	Tables 3, 4, 6, 7 and 12 indicate that at least 79.5% of the students gave correct responses to the evaluation questions.
2. Enhanced students' learning and retention of concepts through group tasks and presentations	Presentations of outcomes of Numbered heads together strategy from lessons one to five showed that students' learning and retention from group tasks were enhanced. Also, Tables 2, 5 and 8 (KWL charts) indicate that students' learning and retentions were improved.
3. Direct participation of students and students' involvement in learners' activities	Table 15 showed that majority of students directly participated in the lessons. Also, findings from lessons one to five indicated that most students were involved in learners' activities.
4. Demonstration of skills by students	Table 14 indicates that the majority of the students (at least 68.1%) acquired and demonstrated science process skills needed to carry out academic activities related to measurement concept. Also, Table 15 indicates that majority of the students' listening comprehension at the end of lesson five was improved enabling them to effectively communicate their output of work during lessons.

Table 16 shows that the use of advance organisers improved students' academic performance in a cooperative learning classroom supported by the results in the justification section. Table 16 clearly indicated that there is a significant improvement in students' assessment scores through evaluation questions. Moreover, there was an improvement in academic performance in: students' exhibiting of knowledge acquired through solving tasks in numbered heads together strategy and presentations; direct participation of students in lessons; students' demonstration of skills.

4.6 Discussion of findings

The findings of this research were discussed in line with the research questions that guided the study.

4.6.1 Research Question 1:

What science process skills students acquire when taught Integrated Science using advance organisers in a cooperative learning classroom?

This research question was answered by the findings indicated in Table 13 and Table 14. The findings in the tables showed that when the students were taught Integrated Science using advance organisers in a cooperative learning classroom, they acquired the following science process skills:

Observation, measuring, drawing, communication, experimentation, manipulation skills, prediction, inference, data interpretation skills and hypothesis formulation.

Observation skill was demonstrated by the students as they observe various measuring instruments, identify the parts and characteristics. Measuring skill was exhibited by the students as they determine the quantity (like length, mass, weight, volume, time and density) of objects by using various measuring instruments. Communication skill was exhibited by the students through their respond to questions and interactions with one another during the cooperative activities. Experimentation and manipulation skills were demonstrated by the students as they were taken through several experimental activities. The students through guidance of the researcher carried out various experiments and manipulate variables to determine results. Prediction and inference skills were demonstrated by the students as they attempted to predict the outcome of the experiments based on relevant ideas and draw conclusions from the experiments respectively. Interpretation of data was exhibited by the students through the collection and organisation of data from the experiments into tables and or graph format for conclusions. Also, hypothesis formulation was exhibited by the students as they make statement of expectations prior to experiments so that they can be tested by the experiments.

Based on the results in Table 14, it can be noticed that all types of science process skills have increased after the five lessons. The highest increase is the observation skill with 95.4% students exhibiting it. The lowest type of science process skill is the formulating a hypothesis with 59% students demonstrating it, this is due to the way students feel unfamiliar when answering application related questions as stated by Sulistri (2019).

Results from Table 13 and Table 14 indicate that students' basic science process skills have been demonstrated much more than integrated science process skills.

This outcome agreed with the finding of Akinbobola and Afolabi (2010) who revealed that because students are not used to being taught integrated science process skills, they are more difficult to improve or demonstrate. Similar finding was made in a study by Padilla (2018) who indicated that teachers cannot expect mastery of experimenting or integrated skills from students after a few practice sessions instead students should be given multiple opportunities to work with these skills in different content areas and contexts. However, students were able to demonstrate their integrated science process skills by carrying out experiments and answering questions on the worksheet given by the Researcher.

Based on the findings from Tables 13 and 14, it was identified that there was a massive improvement in students' demonstration of science process skills from lesson to lesson. This is possibly through the intervention lessons, because students' process skills were demonstrated as they actively engaged in the practical lessons. Padilla (2018) was of the opinion that students learn science process skills better if they are considered an important object of instruction and if proven teaching methods are used. Also, Colley (2006) asserted that science process skills require instructional approaches that place emphasis on active learning, student-directed learning and integration of content and process. Hence, it can be deduced that the teaching of practical concepts through the use of advance organisers in cooperative learning environment created more opportunities for acquisition of science process skills by the students. These findings are consistent with the findings of Sulistri (2019) that stated that when students are taken through learning model that pays attention and considers students' initial knowledge, provides series of experiences in form of real activities and allows social interactions among them, their science process skills are improved. Ekon and Eni (2015) and Mandor (2002) research findings were also in agreement with the findings of this study by demonstrating that active involvement of students during classroom activities enable students to apply their five senses to their lessons which contributes to acquisition of more science process skills of students.

4.6.2 Research Question 2:

What effects does the use of advance organisers in a cooperative learning classroom have on students' attitudes towards Integrated Science?

