UNIVERSITY OF EDUCATION, WINNEBA

IMPACT OF REGULAR EXPLANATORY CLASSROOM TEST ON STUDENTS' LEARNING AND CONCEPTUAL UNDERSTANDING OF ELECTROLYSIS

FRANCIS ADJEI

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FRANCIS ADJEI

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A thesis in the Department of Science Education, Faculty of Science Education, submitted to the School of Graduate Studies in partial fulfilment of the requirements for the award of the degree of Master of Philosophy (Science Education) in the University of Education, Winneba

DECEMBER, 2022

DECLARATION

STUDENT'S DECLARATION

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

SIGNATURE:…….

DATE:…….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this thesis is in accordance with the guidelines on supervision of thesis laid down by University of Education, Winneba.

SUPERVISOR'S NAME: DR. ARKOFUL SAM (Ph.D.)

SIGNATURE:…….

DATE:…….

DEDICATION

The work is dedicated to God Almighty.

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ABSTRACT

This study investigated the impact of regular explanatory classroom tests on form two science one students' understanding in the concepts of electrolysis. The sample for this study consisted 35 science students from Winneba Senior High School. The sample was selected from form two class in the school. Purposive sampling was used to select students for the study. Pre and post intervention test items as well as students' monitoring book were used as the main instruments to collect data for the study. The reliability of the, pre-test and post-test items were determined using Cronbach-Alpha ranged from 0.76 to 0.80. A regular explanatory classroom tests instruction was applied formatively in teaching the students. The data obtained were analysed using t-test. It was also found that 98% of the students who took part in the study had wrong notions about electrolysis. The findings showed that there was a statistically significant difference in performance between pre-intervention achievement of students and post-intervention achievement of students. The students performed better in the post-test compared to pre-intervention test. The implication is that chemistry teachers in Winneba Senior High school should employ regular explanatory classroom tests approach in teaching concepts of electrolysis to enhance students understanding.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This is an introductory chapter that looks at the background to the study, statement of the problem and the purpose of the study. It also covers the objectives and research questions, the significance of the study as well as the limitations and delimitations. This chapter ends with the provision of abbreviations and operational definitions of some terms mentioned in the report.

1.1 Background to the Study

One of the dreams of Ghana government on education is raising the quality of teaching and learning for effective outcomes (Taale, 2012). Agreeing to Feathersion (2007), in order to help evaluate teaching and learning effectively, there have been a quest by researchers to find out assessment procedures which motivate, promote and improve the learning and students' conceptual understanding of topics. Classroom tests have been recognised as one of the powerful assessment tools in the classroom (Bueno, 2017; Brown, 2004). According to the System Approach for Better Education Result report (2013), Ghana assessed the strength and weakness of its existing assessment system via the use of standardized tool developed under the World Bank's System Approach for Better Results (SABER).

The goal of SABER – Student Assessment, was to augment assessment systems that culminate in improved education quality and learning for all. National syllabi which are formal documents authorized by the Ministry of Education (MoE), include guidelines for classroom assessment. The National Education Assessment (NEA) has been operating on a regular schedule. There is regular (continuous and predictable)

funding for the exercise, albeit allocated by non-government sources (specifically, USAID). This funding covers core NEA activities, but not research and development. The NEA measures performance against the national curriculum, and is largely accepted by stakeholder groups. However, the office in charge of carrying out the NEA is inadequately staffed to effectively carry out the assessment. Furthermore, proper student assessment system is tantamount to ensuring quality education and learning outcomes as it endows stakeholders with the necessary information in decision-making. The Basic Education Certificate Examination (BECE) is taken by students in Grade 9 for school cycle completion and admission to senior high school. Again, the West African Secondary School Certificate Examination (WASSCE) is administered to students at the end of senior high school, and is used for higher education. Quansah, Amoako and Ankomah (2018) contented that from South Korea to Singapore, Malaysia, Japan and China, economic success has been built on the foundation of effective assessment.

For this reason, the relevance of classroom assessment cannot be over stressed. This study explored how regular explanatory classroom test method for learning can help teachers gain the strategies, skills, and ready-to-use resources to incorporate effective assessment practices into their daily teaching pedagogies to motivate student learning. National syllabi, which are formal documents authorised by the Ministry of Education, include guidelines for classroom assessment. There are some system-level mechanisms in place to ensure that teachers develop skills and expertise in classroom assessment. However, there are limited resources (such as tools and materials) available to teachers for conducting classroom assessment activities. Classroom assessment practices are generally known to be weak, and there are limited formal mechanisms in place to monitor their quality.

In addition, Ghana has been participating in Trends in International Mathematics and Science (TIMS), an assessment programme, to enhance its assessment strategies in mathematics and science. Moreover, the results from such programmes are for tracking the impact of reforms and informing curriculum improvement on student achievement levels. Furthermore, assessment programmes for Ghana and Honduras funded by United States Agency for International Development (USAID) were developed from Request for Application (RFA) that explicitly called for the development of national assessments (SABER Country Report, 2013). The programme posited that, the use of the assessment as monitoring tool help students' learning.

Assessments were better suited as a national assessment for measuring students' mastery of grade level content rather than as a monitoring and evaluation tool to measure the impact of teacher interventions on students' critical thinking. Testing students regularly serve as reinforcement for students to learn. Research has shown that students put much effort in their studies whenever time for tests and examination are announced. The full potency of education in relation to economic growth can only be realised if the education provided is of good quality. Student knowledge and cognitive skills are well developed through effective assessment (Clark, 2012).

Assessment is the evaluation of learning activities which is carried out by teachers to measure students' competence. According to Brown (2012), assessment is a process ongoing that encompasses a much wider domain. Assessment is the sequence of teaching-learning process including performance assessment, portfolio, and student self-assessment. One important principle for assessing a learner's competence is to consider the fallibility of the results of single performance, such as that is produced in

a test. A test itself has definition, which the process of teaching and learning end to measure the student's achievement. Test needs two language forms; they are spoken and written test. In oral test, the student needs accuracy and effectiveness that is the reliability and validity of an oral production test. It consists of speaking and reading skills. The student needs to pay attention to pronunciation, fluency, and diction.

Ghana Commission for UNESCO (2014) outlined that assessment is to promote, monitor and assess the processes and outcomes of competency-based learning. International initiative such as the Education for All (EfA) and Millennium Development Goals (SDG) in aggregation with Ghana government have set the improvement of access and quality of primary education as the fulcrum of initiatives through effective assessment. Cizek (2010) posits that the foundation of sound decision making is good measurement with the aid of accurate assessments. According to Clarke (2005) the large body of empirical evidence linking education to economic growth indicates that improved enrolment completion rate is necessary, but not sufficient conditions for poverty reduction. Rather, enhanced learning outcomes in the form of increased students' knowledge and cognitive skills are to alleviating poverty and improving economic competitiveness.

Educational practitioners suggest that assessment is of special value in ensuring effective learning. Moreover, there is National Education Assessment which has been operating on regular schedule, adequately staffed to effectively carry out the assessment (SABER Country Report, 2013). In spite of the above interventions, regular classroom tests have not been fully instituted to enhance students' learning (Taale, 2012). Professional in the teaching business, particularly teachers must keep learning and adapting new skills. This only can come from being reflective in the

practice, as according to Featherston (2007), reflection on action leads to identification of processes, experiences, and understandings that can then be used in future lessons. Effective teachers therefore know how to coordinate diverse array of instructional elements (such as planning, lesson design, time management, classroom management, instructional methods, student motivation, and assessment techniques) and adapt them to differences in student needs, materials and purposes (Brookhart, 2011). In educational systems worldwide, tests and examinations are a classic way of measuring students' progress and are integral to accountability of schools and the educational system. Assessment is inseparably linked with teaching and learning. The contribution of assessment to an educational system is so significant that it forms the basis for almost all fundamental decision making. Throughout an educational system, decisions have to be made about students, curricula and programmes, and educational policies.