This research question was answered by the findings in Table 15. In this table, majority of the students exhibited positive attitudes. All students were awake during the lessons. Most of students were regular in class with high interest, participated actively in lessons and interacted appropriately with one another during the lessons. Yara (2009) asserted that teacher's attitude and his or her method of teaching can significantly influence the students' attitude. It can therefore, be concluded that the use of advance organisers in a cooperative learning classroom possibly had positive impacts on students' attitudes. These findings are in line with that of Amune (2014) who reported that cooperative learning can improve attitudes towards learning. Amune pointed out that, majority of the students in study felt cooperative learning makes the learning interesting, improves good relationship among learners and enhances group participation. Boamah (2017) also made similar findings by indicating in his study that students generally exhibited negative attitudes towards the individual learning approach than cooperative instructional approach. Also, a meta-analysis study conducted by Sugano and Mamolo (2021) about the effects of different teaching methodologies on students' attitudes indicated that cooperative learning demonstrated to have the most significant effect on attitude and motivation.

In line with cooperative learning setting, Table 15 indicated that the majority of students (79.5% and above) were regular in class because they were motivated by the activities in the lessons. It is therefore further reported that majority of students' interest in the practical lessons improved from lesson one to lesson five. These findings are consistent with Kapri (2017) who revealed that advance organiser model of teaching appealed to the students in experimental group very much as they felt encouraged to learn the subject matter with interest. Similar findings were made in a study by Tsay and Brady (2010) who indicated that cooperative classroom can increase students' motivation, enjoyment of school, attendance, time on task, and classes and independence among learners involved.

As indicated in Table 15, students were able to interact with one another effectively and as a result of the interaction, all students in the class were involved in the measuring, reading of instruments, recording and tabulating and or plotting of the data. Hence, the use of advance organisers in cooperative learning environment could be seen as a valuable tool in improving the students' involvement in teaching and learning of practical concepts in Integrated Science. This finding conforms to Sunasuan and Songserm's (2021) assertion that the use of advance organiser model in a collaborative classroom enhances a greater student participation in lessons as students are motivated to discuss and exchange information using existing knowledge and experiences.

In addition, Choudhary and Qamar (2015) reported that teachers can use the advance organiser to facilitate whole class discussion. This finding agrees with researchers such as UzZaman et al, (2015) and Brooks, Githua and Angela (2008) who reported that the use of advance organisers encourages students to directly participate in their learning and to be self-reflective throughout the lesson.

4.6.3 Research Question 3:

What are the effects of the use of advance organisers in a cooperative learning classroom on the academic performance of students in Integrated Science?

This question was answered by findings in Table 16. The outcomes in the table showed that the effects of the use of advance organisers in a cooperative learning classroom on the academic performance of students in Integrated Science were:

Improved performance in students' academic achievement through evaluation questions; Enhanced students' learning and retention through group tasks and presentations; Direct participation and involvement of students in learners' activities; Demonstration of skills by students.

The academic achievement of the students was improved because most of them (79.5% and above) gave correct responses to the evaluation questions. Also, the students' direct participation and involvement in learners' activities and demonstration of skills were enhanced because most of the students were able to measure length, read stop clocks and weighing scale, determine volume and density of objects, interpret data (by constructing tables; by naming of axes and title of graph; by plotting of linear graph; by calculating slope of graph) and communicate their results.

The findings in Table 16 indicated that there was a significant improvement in students' academic performance because initially:

The students can only measure with metre rule but they can now measure length with metre rule, Vernier calliper and micrometer screw gauge in significant figures or to correct decimal place; The students can read stop clock in whole figures but they can now read stop clocks, weighing scale and measuring cylinder with significant figures or to correct decimal places; The students can only explain density but they can now demonstrate how to determine the density of substances; The students can only draw vertical and horizontal axes and determine scale of graph using simple whole figures but they can now determine scales of graph with decimal or significant figures, plot points with these figures, draw line of best fit and determine slope of graph.

Oyeniyi and Owolabi (2020) reported that advance organisers positively impact students when used effectively with other innovative instructional strategies. Based on these findings, it can be suggested that teaching with the use of advance organisers in a cooperative learning environment enhanced the students' practices, experiences and attitudes which positively influenced the students' academic performance. These findings are consistent with Box and Little (2003) who conducted a study to determine if cooperative small-group instruction in combination with advance organisers could positively impact the self-concept and academic achievement of elementary school students. Box and Little reported that a substantial improvement in the students. These findings corroborate a study by Sunasuan and Songserm (2021) who noted that using advance organisers model in collaborative classrooms can influence meaningful learning of new concepts and improve academic achievements for learners. The Nyabwa's study (2005) also found that use of advance organisers in teaching can make significant impacts on learners by providing appropriate learning opportunities to them and motivating them to learn both inside and outside the school environment.

Findings from the five lessons indicate that the improvement in academic performance may possibly be due to the exhibition of positive attitudes of the students. This is because, the students had opportunity to positively interact and manipulate the learning resources provided in the lessons. Based on Table 15, it was also observed that the students' interest, interactions and contributions in the lesson improved from lessons one to five. The students were also regular in class and active since they were motivated by the teaching strategies and activities in the lessons. These observations from the current study confirm that of Marcela and Mala's (2016) study that indicated that positive attitudes bring out positive results whiles negative attitudes result into negative result. This was also reported by Melad (2022) who showed that attitude components have a significant positive relationship on the academic achievement of students.

In addition, findings from lessons one to five, Table 13 and Table 14 indicate that the students acquired from various science process skills needed for carrying out activities and interpreting data which may subsequently led to the improvement of their academic performances. The students developed these process skills as they actively engaged in practical activities in the lessons. The students reported that these practical lessons helped in making the taught concepts more understandable as they demonstrated these science process skills. It can therefore be argued that advance organisers usage in a cooperative learning environment enhanced the students understanding of concepts via demonstration of their science process skills which helped them to effectively answer measurement concept questions and correctly plot linear graphs. These findings agree with Abungu, Okere and Wachanga (2014) who suggested that science process skills-based instruction improves students' academic performance. Also, Ekon and Eni (2015) reported in their study that acquisition of science process skills significantly influenced students' academic performance. Ekon and Eni further indicated that acquisition of science process skills leads to effective learning of science subjects.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter gives the summary of the findings of the study that emerged out of the intervention lessons. The chapter also contains conclusions derived from the findings of the study. It also made recommendations to teachers among others and suggestions for further studies.

5.1 Summary of findings

The following were the major findings that emerged from the study.

1. The science process skills acquired by the students were observing, measuring, drawing, prediction, communication, inference, formulation of hypothesis, experimentation, manipulation and data interpretation. There was a massive improvement in students' demonstration of these science process skills.
2. Basic science process skills have been acquired much more than Integrated science process skills
3. The students were regular in class with high interest, participated actively in lessons and interacted with one another effectively.
4. There was a significant improvement in academic performance of the students.

   Majority of the students actively engaged in the learning activities, demonstrated retention and required skills and gave correct responses to the evaluation questions.

   The improvement in demonstration of the students' skills was through measuring to correct number of significant figures, recording to correct decimal places, plotting of graph with these figures and communication of results through presentations and written assessments which initially cannot be done by the students.

5.2 Conclusions

Students' academic performance in science is a key factor to all stakeholders in the education sector. Consequently, several studies have been conducted to determine ways to improve students' academic performance and many researchers have laid emphasis on teachers to use effective teaching strategies and method for improving performance of students. Based on the review of available literature, the main motive behind this study was to improve students' performance in Integrated Science test of practical work. As a result, an effort was made to gain an understanding into the effects of advance organisers on teaching and students' performance in Integrated Science in a cooperative learning classroom.

Findings of this study showed that the use of this instructional strategy produced a significant improvement in students' academic performance in Integrated Science. It also provided opportunities to the students to acquire science process skills needed to comprehend concepts. In addition, the students showed positive attitudes towards using this instructional strategy in learning Integrated science by regularly attending class, interacting and participating actively during lessons.

The study showed that instructional strategies, like advance organisers with cooperative learning, can be included into teaching of Integrated Science. Moreover, the findings of this study are in line with the outcomes of many studies including David Ausubel himself, Ministry of Education's policies and chief examiner's reports of West African Examinations Council. This study, accordingly, stipulated some evidence for the positive effects of advance organisers on students' performance in cooperative learning classroom and as a result, it may be argued that using this instructional strategy will enhance students' performance in Integrated Science. Hence, teachers are encouraged to use these findings in teaching Integrated Science.

5.3 Recommendations

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

1. Students should be given more chance to carry out practical activities that involve the demonstration of science process skills.
2. Students should be given multiple opportunities and more practice sessions of experiments that deals with integrated science process skills in different content areas and contexts so that students can get use to these process skills.
3. Integrated Science lessons at Adugyama Senior High School should be made interactive, student-centered and activity based. This will encourage students' participation in the development of the lessons which promote meaningful learning of scientific concepts.
4. Integrated Science lessons at Adugyama Senior High School should be made to include the use of advance organisers with cooperative learning strategies. This will help develop the students' interest and activeness and enhance their retention and improve their learning of Integrated Science which will eventually improve their academic performance.