According to Cizek (2013), decisions about students include management of classroom instructional delivery, placement of students into different types of programmes, assignment of students into appropriate groups, guidance and counselling of students, selection of students for educational opportunities such as award of scholarship and prizes, and giving them credentials and certificates based on their competence. Decisions about students' learning, curricula and programmes include decisions about their effectiveness (summative assessment) and about ways to improve them (formative assessment). In many parts of the world and especially in developing countries, the use of assessment for instructional management decisions in the classroom and the school settings have been limited to the norm referenced approach to the interpretation of assessment results where individual student's results are described in terms of the performance of a whole class or norm group. This is

done mainly by ranking of students (Black & William, 2014; Garrison & Ehringhaus, 2009; Stiggins, 2005; Myers, 2004; Stiggins, 2002). The near absence of classroom based formative assessment practices (assessment for learning) as prescribed by the formative aspect of the Continuous Assessment (CA) and the School Based Assessment (SBA) in many Ghanaian classrooms renders the instructional management decisions function of classroom assessment unrealised to its fullest. The fact here is corroborated by two studies by Asamoah-Gyimah (2016) who evaluated the practice of the CA programme in the Ashanti Region of Ghana and Nugba (2009) who investigated basic school teachers' adherence to laid down rules in the practice of the SBA in the Obuasi Municipality of the Ashanti Region of Ghana. Both researchers concluded that to a greater extent, Ghanaian teachers do not follow the laid down rules in conducting the CA and the SBA programmes. The obvious implication here is that the formative aspect of the CA and SBA, which is the main driving force for improvement in classroom instruction is also not given any attention.

Earlier researches in the field of assessment in Ghana investigated into the general testing practices of secondary school teachers in parts of the country and reported that, to a great extent, teachers followed the standard approved principles in their classroom test development (Gonski, 2018; Oduro-Okyireh, 2013; Erbe, 2007;). These studies focused only on general adherence to laid down testing principles and not formative assessment to be specific. This means that as a country, our educational system has not paid the needed attention to the formative aspect of our classroom assessment and hence the unavailability of enough empirical literature on formative assessment in the country. It also paints the bigger picture that the state of affairs concerning the practice of formative assessment in the Ghanaian classroom is uncertain. The state of affairs concerning formative assessment in the country is

suggestive of the fact that the Ghanaian educational system is losing out on all the probable gains that formative assessment holds in contributing to improvement in the instructional practices of the teacher in the classroom. The connection between good assessment practices and improvement in instruction has been established locally by research (Oduro-Okyireh & Partey, 2014). Earlier empirical studies elsewhere have also proven that the systematic use of assessments, particularly formative assessment has in reality shown promise in improving students' learning and achievement (Black & William, 2006; Earl & Katz, 2006).

The conclusion to this empirical evidence in the form of a recommendation was given by Black, Harrison, Lee, Marshall & William (2004) upon their review of studies on formative assessment, they reported that formative assessment needs to be mostly stressed in the classroom because it has the potential to reduce the achievement gap by helping low achievers the most. On the part of Oduro-Okyireh & Partey (2014), to ensure that the gains of formative assessment are fully realised, teachers must approach classroom assessment with a comprehensive view and also vary their interpretation of assessment results, to focus more on criterion referenced interpretation which is diagnostic in nature with the tendency to help students identify problem areas in their learning and also know the extent to which they have achieved stated instructional objectives.

The effective integration of formative assessment with classroom instruction and the subsequent realisation of the gains that it holds for instruction and learning are a matter of necessity in the classroom if there must be any improvement in instructional delivery and learning. Individual student's results are described in terms of the performance of a whole class or norm group. This is done mainly by ranking of

students (Oduro-Okyireh & Partey, 2014; Looney, 2016; Stiggens, 2005; Stiggins, 2013; Myers, 2004, Garrison & Ehringhaus, 2007).

The obvious implication here is that the regular explanatory classroom test aspect of the CA and SBA which is the main driving force for improvement in classroom instruction is also not given any attention. It also paints the bigger picture that the state of affairs concerning the practice of formative assessment in the Ghanaian classroom is uncertain.

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In educational systems worldwide, tests and examinations are a classic way of measuring students' progress and are integral to accountability of schools and the educational system. Assessment is inseparably linked with teaching and learning. The contribution of assessment to an educational system is so significant that it forms the basis for almost all fundamental decision making. Throughout an educational system, decisions have to be made about students, curricula and programmes, and educational policies. According to Madison-Harris, Muoneke and Times (2012) decisions about students include management of classroom instructional delivery, placement of students into different types of programmes, assignment of students into appropriate groups, guidance and counselling of students, selection of students for educational opportunities such as award of scholarship and prizes, and giving them credentials and certificates based on their competence. Decisions about students' learning, curricula and programmes include decisions about their effectiveness (summative assessment) and about ways to improve them (formative assessment). In many parts of the world and especially in developing countries, the use of assessment for instructional management decisions in the classroom and the school settings have been limited to the norm referenced approach to the interpretation of assessment results. According to SABER, World Bank (2013), Ghana joined the Russia

Education Aid for Development (READ) trust fund program, the goal of which is to help countries improve their capacity to design, carry out, analyze, and use assessments for improved student learning.

As part of the READ trust fund program, and in order to gain a better understanding of the strengths and weaknesses of its existing assessment system, Tajikistan participated in a formal exercise to benchmark its student assessment system under The World Bank's Systems Approach for Better Education Results (SABER) program. SABER is an evidence-based program to help countries systematically examine and strengthen the performance of different aspects of their education systems. SABER-student assessment is a component of the SABER program that focuses specifically on benchmarking student assessment policies and systems. The goal of SABER-student assessment is to promote stronger assessment systems that contribute to improved education quality and learning for all. The importance of assessment is linked to its role in: providing information on levels of student learning and achievement in the system; monitoring trends in education quality over time; supporting educators and students with real-time information to improve teaching and learning; and holding stakeholders accountable for results. The SABER-student assessment framework is built on the available evidence base for what an effective assessment system looks like. The framework provides guidance on how countries can build more effective student assessment systems. The framework is structured around two main dimensions of assessment systems: the types/purposes of assessment activities and the quality of those activities. Assessment systems tend to be comprised of three main types of assessment activities, each of which serves a different purpose and addresses different information needs. These three main types are: classroom assessment, examinations, and large scale, system level assessments.

This report focuses specifically on policies in the area of student assessment. Assessment for Learning is a formative feedback tool that is implemented during practice work as opposed to on the final product (Clark, 2012). Since students need time to act on feedback, the most appropriate time to allow for students to get feedback is on practice work, such as an assignment or project, where students still have time to make improvements or changes that will benefit their learning (Chappuis, 2005; Magno & Lizada (2015). In Assessment for Learning initiatives, teachers can use a variety of methods to help students understand a) where are they going in their learning; b) where are they now in their learning; and c) how can they close the gap? The benefit of using assessment for learning is that it has the potential to motivate learners and improve student achievement; teachers still have time to make any adjustments to the learning; when adjustments occur, students benefit; and students can use the results to adjust and improve their own learning. The teachers involved in the study taught their perspective grades but incorporated the methods that were provided in the workshop for the 2014 to 2015 school year. Again, in most Ghanaian schools and institutions, classroom tests are employed to grade students and also place students on courses. However, its effect on teaching and learning in the classroom has not been fully utilised in majority of schools in Ghana (Taale, 2012). Hence, the need for a study of the impact of regular explanatory classroom tests on learning and students' conceptual understanding of electrolysis in chemistry.

1.2 Statement of the Problem

Testing in the classroom is one of the routine activities that engage teachers and students. The use of classroom tests in Ghanaian classroom appears to be limited to determining students' learning only. However, when teacher uses tests for formative purposes, students are able to learn what went wrong with their learning and also to

correct their errors. In Ghanaian classroom, however, the trend appears to be the use of tests to determine the extent of learning rather than the depth of understanding of the topic taught. The researcher in introductory lesson on electrolysis identified that; Students have difficulty distinguishing between electrolytic cell and electrochemical cell. Students were unable to solve simple problems involving reducing agent and oxidizing agent. Moreover, students have difficulty determining oxidation number of an atom in a compound. The researcher attributes these conceptual difficulties to the observation that most chemistry teachers in Winneba Senior High School are still glued to the use of traditional lecture method which has been proven to be ineffective by research (Crooks, 2019; Cizek, 2011) for chemistry lessons. It is on this background that this study utilised regular explanatory classroom test approach in a formative way to improve the conceptual understanding of 2 Science 1 students of Winneba Senior High in concepts of electrolysis.

1.3 Purpose of the Study

The purpose of this study was to evaluate the impact of regular explanatory tests on academic performance of selected Winneba Senior High School chemistry students in their study of electrolysis.

1.4 Research Objectives

The objectives of the study were to:

1. Assess the impact of regular explanatory tests on students' learning in chemistry.
2. Examine the impact of regular explanatory tests approach on students' learning and conceptual understanding of electrolysis.

3. Evaluate the impact of regular explanatory tests on students' motivation in learning chemistry.
4. Assess the impact of regular explanatory test on students' performance in electrolysis.

1.5 Research Questions

The following research questions guided the study:

1. What impact does regular explanatory tests have on students' learning in chemistry?
2. What is the impact of regular explanatory test on the students' conceptual understanding of electrolysis?
3. What is the impact of regular explanatory tests on the motivation of students in learning electrolysis?
4. How can regular explanatory tests be used to enhance students' performance in electrolysis?

1.6 Null Hypothesis

H_0: There is no statistical difference between students' average mean achievement score in pre-intervention exercise and post-intervention exercise in electrolysis.

1.7 Educational Significance of the Study

The outcome of this study will enable science instructors, subject advisors, curriculum designers and developers realize the impact of regular classroom tests on students' understanding of some selected topics in chemistry. It will also be a resource for teachers and schools who want to improve teaching and learning of chemistry in the classroom. Furthermore, the outcomes of the study will provide source references for other researchers who wish to research issues on how assessments may be used to

improve students' learning and conceptual understanding of topics in chemistry and other related science disciplines.

1.8 Limitations

The period for the study should have been more than eight weeks but due to the frequent provision of logistics for the study, the researcher resorted to eight weeks. Again, the study should have covered the entire science classes in the school but the researcher relied on one science class, thus 2 science 1 due to truancy and lateness of the day students in the other science classes.

1.9 Delimitations

The researcher focused only on selected form two chemistry students. The researcher did not use the first years because they do not have sufficient background in the topic. The form three (3) students are also about to take their final examination and so were part of this study. Again, due to the number of periods allocated for chemistry in a week (4 periods) the study confined itself to the teaching and learning of electrolysis.

1.10 Organisation of the Thesis

This write-up is divided into five chapters. The first chapter provides an introduction to the study. It also includes the problem of the study, purpose of the study, research questions, and significance of the study as well as limitations and delimitations. The second chapter consists of review of the related literature from which was derived a theoretical framework for the study. The third chapter outlines the detailed information of research methodology employed in the study. The fourth chapter presents the data collected and their analysis. The fifth chapter presents the discussion of the results, summary of the study, conclusions and recommendations.

1.11 Definition of Terms

Explanatory test is the test that aims at the discovery of ideas and thoughts. It is designed to explain concept pertaining to a topic.

Formative Assessment: It is the process of gathering information to monitor student learning to provide ongoing feedback that can be used by the teacher to improve the teacher's teaching and the students' learning.

Abbreviations

BECE: Basic Education Certificate Examination

CA: Continuous Assessment

EfA: Education for All

ETS: Educational Testing Service.

MoE: Ministry of Education

NEA: National Education Assessment

RfA: Request for Application

SABER: System Approach for Better Results

SBA: School Based Assessment

SDG: Standard Development Goals

SHS: Senior High School

TIMSS: Trends in International Mathematics and Science

UNESCO: United Nations Educational, Scientific and Cultural Organization

USAID: United States Agency for International Development

WASSCE: West African Secondary School Certificate Examination

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The review of literature focused on work done by other researchers in areas related to regular classroom tests (assessment). The relevant issues reviewed in the literature include the concepts of classroom tests, theoretical framework for the study and its relationship with learning in the classroom. Again, it outlined the importance of regular explanatory classroom tests and the impact it has on learning when it is used formatively in the classroom. It also deliberated how classroom tests motivate students to learn.

2.1 Explanatory Test

According to Buchannan (2013), explanatory test is the test that seeks to explain a concept pertaining to a topic. It helps increase understanding of a given topic. Again, it ascertains how or why a particular situation is occurring. Explanatory test is conducted with the aim of helping students to study a topic in a greater depth. The main use of the explanatory test is problem-solving by enhancing students understanding in concepts. Explanatory test allows the researcher to become familiar with topic to be examined and to design theories to test them. In-depth exposure of students to explanatory test creates a cycle, and critical thinking of subject creates more questions and those questions lead to more ways for students to study more things related to that topic.

2.2 Theoretical Framework

For regular explanatory classroom test as formative assessment in the classroom setting, Madison-Harris, Muoneke and Times (2012) reviewed series of literature on

regular classroom test as formative assessment and concluded that "it is a systematic, continuous process used during instruction that provides a feedback loop to check for progress and detect learning gains, identify strengths and weaknesses and narrow gaps in learning". Magno and Lizada (2015) in their review, also cited some of the important reports that centered on issues on regular classroom test at the start of the 21st century and included that regular classroom assessment is an instructional process that builds lasting learning competencies. On the part of Heritage (2010), regular classroom test assessment is explained as an essential part of facilitating the learning process stemming from Vygotsky's (1978) Zone of Proximal Development. Magno and Lizada (2015) again emphasized that regular classroom assessment is a way of refining the instructional process to meet students learning needs.

According to Clark (2012), the theory of regular classroom assessment is best perceived to be a unifying theory of instruction, which guides instructional practice and improves the classroom learning process by developing Self-Regulated Learning (SRL) strategies among learners. Theoreticians in educational regular classroom assessment agree that SRL is predictive of improving academic outcomes and motivation due to the fact that students gain the needed adaptive and self-directed learning characteristics required for an enhanced commitment to the learning process and consequent successful performance. SRL is a self-regulatory behaviour which refers to a process of taking absolute charge of one's own learning behaviour and possessing the ability to evaluate it. The main aim of regular classroom test is for improvement in students' learning and conceptual understanding of a topic.

Clark (2012) posited that this is best achieved if regular classroom test is used strategically to develop SRL in learners through metacognition, strategic action, and

motivation to learn. This leads the development of lifelong learning capabilities in the learner. The knowledge about operant conditioning has greatly influenced educational practise in the classroom. Thus, operant conditioning theory of learning focusses on changes in students' learning behaviour. In operant conditioning, new or continued learning behaviour are impacted by regular explanatory classroom tests. According to Overskeid (2012), behavioural studies in the regular classroom test settings have provided principles that help teachers arrange and organise classroom experiences to facilitate both academic and behaviour. Based on the theory of operant conditioning, students perform better through regular classroom test or to begin the desired behaviour (Vyse, 2013). Vyse argued that operant conditioning and reinforcement scheduling support the belief that students wait until the "last minute" to study. Moreover, under operant conditioning, students' learning of concepts in the classroom can be reinforced by the use of regular explanatory classroom tests. Regular classroom testing stimulates students to learn. One of the proponents of behaviourism is that learners are actively involved in the learning process when prompt feedback is provided in a timely manner.