5.4 Suggestion for further studies

The study was limited to General Art form three students only of Adugyama Senior High School in the Ashanti Region of Ghana. Hence, the following suggestions are made for further studies:

1. A study can be conducted with a larger and more representative sample from other regional and district senior high schools to examine the effects of advance organisers in teaching Integrated Science in cooperative learning classroom.
2. A study can be carried out for different levels of education and subject areas to investigate the effectiveness of advance organisers in a cooperative learning classroom.
3. A study should be carried out to determine the perceptions and knowledge of science teachers on the use of advance organisers.
4. A further study can be carried out to determine how various advance organisers affect students' demonstration of science process skills and positive attitudes in a cooperative learning classroom.

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APPENDIX A

LESSON PLAN ONE

Date: 18/5/2022

Class: 3A2A

Class size: 44

Duration: 90 minutes

Topic: Measurement

Subtopic: Measurement of Length

Relevant Previous Knowledge: Students have an idea of measurement and various measuring instruments in the previous lessons.

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

1. Identify length measuring instruments;

2. Describe length measuring instruments;

2. Use length measuring instruments accurately.

Resources: Metre rule, Vernier caliper, micrometer screw gauge, pair of calipers, measuring tape, charts and diagrams on the length measuring instruments and their parts.

Advance organisers: Brief description with skimming, KWL ("What I Know", "What I Want to Know", "What I Learned") chart

Cooperative learning strategy: Numbered heads together

Learners' Activities

Phase One: Introduction (15 minutes)

1. Ask the students to state some instruments used to measure length.

2. Brief description: Introduce the topic and brief students on objectives and goals to be determined by them after the lessons; Let the students skim through handout and weekly forecast and write the subheadings under measurement of length on the board as a numbered list of agenda items to cover; Present questions that will be answered in the given lesson.

3. KWL chart: Distribute sheets of paper to the students and let them split the papers into three columns (Know section, Want to Know section, Learned section); Allow the students to independently complete the "Know" section of the chart and then share individual answers and discuss responses; Allow the students to independently complete the "Want to Know" section and then share and discuss responses among themselves.

Phase Two: Main lesson (50 minutes)

1. Through discussions teacher explains the meaning of length.

2. Place a metre rule along straight edges (like classroom door and marker board) and take the readings.

3. Allow the students to practise the use of metre rule and measuring tape in groups by placing them along the length of exercise books, the height of student's table and size of classroom windows.

4. Through discussions with students, identify the parts of Vernier calliper and its uses.

5. Show students how to use Vernier calliper: Let the students identify the two scales on the caliper; Explain to the students differences in the two scales; Let the students place the calliper on the object to be measured; Let the students read the main scale where it lines up with Vernier scale's zero; Let the students to read the Vernier scale by identifying the first mark that lines up perfectly with any line on the main scale; Let them multiply the reading with its inch increments (least count); Let the students add reading of both scales to determine total reading.

6. Numbered heads together: Let students teach each other about how to use and read Vernier calliper in groups using specific examples. Call on any number of any group to present the findings from his or her group to the whole class.

7. Through discussions with students, identify the parts of Micrometer screw gauge and its uses.

8. Illustrate to students how to use Micrometer screw gauge: Let the students identify the two scales on the micrometer screw gauge; Explain to the students the differences in the two scales; Let the students place the object to be measured between the jaws (anvil and spindle) whiles using the ratchet; Let the students read the upper main scale (sleeve scale) by identifying the mark above the datum or centre line close to the thimble scale; Let the students read the lower main scale by identifying mark below the data line using a count of 0.5; Let the students read the thimble scale by identifying mark on the thimble scale that lines up exactly with or little below the datum line of the main scale and multiply the reading with its inch increments (least count); Let the student add reading of both scales to determine total reading.

9. Numbered heads together: Allow students to teach each other about how to use and read Micrometer screw gauge in groups using specific examples. Call on any number of any group to present the findings from his or her group to the whole class.

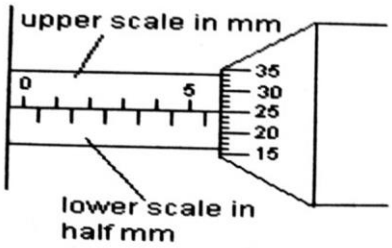
Core points

Measurement of Length

Length is the distance between two points. Measurement of length can be done using: Metre rule: measures length of straight edges from few millimetres to 1 metre; A pair of callipers: measures internal and external diameter of substance (used with metre rule); Micrometer screw gauge: measures extremely short length.

Assessment (10 minutes)

1. The diagram below shows a length measuring instrument. Study the diagram carefully and answer the following questions.



d. Identify the measuring instrument illustrated above

e. Name any two objects that the instrument illustrated can effectively measure.

f. What's the reading of the instrument?

2. The figure below shows lengths of wire used during an experiment. Measure and record the length L = L_1, L_2, L_3, and L_4.

Phase Three: Reflections (15 minutes)

1. Ask a group to volunteer and summarise what happened in the day's lesson.

2. Let students indicate areas of weakness.

3. Clarify the areas of doubts and weakness.

4. Have students to complete the "Learned" section of KWL chart independently. Let the students share their responses and discuss about the responses. Encourage students to detail on their responses.