Based on the theory of operant conditioning, students will study more often if given more regular classroom tests. Studies including McNiff (2005), and Oduro-Okyere and Partey (2014) revealed that students who took weekly quizzes and tests in the classroom performed better in the final examination than did those who took only midterms tests. According to Asamoah-Gyimah (2016), classroom tests administered regularly reinforced learning by providing students with indicators of what topics or skills they have not yet mastered and should concentrate (Overskeid, 2012). Frequent classroom tests help to evaluate students and assess whether they are learning what they are expected to learn. Regular classroom tests with prompt feedbacks serve to

motivate and help students structure their academic efforts as they learn in ways that they think they would be tested (Arter & Spande,2012; Brookhart, 2011). Figure 1presents the theoretical framework of the study.

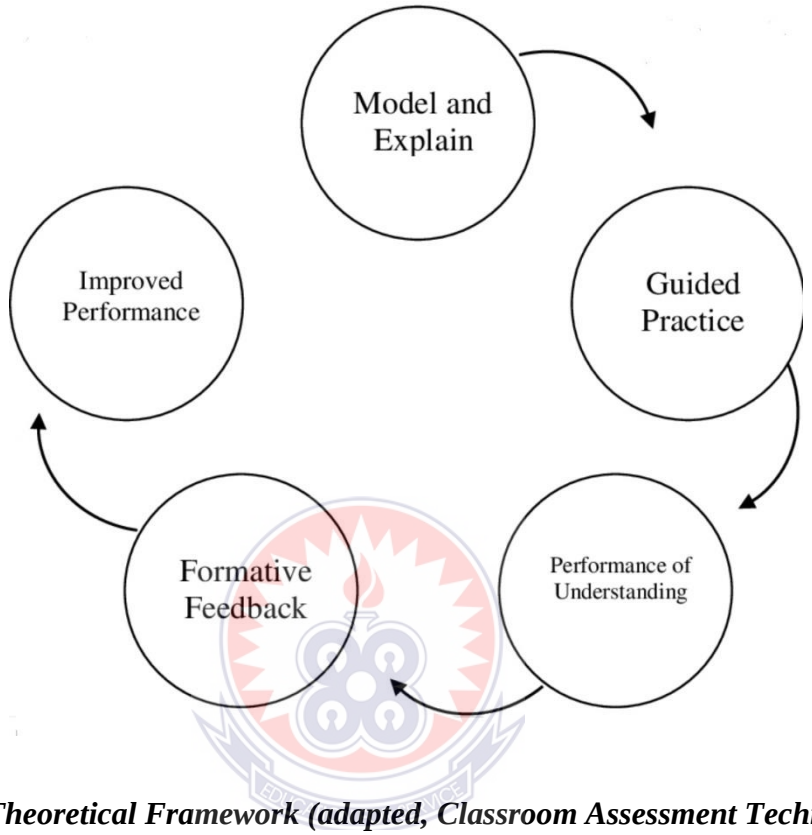

Figure 1: Theoretical Framework (adapted, Classroom Assessment Techniques, 2012)

2.3 Modeling

Modeling has been emphasized by many local and state guidelines as sharing one's thinking and demonstrating or explaining something (Louca & Zacharia, 2012; Schwarz et al, 2009) However, in explanatory test learning, modeling is to share with students not only what one is thinking about the content to be learned, but also the process of explanatory learning. Modeling may involve thinking aloud (sharing thought about something) or demonstrating (showing students how to do something in a step-by-step fashion) (Bandura, 1986). In terms of content, teachers might verbalize the thinking processes they use to make a prediction about a scientific experiment, to

summarize ideas in passage, to figure out the meaning of unfamiliar word, to represent and solve a problem, to organize complicated information, and so on. Just as important, they would also think aloud about their doubts and uncertainties. This type of metacognitive thinking and thinking aloud when things do not go smoothly is invaluable in helping students understand that learning requires effort and is often difficult for people. With respect to group process, teachers may share their thinking about various roles, rules, and relationship in explanatory learning. Consider leadership, for example, a teacher might model what he or she thinks about how to manage the group's time or how to achieve consensus.

Similarly, showing students how to think through tough group situations and problems of communication is as invaluable as how to plan an approach to an academic problem, monitoring its progress, and assessing what was learned. One of the greatest challenges in mediating learning is to find out when it is appropriate to model by thinking aloud and when it is useful to select and demonstrate modeling. If a teacher is certain that students have little experience with, say, a mathematical procedure in chemistry, then it may be appropriate to demonstrate it before students engage in a learning task. (This is not to say that the teacher assumes or states that there is only one way to perform the procedure. It is also important to allow for individual variations in application.) If, on the other hand, the teacher believes students can come up with the procedure themselves, then he or she might elect to ask the students to model how solved the problem; alternatively, the teacher could give students hints or cues.

2.4 Differences between Explanatory Test and Exploratory Test

It can be easy to confuse explanatory test with exploratory test. Explanatory test is a type test that attempts to explain why certain phenomena (concept) work in the way that they do. It links different ideas to understand the nature of cause-and-effect relationships in order to explain why certain phenomena occur. However, exploratory test is a type of test that attempts to explore and investigate a problem that is not clearly defined. It explores the research problem but does not offer final or conclusive solutions to existing problem (Faris & Felmlee, 2011).

2.5 Students' Roles in a Regular Explanatory Classroom Test

It is critical that students understand their role in a formative assessment classroom environment. Student behaviors include: engaging with learning goals, developing success criteria, providing feedback to peers, receiving feedback from teachers and peers, and more. Students also assume new roles in explanatory test classrooms. Their major roles are collaborator and active participator. It is useful to think how these new roles influence the processes and activities students conduct before, during, and after learning. For example, before learning, students set goals and plan learning tasks; during learning, they work together to accomplish tasks and monitor their progress; and after learning, they assess their performance and plan for future learning (Crooks, 2010).

2.6 Goal Setting

According to Grant (2012), students prepare for learning in many ways, such as goal setting goals, setting a goal is a critical process that helps guide many others before-, during-, and after-learning activities. Although teachers still set goals for students, they often provide students with choices. When students collaborate, they should talk

about their goals. For example, one teacher asked students to set goals for a unit on garbage. In one group, a student wanted to find out if garbage is a problem, another wanted to know what happens to garbage, a third wanted to know what is being done to solve the problem of garbage. These students became more actively involved in the unit after their discussion about goals, and at the end of the unit, could better evaluate whether they have attained them.

2.7 Assessment and Tests

A test is the part of assessment that has function to measure the student's achievement. Teacher needs some aspects and techniques to measure the student's achievement. Assessment of students' learning has become a topic of great importance in educational literature currently (Kwang-Hyun, 2017; 2018; Sheperd, 2005; Thissen and Waimer, 2001; Chun, 2010). The relationship between assessment and students' learning has been extensively researched (Popham, 2006; Nugba, 2009; Cizek, 2010). Assessment is the systematic process of documenting and using empirical data on the knowledge, skills, attitudes and beliefs. By taking assessment, teachers try to improve students learning. According to Black and Wiliam (2003) and Clark (2012), assessment refers to all activities teachers use to help students learn and gauge their progress. The main goal of classroom assessment is to attain valid, reliable, meaningful, and appropriate information about students' learning (Wiggins, 2008; Sweet,2013; Thompson, & Part, 2008; Clark, 2012). Assessment offers feedback to students and information to teachers about students' performance in a course. There are two main procedures of assessment practised in the classroom. These are summative assessment and formative assessment. Garrison and Ehringhaus (2007) posited that summative assessment is a form of assessment used to determine the overall performance of students at the end of a course or a term. Summative

assessment serves as a means to evaluate students' learning relative to content standard and course objectives. According to Lau (2016) summative assessment refers to as a static measure of learning. It occurs when teachers evaluate a final product. Summative assessment takes place at the end the chapter, a unit of study, a benchmark period, a course, a semester or an academic year.

According to Popham (2011) summative assessment refers to the use tests whose purpose is to make a final success or failure decision about a relatively modifiable set of instructional activities. On the other hand, formative assessment is a self-reflective process that proposes to promote students' attainments (Clare, 2010). Deluca and Klinger (2012) defined formative assessment as the bidirectional process between teacher and students to enhance students' learning. Morzano (2010) defines formative assessment as a process that narrows the scope by requiring that the assessments be used for purposes of modification.

Harlen (2010) contents that formative assessment provides ongoing feedback to improve learning. Looking for a working description for formative assessment alongside summative assessment in the school setting, Madison-Harris, Muoneke and Times (2012) reviewed series of literature on formative assessment and concluded that "it is a systematic, continuous process used during instruction that provides a feedback loop to check for progress and detect learning gains, identify strengths and weaknesses and narrow gaps in learning". Magno and Lizada (2015) in their review, also cite some of the important reports that centered on issues on formative assessment at the start of the 21st century and included that of Clark (2012) who disclosed that formative assessment is an instructional process that builds lasting learning competencies. On the part of Heritage (2010), formative assessment is

explained as an essential part of facilitating the learning process stemming from Vygotsky's (1978) Zone of Proximal Development. Magno and Lizada (2015) again cite Partey (2014) who emphasized that formative assessment is a way of refining the instructional process in higher education.

The theory of regular classroom test as formative assessment is best perceived to be a unifying theory of instruction, which guides instructional practice and improves the classroom learning process by developing Self-Regulated Learning (SRL) strategies among learners (Zimmerman, 2002). Theoreticians in educational assessment agree that SRL is predictive of improved academic outcomes and motivation due to the fact that students gain the needed adaptive and self-directed learning characteristics required for an enhanced commitment to the learning process and consequent successful performance. SRL is a self-regulatory behaviour which refers to a process of taking absolute charge of one's own learning behaviour and possessing the ability to evaluate it. The main aim of formative evaluation is improvement in classroom instruction and Zimmerman (2002) posits that this is best achieved if formative assessment is used strategically to develop SRL in learners in which through metacognition, strategic action, and motivation to learn, will later result in the development of lifelong learning capabilities in the learner. Formative assessment helps teachers to monitor their students' progress and modify instructions accordingly (Bombly, 2013). Formative assessment is not an assessment used for scoring and grading. It is not used to formally report student status at a given point in time.

The impression of assessment is often used synonymously with test. Black et al (2013) addressed the distinction between assessments and testing. According to Bennett, assessment involves the gathering of evidence of students' performance over

a period of time to measure learning and understanding. Evidence of learning takes the form of dialogue, journal, written work, portfolios and tests. However, a test is a timed exercise often in a multiple-choice or short answer form intended to measure students' knowledge or skills in concepts taught (McMillan, 2008; Black & William, 2006). According to Bombly (2013) test is one of the ways of measuring students' progress and is integral to accountability of an education system. A test is used to examine students' knowledge of concept learnt. Again, test measures the level of skill or knowledge that has been reached. An evaluative device or procedure in which a sample of an examinee 's behaviour in a specified domain is obtained and subsequently evaluated and scored using a standardized process. (The Standards for Educational and Psychological Testing, 1999). A test may be administered formally or informally. Formal tests are given a numerical score or grade based on student performance whilst informal tests do not contribute to students' final grade. Tests can be classified as criterion-reference and non-reference. Criterion-reference test is used when the performance of students is measured against defined criteria. Non criterion reference test on the other hand is employed when the performance of individual student is compared.

2.8 Explanatory Classroom Test as a Form of Classroom Test

Regular explanatory classroom assessments (tests) that serve as meaningful sources of information do not surprise students. Teachers facilitate learning by providing students with important feedback on their learning progress and by helping them identify learning problems (Stiggins, 2002; Flórez, & Sammons, 2013; Airasian, 2011).

A test or examination (exam or evaluation) is an educational assessment intended to measure a test-taker's knowledge, skill, aptitude, physical fitness, or classification in many other topics (e.g., beliefs). A test may be administered verbally, on paper, on a computer, or in a predetermined area that requires a test taker to demonstrate or perform a set of skills. Tests vary in style, rigor and requirements (Waldrip, Romanoski, Fisher, & Dorman, 2005). There is no general consensus or invariable standard for test formats and difficulty. Often, the format and difficulty of the test is dependent upon the educational philosophy of the instructor, subject matter, class size, policy of the educational institution, and requirements of accreditation or governing bodies. A test may be administered formally or informally. An example of an informal test is a reading test administered by a parent to a child. A formal test might be a final examination administered by a teacher in a classroom or an Intelligence Quotient (IQ) test administered by a psychologist in a clinic. Formal testing often results in a grade or a test score. A test score may be interpreted with regards to a norm or criterion, or occasionally both. The norm may be established independently, or by statistical analysis of a large number of participants. A test may be developed and administered by an instructor, a clinician, a governing body, or a test provider. In some instances, the developer of the test may not be directly responsible for its administration. For example, Educational Testing Service (ETS), a nonprofit educational testing and assessment organization, develops standardized tests such as the SAT but may not directly be involved in the administration or proctoring of these tests.

Heritage, (2010) and McMillan, (2001) stated that test is a method of measuring a person's ability or knowledge in a given domain. According to Damian (2014) the chief aim of any classroom assessment is to gather reliable information about

students' learning. An ideal assessment is one that is objective and reliable, reduces the influence of context on responses, and captures something of the mechanical nature of the subject knowledge (Florez & Sammons, 2013). Tests as means of assessing students' achievement in the classroom have been a combative issue in the educational circles. Test advocates argue that regular classroom testing increases instructional effectiveness and encourages students to study and revise more often. Frequent testing also provides opportunities for teachers to correct students' errors, to reward poor performance, and to give students a good indication of what they were expected to learn. However, opponents of regular testing are of the view that frequent classroom testing takes away instructional time. According to Mikre (2010), testing rather than exerting a positive influence on student learning could take away valuable instructional time. With a greater teacher emphasis on tests, some educators maintain that students might put their efforts towards performing better on the tests rather than learning for understanding (McNiff, 2005).

In general, classroom tests are used by teachers to diagnose students' strengths and weaknesses, monitor each student's progress, determine teacher's own instructional effectiveness and help teachers to clarify their instructional intentions (Cizek, 2010). Other authors have noted that teachers use tests to grade students (Gonzales, & Fugan 2012; Mullis, & Martin, 2015). However, how much formative use can be made of a written test depends on the quality of the test design. Classroom tests should be constructed with increasing cognitive demands. This is because engaging students in critical thinking enhances their learning. A research result shows that most tests administered by some teachers relied too heavily on students' recall of information (Hambleton et al 2009; O'Leary, 2013). It is important for tests to measure higher cognition of students as well. Findings from Liptak (2015) revealed that elementary

school pupils trained to take test composed of items of higher cognition (according to Bloom's taxonomy) obtained higher scores than control pupils trained with factual items. Questions serve as a central mechanism for eliciting students' thinking and responses (Minstrell & van Zee, 2003; Hendrickson, 2011). Therefore, classroom assessments that facilitate learning require careful consideration as to how they may elicit responses from students and how they promote students' thinking.