APPENDIX B

LESSON PLAN TWO

Date: 25/5/2022 **Class**: 3A2A

Class size: 44 **Duration**: 90 minutes

Topic: Measurement **Subtopic**: Measurement of Volume

Relevant Previous Knowledge: Students have learnt about measurement of volume at Junior High School level.

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

1. Identify volume measuring instruments;

2. Describe volume measuring instruments;

2. Use volume measuring instruments accurately;

3. Perform simple calculations relating to volume of regular objects.

Resources: Measuring cylinder, burette, pipette, volumetric flask, rectangular box, charts and diagrams on the volume measuring instruments and their parts.

Advance organisers: Concept mapping, Brief description with outline

Cooperative learning strategies: Jigsaw method, Think-Pair-Share, Cooperative problem solving

Learners' Activities

Phase One: Introduction (15 minutes)

1. Ask the students to state some instruments used to measure volume.

2. Concept mapping: Introduce the concept "Volume" to the students by writing and circling it on the board; Using probing questions, ask the students to give words or ideas that comes into their minds when presented with the concept; Write the ideas around the main concept as the students give their ideas; Circle five key words that

are in the lesson to be treated; Ask the students how two words are linked and get the students to make links between words using arrow and ways the words are connected; Write the links between the words on the marker board and make them into a concept map.

3. Brief description with outline: Introduce the topic and brief students on objectives and goals to be determined by them after the lessons; Present the day's activities to the students and give them the item list and let the students cross out the item and move to the next one as they complete activity; Present questions that will be answered later.

Phase Two: Main lesson (50 minutes)

1. Through discussion, guide the students on how to use measuring cylinder and volumetric flask: Let the students fill measuring cylinder with water to a certain level and take the reading; Let the students fill a 250cm^3 volumetric flask with water to its mark and take the reading.

2. Cooperative problem solving: Let the students in groups solve some trial questions that involves reading of various measuring cylinders containing liquids.

3. Through discussion, guide the students on how to use pipette and burette: Allow the students observe the filling of 25 ml volumetric pipette with water to it mark using rubber bulb; Let the students practice the filling of the pipette to the mark with water using rubber bulb in groups; Allow the students to observe the filling of burette with water using beaker and funnel and reading of the burette; Let the students practice the filling of burette with water using beaker and funnel in groups; Let the students practice of readings burette in groups.

4. Using Jigsaw method, let students teach each other the uses of pipette and burette.

5. Through discussion, explain to students what regular objects and present to the students the formula for finding regular objects.

6. Demonstrate to students how to find the volume of rectangular box: Measure the length, the breadth and height of the box; Use the formula of “volume = length x breadth x height” to find the volume of the rectangular box.

6. Think-Pair-Share: Let students find the volume of regular objects using the formulae of volume of rectangular object individually, as they show each other steps used to arrive to the answer. In pairs, they assess each other’s answers.

7. Through discussion, explain to students what irregular objects and let the students give some examples of irregular objects.

8. Video clip: Show students a video clip of how to determine the volume of irregular object (Knight, 2020).

9. Cooperative problem solving: In groups, let students practice the determination of volume of irregular objects like rock.

Core points

Measurement of volume

Volume is the total space occupied by an object. In science laboratory, volume is measured in centimetre cube (cm^3) or millilitre (ml).

-Regular objects have dimensions that can be measured using length measuring instruments and appropriate formula applied. Example of common formulae are: Volume of a rectangular block is length (l) x breadth (b) x height (h); Volume of cylinder is $\pi r^2 h$ (where r is radius, π is 22/7); Volume of sphere is $4/3\pi r^3$.

-Liquids: various graduated cylinders are used to measure the volume of liquids. Example of such instruments are pipette, burette, measuring cylinder, volumetric flask.

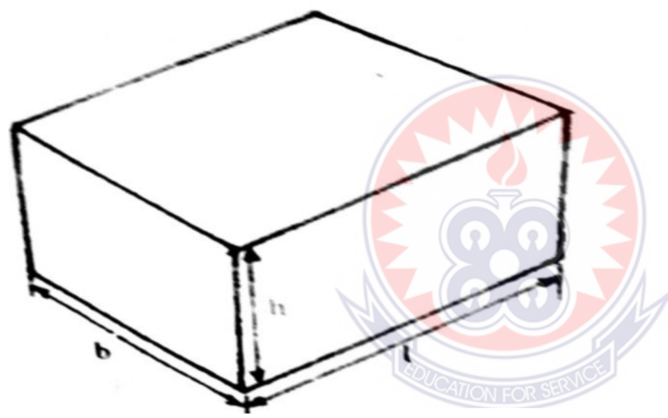
-Irregular objects have no dimensions, hence volume is determined by immersing the objects into liquid in a displacement can or measuring cylinder.