Today, students have become accustomed to taking tests so it is necessary that questions must be written in a manner that does not give away the correct answers (Claycomb, & Kysilko 2011; Cizek, 2013). Some studies have revealed that higher scores obtained by students in frequent testing might be due to students' test-wiseness (Johnson, 2012; Koh, 2011). Due to students' test-wiseness, test scores can go up without a corresponding gain in learning (Shepard, 2005; Hendrickson. 2011). A formative test should be designed and developed in a way to suit the purpose of improving teaching and learning in the classroom. Tests administered at the beginning of a unit, can be an accurate way of determining exactly what students already know and what skills they can perform. This information is then to shape the teacher's approach to the teaching of the topic. A test given mid-way through a unit by a teacher may be used to determine students' progress in learning. Such tests allow for the determination of gaps in students' understanding of scientific concepts. This allows teachers to refocus students' thinking and understanding of the topics being taught through appropriate feedback to students.

2.9 Impacts of Explanatory Classroom Tests on Students' Learning

Teachers are assessment literate and thus are able to transform those expectations into assessment exercises and scoring procedures that accurately reflect student

achievement (Palm, 2008). They use classroom assessment to build student confidence in themselves as learners, helping them take responsibility for their own learning so as to lay a foundation for life-long learning. Classroom assessment results are consistently translated into informative (not merely judgmental) feedback for students, providing them with specific insights as to how to improve. Students work closely with their teacher to review assessment results, so as to remain in touch with, and thus feel in charge of, their own improvement over time. Teachers continuously adjust instruction based on the results of classroom assessments. Students are actively involved in communicating with their teacher and their families about their achievement status and improvement. Contrary to the views advocating the beneficial use of formative assessment, an emergent movement has been towards a balance of standardized and classroom assessment that can serve to provide a more impartial approach to assessment, afford it more credibility, and facilitate its use in more constructive ways (Coladarci, 2002; Rabinowitz, 2001).

Baker, Linn, Herman, & Koretz (2002); Claycomb & Kysilko (2001); Hanushek & Raymond (2002), as well as national organizations, have made recommendations for the design of these systems, but as Hanushek notes: "it still represents a young and highly selective body of work. What is important about this movement is that there is a growing belief "if we wish to take full advantage of the power of assessment to maximize student achievement. We must rely on a balanced combination of high-quality standardized assessments of learning and high-quality classroom assessment for learning (Stiggins, 2002)". As the forces on assessment have evolved from standardized, to alternative (authentic), this emerging movement towards balanced assessment systems has the potential to have a significant impact on policies regarding school-based assessment (Cutlip, 2003; Rabinowitz, 2001). Stiggins (2002)

believes that it is flawed to think that all assessment informs decisions and motivates learning. Standardized assessments of learning provide evidence of achievement for public reporting. He advocates for the use of assessment for learning which he says takes formative assessment to the next level by involving students in the assessment process.

According to Wang (2013), assessment for learning keeps students learning and grants them more confidence and ability to continue to learn at productive levels if they keep trying to learn. He feels that many of his principles of assessment for learning are embedded in the standards for assessment of many national organizations but that teachers haven't necessarily mastered those essential classroom assessment competencies. Stiggins (2002) states that "there are no good arguments against balancing our assessment of and for learning" and that "harm arises directly from our failure to balance our use of standardized tests and classroom assessment in the service of school improvement" Stiggins (2002). Balance benefits all stakeholders including students, teachers, parents, administrators, and the community. A number of well-established organizations were reviewed offering a set of useful quality control criteria for effective classroom assessment.

This is what will be the concern. Testing with feedback produces the strongest positive effect on achievement. Adding stakes or frequency also strongly and positively affects achievement. Testing of students in the classroom has been of interest to researchers and teachers in the science education community today. Much research has been done on how to use tests to improve students' learning in the classroom. Many of these studies report that taking tests in concept learnt in the classroom improve retention of the concepts (Earl, & Katz, 2006; Stiggins, 2010;

Lyon, 2010). Studies in second cycle institutions and colleges in the United States reveal that students who are tested or quizzed on weekly basis perform better than other students in mid-term and final examination (Bombly, 2013). Bombly in an extensive review of other studies found out that those students with lower grades in terms of achievement benefit most from frequent testing. Interim tests during the course of instruction or questioning during discussions serves to elicit students' thinking. Feedback can be used to encourage students to confront their misconceptions and misunderstandings, and the process itself can be an instrumental in helping students move to higher levels of understanding (Clare, 2010)

Gonski (2011) conducted a quasi-experimental study on twenty-eight studies in one section of Introductory Psychology at University of Melbourne in Australia. The students were not randomly assigned to groups; they were allowed to choose their testing frequency. Exactly half of the students chose frequent testing; the other half chose the less frequent option. Both groups were taught the same time in the same room by the same instructor. Although significant difference was not found between the groups on the tests, but concerning preference, 70% of the students said they would pick frequent testing next time. All the frequently tested students said that if they had it to do all over again, they would select the same option. In another study, McDaniel, et al. (2007) found that quizzing students throughout the semester of a web-based college course had positive impact on their performance especially in the final examination. Frequent testing offers the students feedback or knowledge of their results giving them the opportunity to see their areas of strength and weakness (Clare, 2010). If students' performance in a course are regularly reviewed and feedback given to them, they can dispel any mystery surrounding successful achievement. Despite these merits, testing is also emotionally charged and anxiety producing. The findings

of a study on test anxiety revealed that tests were a great source of emotional discomfort for learners (Vyse, 2013).

2.10 Making Formative use of Regular Explanatory Classroom Tests

According to Quansah, Amoako and Ankomah (2016), formative assessment is a planned ongoing process used by teachers and students during teaching and learning to elicit and use evidence of students' learning to improve students' understanding of intended disciplinary outcomes and support students to become more self-directed learners. Giving tests in the form of regular quizzing can allow teachers to assess the knowledge of the students and therefore teach accordingly (Black & Wiliam, 2010). Having frequently to take regular quizzes also causes students to need to study more (Leeming, 2002; Lyon, 2011). Research suggests that students knowing that they will have a final test will outperform students who are unaware of a final test (Black, & William, 2014; Mertens, 2014). Presenting feedback in classroom settings have been shown to enhance performance on exams (Butler & Roediger, 2008; Arter, & Spandel; Madison-Harris, Mouneke, & Times, 2012).

Tests, is one of the most popular forms of the formative assessment in Nepalese school education system. Different research and reports show that it is crucial to improve students learning and achievement by implementing different types and frequencies of test in classroom activities (Huhta, 2010). Furthermore, this research study represents that it is important to administrate varieties of tests in mathematics classroom and teachers' feedback is also equally important to improve students' achievement in learning. The findings supported that the meta-analysis, which found generally weak effects of feedback in students' achievement (Stiggins, & Bridgeford 2014; DeLuca, & Klinger, 2010) and challenged that the systematically designed

formative feedback has significant effects on learning achievement (Narciss & Huth, 2004; Gonzales, & Fuggan. 2012). Magno and Lizada (2015) in their review, also cite some of the important reports that centered on issues on formative assessment at the start of the 21st century and included that of Clark (2012) who disclosed that formative assessment is an instructional process that builds lasting learning competencies. On the part of Heritage (2010), formative assessment is explained as an essential part of facilitating the learning process stemming from Vygotsky's (1978) Zone of Proximal Development. Magno and Lizada (2015) again cite Chappuis and Stiggins (2013) who emphasized that formative assessment is a way of refining the instructional process in higher education.

According to Clark (2012), formative assessment is best professed to be a joining theory of instruction, which guides instructional practice and expands the classroom learning process by emerging Self-Monitoring Learning (SML) strategies between learners. Scholars in educational assessment agree that SML is predictive of improved academic outcomes and motivation due to the fact that students gain the needed adaptive and self-directed learning characteristics required for an enhanced commitment to the learning process and consequent successful performance (Zimmerman, 2002). SML is a self-regulatory behaviour which refers to a process of taking absolute charge of one's own learning attitude and possessing the ability to evaluate it. The main aim of formative evaluation is improvement in classroom instruction, and Chappuis and Chappuis (2007) posited that this is best achieved if formative assessment is used strategically to develop SML in learners in which through metacognition, strategic action, and motivation to learn, will later result in the development of lifelong learning capabilities in the learner.