Group Assessment (10 minutes)

1. a. State three instruments that can be used to measure a specific volume of kerosene.

b. Explain briefly how to determine the volume of kerosene.

2. The figure below is an illustration of rectangular object. Study the figure carefully and answer the question that follows.



Determine the volume of figure A

Phase Three: Reflections (15 minutes)

1. Let a volunteer group summarise the determination of volume of objects.

2. Lose the lesson by alerting the students issues to be considered in the next lesson.

APPENDIX C

LESSON PLAN THREE

Date: 1/6/2022 **Class**: 3A2A

Class size: 44 **Duration**: 90 minutes

Topic: Measurement **Subtopic**: Measurement of Time and Mass

Relevant Previous Knowledge: Students have learnt about time and mass measuring instruments at Junior High School level.

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

1. Read time measuring instruments accurately;
2. Use mass measuring instruments;
3. Use weight measuring instruments accurately;
4. State at least two differences between mass and weight.

Resources: Stop watch, stop clock, electronic balance, charts on volume measuring instruments and their parts, charts and diagrams on weighing scale and spring balance

Advance organisers: Brief description with skimming, KWL ("What I Know", "What I Want to Know", "What I Learned") chart

Cooperative learning strategy: Numbered heads together

Learners' Activities

Phase One: Introduction (15 minutes)

1. Ask the students to state some instruments used to measure time.
2. Brief descriptions: Introduce the topic and brief students on objectives and goals to be determined by them after the lessons; Let the students skim through handout and

weekly forecast and write the subheadings under measurement of time, mass and weight on the board as a numbered list of agenda items to cover; Present questions that will be answered in the given lesson.

3. KWL chart: Distribute sheets of paper to the students and let them split the papers into three columns (Know section, Want to Know section, Learned section); Allow the students to independently complete the "Know" section of the chart and then share individual answers and discuss responses; Allow the students to independently complete the "Want to Know" section and then share and discuss responses among themselves.

Phase Two: Main lesson (50 minutes)

1. Through discussion, let the students give time measuring instruments and units of time.

2. Assist students to read stop clocks in groups: Display stop clock and chart of stop clocks in the classroom; Engage the students to read the stop clocks.

3. Through discussion, explain what mass and weight are and let the students give units of mass and weight.

4. Let students identify mass measuring instruments.

5. Through discussion, guide the students to use electronic balance: Display electronic balance in the classroom; Let the students place objects on the balance and observe the readings.

6. Present a chart of weighing scale with object to students and let them take the reading.

7. Let students identify weight measuring instrument. Discuss how the weight measuring instrument (spring balance) works.

8. Video clip: Show students video clip of how the spring balance works (GIS LMC, 2018).

9. Through discussion, explain the relationship between mass and weight using the formula "weight (w)= mass (m) x acceleration due to gravity (g)"; Let the students know that mass can be derived by rearranging the formula making the m the subject, giving m = w/g.

10. Numbered heads together: In small groups, let students practice the reading of stop clock and weighing scale through group works; Let students discuss the differences between mass and weight; Call on any number of any group to present the findings from his or her group to the whole class.

Core points

Measurement of time

Time is measured with a stop clock or stop clock. Time is measured in seconds.

Measurement of mass and weight

Mass of a body is the quantity of matter that the body contains. It is measured in kilogrammes. Weight of a body is the force of gravity acting on a body. It is measured in Newtons. Mass and weight are related by the relation W = mg (where W is weight, m is mass and the g is acceleration due to gravity).

-Measurement of mass: Instruments used are electronic balance, beam balance and weighing scale.

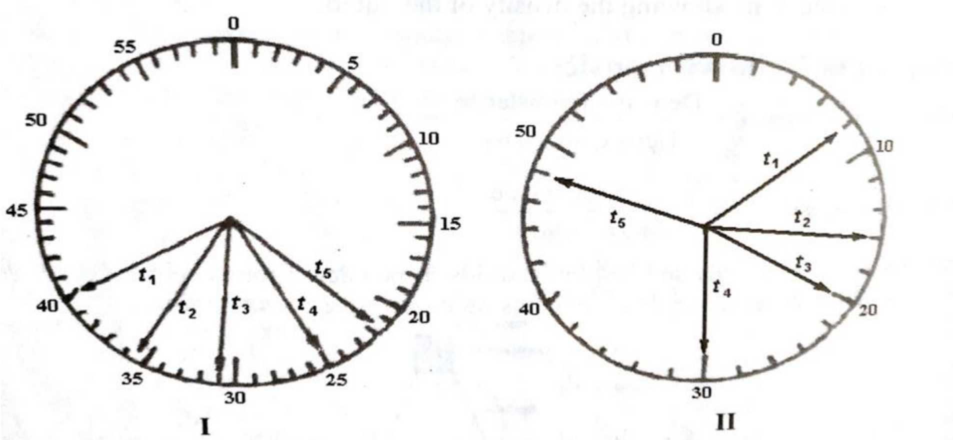
-Measurement of weight: Instruments used mainly is spring balance.

Assessment (10 minutes):

1. If the mass of a block is 120kg, calculate the weight. (Take $g=9.8m/s^2$)

2. Tabulate two difference between mass and weight

3. A car travelling at a certain velocity begins to accelerate continuously for a period of time with corresponding times t = t_1, t_2, t_3, t_4 and t_5 as illustrated below (t in seconds).



Stop watch (in seconds)

Read and record the times t = t_1, t_2, t_3, t_4 and t_5 for figure I and II

Phase Three: Reflections (15 minutes)

1. Ask volunteer group to summarise what happened in the day's lesson.

2. Have students to complete the "Learned" section of KWL chart independently. Let the students share their responses and discuss about the responses. Encourage students to detail on their responses.

APPENDIX D

LESSON PLAN FOUR

Date: 8/6/2022 **Class**: 3A2A

Class size: 44 **Duration**: 90 minutes

Topic: Measurement **Subtopic**: Measurement of Density

Relevant Previous Knowledge: Students have an idea about measurement of density at Junior High School level.

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

1. Explain density;
2. Demonstrate how to determine the density of substances;
3. Perform basic calculations related to density.

Resources: Measuring cylinder, thread, stone, weighing scale charts and diagrams on the measurement of density.

Advance organisers: Concept mapping, Brief description with skimming

Cooperative learning strategies: Numbered heads together, Think-Pair-Share

Learners' Activities

Phase One: Introduction (15 minutes)

1. Concept mapping: Introduce the concept "Density" to the students by writing and circling it on the board; Using probing questions, ask the students to give words or ideas that comes into their minds when presented with the concept; Write the ideas around the main concept as the students give their ideas; Circle five key words that are in the lesson to be treated; Ask the students how two words are linked and get the students to make links between words using arrow and ways the words are connected;

Write the links between the words on the marker board and make them into a concept map.

2. Brief descriptions: Introduce the topic and brief students on objectives and goals to be determined by them after the lessons; Let the students skim through handout and weekly forecast and write the subheadings under measurement of density on the board as a numbered list of agenda items to cover; Present questions that will be answered in the given lesson.

Phase Two: Main lesson (50 minutes)

1. Let the students brainstorm to bring out the meaning of density.

2. Through discussion, present the formula of density (Density = mass/ volume) to the students and let them bring out the units of density.

3. Video clips: Show the students video clips that illustrates the determination of density of regular objects and irregular objects (Smith, 2021).

4. Guide students to determine the density of an irregular object like a stone; Place a stone on weighing scale and let students observe and read the its mass; Let the students fill measuring cylinder with water and take note of the level of water as "V 1"; Let the students tie thread to the stone and gently immerse the stone into the measuring cylinder containing the water; Let the students take note of the new volume as "V2". Let the students determine the volume of the stone by subtracting V1 from V2 (Volume of stone = V2 – V1); Let students find the density of the stone using the formula Density = mass of the stone ÷ volume of the stone.

5. Numbered heads together: Let the students write on the process of determining the density of irregular objects. Call on any number of any group to present the findings from his or her group to the whole class.

6. Through discussions, illustrate to students how to determine the density of liquid using measuring cylinder and weighing scale: Place an empty measuring cylinder on weighing scale and let the students read the mass as “M1”; Fill the measuring cylinder with the liquid and let students read the mass as “M2”; Let students get the mass of the liquid by subtracting M1 from M2; Let the students fill measuring cylinder with the liquid and take the reading as the “volume”; Let the students determine the density of the liquid using the relation, mass of the liquid/ volume of the density.

7. Through discussions, recap the formula and units of densities; Explain to students how the two main units of density are related.

8. Using Think-Pair-Share method, let the students solve some questions related to density.

Core points

Measurement of Density

Density is the mass per unit volume of a substance. It is measured in: kilogramme per metre cube (kg/m^3) or gramme per centimeter cube (g/cm^3).

Measurement of density includes

-Determination of density of liquid using: (i) hydrometer (ii) weighing scale and beaker

-Determination of density of irregular objects using weighing scale and measuring /Eureka can

-Determination of density of regular objects using weighing scale and length measuring instruments

Assessment (10 minutes)

1. What is the density of a substance?

2. A piece of iron has a volume of 15 cm^3 and a mass of 27 g. Calculate the density of the iron in: (a) g/cm^3 (b) kg/m^3

3. A piece of metal weighs 90 g. When it is put into a measuring cylinder containing water, the water level rose from 45 cm^3 to the 85 cm^3 mark. Find the density of the metal.