Assessment that supports student learning requires both quality assessment and effective use of results, and that both must be carefully crafted and aligned with goals for student learning (Herman & Baker, 2005; Herman, et al. 2005). Classroom tests serve as practice for students when teachers assess student learning for formative purposes. A test is formative if the feedback is used to adjust teaching and learning in the classroom (Chappuis & Chappuis, 2007). This is the most valuable formative assessment called assessment for learning. Learning often takes place best when students have opportunities to express ideas and get feedback from their teachers. One of the key components of formative assessment is providing students with descriptive feedback as they learn (Heritage, 2010; Black & William, 2009). Many teachers and administrators find single, end-of-year summative assessments far less useful for making data-driven decisions than more frequent, local assessments (Marsh, Pane, & Hamilton, 2006; Li-Yi, 2016). Meta-analyses focused on the frequency of teachers' assessments suggest that more frequent assessment alone can produce a small to medium positive effect on student achievement (Gonzales, & Fugan, 2012; Damian, 2014).

In addition to frequent assessments, the need to measure students' understanding of core concepts and their ability to engage in scientific practices requires more than one single type of assessment (National Research Council, 2001, 2012). Descriptive feedback provides students with an understanding of what they are doing, and gives specific input on how to reach the next step in the learning progression. However, for feedback to be most helpful to learners, it ought to be analytical, suggestive, and come at a time when students are interested in it. Studies on feedback reveal that much of the feedbacks that students receive are at best, no impact on learning. Florez and Sammons (2013) reviewed over 131 research report on the effect of feedback in

schools and institutions. Across these 131 studies, they found that on the average, feedback did increase students' achievement, but that in 40% of the studies, feedback actually did not improve students' performance. This was because the latter type of feedback focused attention on the person rather than the quality of the work. However, the 60% of studies that found positive impact on performance, Florez and Sammons (2013), found that the biggest impact occurred when feedback told not just what to do to improve, but also how to go about it.

According to Mullis and Martin (2015), and Ministry and van Zee (2003) the most desirable type of feedback on tests provides specific comments about errors and specific suggestions for improvement. This type of feedback encourages and reinforces students to focus their energy thoughtfully on the task rather than on simply getting the correct answer. Some studies support the use of descriptive, criterion-based as against numerical scoring or letter grades without any defined criteria (Quansah, Amoako, & Ankomah, 2016). Mullis and Martin selected a group of students and worked with them over a series of three sessions. He provided these students with one the following three types of feedback on their; 1) both grades and remarks 2) grades only and 3) tailored written comments addressing criteria that they had used in assessing students' work. Post-test performance showed that scores on the tasks increased most significantly for those who received comments across all three sessions, while scores declined across the three sessions for those who received only both remarks and grades. Those getting grades only had their scores declining. The result of this study suggests that providing clear and explicit standards of quality work provide with an ability to know what is expected of them and this can assist them monitor their own progress (Popham, 2008). In another similar study Pashler, Cepedia, Wixted, and Rohrer (2005) found that if people who missed an item on an in

initial test were given corrective feedback, they were very likely to get the item correct on a subsequent test, whereas people who were not provided corrective feedback on missed items performed poorly on a final test on these items.

2.11 Involving Students in Regular Explanatory Classroom Assessments

As a result, students may come to view assessment as a dreaded and unknowable process handed down by those in power (Castilo, 2009). Ensuing feelings of powerlessness in students can result in multiple negative outcomes such as confusion (Marziliano, LaPan-Dennis, Zito, & Gillespie, 2015; Zeliff, 2000), failure to engage with material (Price, Handley, Millar, & O'Donovan, 2010), and a narrow focus on the grade received, to the detriment of learning (Pintrich, & Schunk 2002; Koloi-keaikitse, 2017; Taras, 2002). Boston, 2002; Ruben & Gigliotti, 2016). This model does not help students to experience any ownership of the program or curriculum and does not encourage students to value assessment as a positive tool for improvement (Marziliano et al., 2015). If educators want to improve student involvement and commitment, in the assessment or evaluation of that program (Pintrich, & Schunk 2002; Cizek, 2014, & Bryant, 2012).

Creating a formal structure for student involvement in assessment, one that continuously included student voices and representation, seemed to be a promising way to dispel that discomfort and more effectively increase student buy-in and engagement in the program as a whole (Nenty, Adedoyin, & Mayor, 2007, & Brown, 2014; Ndalichako, 2017), gives students ownership over the learning process. Increases student motivation to learn. Allows students to develop useful skills in self- and peer-assessment Another distinction that underpins formative assessment is student involvement (McTighe, 2015). Students who are involved in

assessment develop the skills needed to be lifelong independent learners as they know how to set goals and reach them. Unfortunately, in research literature the self-assessment and peer-assessment are mostly viewed in the context of summative assessment, where students assess colleagues' work by points, levels or grades, sometimes making comments. At the same time the researchers point to the diverse problems that arise, when students are invited to assess themselves or their colleagues in a summative way such as doubts about the objectivity and fairness (Ndalichako, 2010; Lysaght, & O'leary, 2013; Clare, 2014). Lysaght, & O'leary, 2013 conducted research at the Universities in Hong Kong surveying 1,740 students and 460 academics on a grade in peer-assessment identifying that grade discourages the peer-assessment and may threaten the potential of formative assessment to promote learning. Black (2003) pointed out that the peer-assessment is an important addition to the self-assessment. Several researchers emphasize the substantial value of peer-assessment -it occurs in an easily understandable language for students, thereby comments and recommendations for further work are better understood (Michelle, 2018; Black, 2003; Clare, 2010).

Besides mutual discussions revealing perspective of solutions and alternative strategies, as well as developing students' capability of judgments, decisions formulation can be motivating to continue the engagement, in addition, it may be easier for the student to accept criticism of his work from colleagues, not from the lecturer (Amadehe, & Asamoah-Gyimah, 2016). As a practical recommendation, Amadehe and Asamoah-Gyimah mentioned a method when during the work presentation students are asked to write their feedback as positive findings about the colleague at work, and to provide recommendations. The feedback the colleague

receives after the completion of the presentation; always starts with a positive message, and includes recommendations for further work (Johnson, 2014).

Students need to be involved to share understanding and feel like they have control over their learning. If students are not involved in the assessment process, formative assessment is not practised or implemented to its fullness. Students need to be both as assessors of their own learning and as resources to peers (Mertens, 2014). According to Huhta (2010) immediate analysis of formative results is a diagnostic tool to determine students' strengths and weaknesses relative to benchmark used to assess them. Again, the information obtained from such analysis is used to adapt instruction to focus on the specific areas where student improvement is needed. In the light of this, students need to be aware of the purpose of the tests they are taking regularly in the classroom. Knowing what the teacher is trying to do can help the students navigate and develop from the process of self-evaluation. A sense of ownership can increase pupil motivation. All learners need to feel that they are in real and active partnership with their teachers. According to McMillan (2008), Lysaght and O'Leary (2013), experimental studies have shown that students who understand the learning objectives and assessment criteria and have opportunities to reflect on their work show greater improvement than those who do not.

Engaging students in assessment-related conversation about their work provides a platform where standards and criteria of quality are negotiated are discussed publicly (Ndalichako, 2014). In a study conducted by Rormer (2010), four science classes in the middle school level were provided with criteria for expectations and grading after they have received the same curricular instruction. Two of the classes were made to discuss and reflect on what they were learning and how they were leading it during

regular classroom time whilst the other two classes spent the same discussing about how the activities could be changed. The classes that spent time involved in assessment-related discussions around, performed better on unit test than the other classes.