Phase Three: Reflections (15 minutes)

1. Ask volunteer group to present the findings of questions on density.

2. Let students indicate areas of weakness.

3. Clarify the areas of weakness of the students.

Assignment

Briefly describe how to determine the density of a stone

APPENDIX E

LESSON PLAN FIVE

Date: 15/6/2022 **Class**: 3A2A

Class size: 44 **Duration**: 90 minutes

Topic: Plotting of linear graph and Determination of slope

Relevant Previous Knowledge: Students have learnt about measurement of length, time and mass. Students have also learnt about plotting of graph at Junior High School.

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

1. Correctly record data;
2. Plot simple linear graphs;
3. Determine slope of the graph.

Resources: Metre ruler, graph sheets, charts and diagrams of stop clock and distances

Advance organisers: Brief description with outline, KWL ("What I Know", "What I Want to Know", "What I Learned") chart

Cooperative learning strategies: Think-Pair-Share, Numbered heads together, Cooperative problem solving

Learners' Activities

Phase One: Introduction (15 minutes)

1. Short discussion about measurement and parts of graph.
2. Brief description with outline: Introduce the topic and brief students on objectives and goals to be determined by them after the lessons; Present the day's activities to the students and give them the item list and let the students cross out the item and

move to the next one as they complete activity; Present questions that will be answered later.

3. KWL chart: Distribute sheets of paper to the students and let them split the papers into three columns (Know section, Want to Know section, Learned section); Allow the students to independently complete the "Know" section of the chart and then share individual answers and discuss responses; Allow the students to independently complete the "Want to Know" section and then share and discuss responses among themselves.

Phase Two: Main lesson (50 minutes)

1. With the help of charts, explain what linear graph is.

2. Through discussions, guide the students to read and record data; Let the students measure the various distances of lines, read stop clocks and tabulate the results.

3. Let students to plot linear graph by using the tabulated values: Let the students identify which set of values represent vertical (Y) axis values and those that represent horizontal (X) axis values; Let the students use the values to plot points on graph sheets; Let the students draw line of best fit through the points; Let students select two best points the line of best fit passes through accurately and let them connects the two points with triangle.

4. Through discussions, explain the formula for determining slope of graph and how to determine the units of slope.

4. Think-pair-share method: Let the students to find slope of the graph by using the two best points of the graph and the formula, slope = $\frac{y2-y1}{x2-x1}$

5. Using Numbered heads together: Give a trial question to students and let the students read and record data, plot a linear graph and determine slope of the graph.

Call on any number of any group to present the findings from his or her group to the whole class.

Core points

Plotting a linear graph

Linear graph is graph of straight line. Parts of linear graph include axes, units, intervals or scales, data points and title. From the graph, slope and intercept can be determined. -The slope can be found using the formula = $\frac{y2-y1}{x2-x1}$ -The intercept is the point where the straight-line crosses x or y axis.

Assessment (10 minutes):

The table below illustrates distances covered by vehicle with corresponding times.

***Table 8*: The distances covered by vehicle with corresponding time.**

Raw distances of d/cm	3.3	5.4	8.2	12.3	14.4
Actual distances of D/m					
Time of t/s	6	10	16	25	30

a. Convert the raw distance, d into actual distances, D using the scale 1 cm = 10 m.

b. Plot a graph of D on the vertical axis against t on the horizontal axis.

c. Determine the slope of the graph you have drawn

Phase Three: Reflections (15 minutes)

1. Ask volunteer group to present the findings of questions on the linear graph.

2. Let students indicate areas of weakness.

3. Clarify the areas of weakness of the students.

4. Have students to complete the "Learned" section of KWL chart independently. Let the students share their responses and discuss about the responses. Encourage students to detail on their responses.

APPENDIX F

OBSERVATIONAL CHECKLIST FOR SCIENCE PROCESS SKILLS

Science process skills exhibited by students during the lessons

"/ " indicates science process skill

"O" indicates no science process skill

N	Science process skills	Lesson (L)					Total
		L1	**L2**	**L3**	**L4**	**L5**	
1	Observation						
2	Measuring						
3	Drawing and Labelling						
4	Prediction						
5	Communication						
6	Inference						
7	Formulation of hypothesis						
8	Experimentation						
9	Manipulation: Controlling variables						
10	Interpreting data						
Total							

APPENDIX G

OBSERVATIONAL CHECKLIST ON STUDENTS' ATTITUDES

Observed students' attitudes	Lesson (L) and Percentage (%) of attitude shown by the students.				
	L1	**L2**	**L3**	**L4**	**L5**
1. Regular in class					
2. Sleeping in class					
3. Working well with teaching aids					
4. Exhibition of disruptive behaviours					
5. Working independently					
6. Complete task and working on time					
7. Following along with instruction					
8. Constructive contributions in class					
9. Interacting appropriately in class					
10. Showing interest in topic					