Agreeing to Pryor and Crossouard (2010) if criteria and goals reflect meaningful aspects of an activity, students begin to develop a better sense of how to engage in that activity. Students' participation in classroom assessment allows them glean valuable information about their performance. One of the key components of engaging students in the assessment of their own learning is providing them prompt feedback as they learn and discussing feedback on task, they performed with them (Wolf, 2011). Teachers therefore stand in a unique position to gain insight into their students' understandings, actions, behaviours, interests and motivations.

2.12 Motivating Chemistry Students to Learn

Many private and public schools invest money into professional development to help teachers gain the strategies needed to be skilled at motivating student learning. The construct of student motivation in learning is the result of task-related and organizational factors, such as the type of assessments embedded in classroom teaching (Clark, 2012; Crossouard & Pryor, 2012; Brown, 2004; Warsen, 2012). The topic of assessment has been widely researched in organizational literature databases because there is a correlation between assessment, performance, and productivity. The motivation of a student depends on the type of assessment practices used in the classroom, which in turn, affects student success (Sage-Xu, & Brown 2016). The government of the education system in India is focused on improving its current system as a whole. Since the country is a developing nation, the quality of education

is important (Government of India, Ministry of Human Resource Development, 2016). Leaders in India contended that because of the economic and social challenges in the country in the 21st century, the educational system as a whole cannot improve (Young, & Jackman, 2014; Wyatt-Smith, & Looney, 2016).

Secondary school education systems in India are integral, as these institutions help to shape the human capital of the country (Magno & Lizada, 2015). Geographically, the areas of Trivandrum, Dehradun, Chandigarh, and Delhi regions heavily emphasize education in comparison to other states in the nation. The quality of education in these regions depends on satisfied and committed teachers who work towards motivating students to help them succeed in their learning (Magno & Lizada, 2015). In particular, Assessment for Learning (AFL) is a method widely adopted in many schools in North America. Since this method has proven to help students increase motivation and engage in the classroom in North America, adopting this practice in India can help motivate students, who are often learning through lecture-style lessons. "We must keep students in touch with the accumulation of evidence of their own increasing proficiency, and give them a vocabulary that will allow them to communicate about that," Stiggins said. "The very process of helping kids prepare to be intelligent reflectors upon their own performance may be one of the most powerful instructional interventions that it's possible to conceive."

By helping students track their progress along performance continuums, "we're holding up a mirror to them so they can watch themselves succeeding," Stiggins said. "And that's where the internal sense of motivation comes from. Kids feel they're in control of their own academic success." The third breakthrough idea, Stiggins said, is "student-involved communication about their own achievement."

Student-led parent conferences, where students describe their progress to someone whose opinion they care about, "appear to bring about a fundamental shift in a student's internally held sense of responsibility for her own academic success," he said.

If teachers combine student-centered classroom assessment with student-involved record keeping, and then "top off the equation" with student-led parent conferences, Stiggins contended, they will get "a motivational package" that far outstrips anything they could get through applying rewards and punishments. "You don't get motivation by threatening people," he emphasized. "You get motivation by bringing people into the process and helping them feel as though they're on internal control."

The typical lesson involves a teacher writing notes on the board for students to copy down and students are regularly given memorization drills; thus, learners are passive recipients of information who rarely get involved in their learning and assessment practices (Ahmad, & Mussawy, 2009). The results from this study are important, as it adds depth to the existing literature in assessment practices and motivation of student learning, and strengthens a literature trail of these variables in the Indian education system. The process of classroom assessment can serve an important role in enhancing student motivation and achievement. Teachers can help enhance student performance by sharing clearly defined learning goals Through student involvement in the assessment process, students learn to take responsibility for their own learning. According to Gross (2012), learning is usually most efficient and rapid when the learner is motivated. Brown (2004) motivation is a complex concept concerned with

the drive, incentive or energy to do something. Pintrich and Shunk (2002) defined motivation as the process whereby goal-directed activity is instigated and sustained.

Incentive theories of motivation propose that people will perform an act when its performance is likely to result in some desired outcome, or the outcome is important to them (Roediger, & Karpicke, 2006; Coldarci, 2000; Shavelson, 2006; Shepard, 2005; Cutlip, 2003) after reviewing a large body of research about motivation concluded that the value of an outcome to the student affects that student's motivation. According to Nikto (2004), motivation leads to cognitive engagement, and such engagement shows itself in the use or application of various learning strategies. Motivation of students in the classroom needs to be intrinsic. Intrinsic motivation influences learners to choose a task, get energized about it, and persist until they accomplish it successfully, regardless of whether it brings a prompt reward (Stiggins, 2004). Louca and Zacharia (2012) and Schwarz, et al (2009) modified the expectancy-value model. They proposed that the effort students will direct toward a test is a function of how well they feel they will do on the test, the effort it will take to complete the test, the importance with which they perceive the test, and their affective reactions regarding the test.

Furthermore, findings from empirical studies show that students perform better when they are motivated to take tests (Looney, 2014; Wise, & DeMars, 2003; Cizek, 2003; McMillan, 2008; Mullis, & Martin. 2015). Looney found that the motivation scores of college students were 0.75 standard deviation units higher when they took a multiple-choice test that would be scored compared to a parallel test that would not be scored. The effect size was even greater, 1.58 for an essay question. Mullis, & Martin. (2015)

found motivation difference of 1.48 standard deviation using similar conditions, and McMillan (2018) had a motivation effect size of 1.63.

2.13 Summary

The outcome of studies on the consequences of tests is that effective utilization of tests can free the intelligence and maximize the potentialities of each individual (Bombly, 2013; Brookhart, 2011; Airasian, 2011). Tests are a quality way of measuring student progress and are necessary to evaluate schools and the educational systems. For evaluation to be truly effective, tests should not be only summative, but should be formative. Tests can be used formatively to ascertain the effectiveness of learning from instruction. A substantial body of research indicates that testing students shortly after they are exposed to the material, facilitates subsequent long-term retention of information (Roediger & Karpicke, 2006). Studies have also shown that majority of students prefer more frequent testing (Cizek, 2014; Clare, 2010; Crooks, 2019). Formative tests held on weekly or monthly basis are suitable for studies and they improve the learning results. Testing students frequently promote learning and retention of concepts because students will study more often (Karpicke & Roediger, 2008). Students commit and motivate themselves to their studies when they are able to see the results of their every week. Also, teachers receive essential information on the progress level and development of the students and direct the remedial instruction to the academically weak ones. Students' effort throughout tests produces test performances that validly permit others to infer students' true level of development (Harlen, 2012). For classroom learning, intrinsic motivation is needed for students to take responsibility for their learning. (Harlen, 2012). According to Huhta (2010), and Campbell and Evans (2000) formative assessment techniques help support the expectation that all children can learn to high levels. The growing interest

in formative assessment practises reflects the view that most important use of assessment occurs hand in hand with classroom teaching and learning (Chappuis, & Chappuis, 2013; Black & Wiliam, 2004; Lampert, 2010; Shavelson, 2006; Shepard, 2005). Making frequent, interactive assessments of student understanding, identifying and responding to students' needs enables teachers to adjust their teaching to meet individual student needs (OECD, 2012). Research and development in the area of classroom testing are essential in order to provide teachers and instructors with the support necessary to make changes in their classroom practice.

The absence of classroom based formative assessment practices (assessment for learning) as prescribed by the formative aspect of the Continuous Assessment (CA) and the School Based Assessment (SBA) in many Ghanaian classrooms renders the instructional management decisions function of classroom assessment unrealised to its fullest (Asamoah-Gyimah, 2016). It also paints the bigger picture that the state of affairs concerning the practice of formative assessment in the Ghanaian classroom is uncertain. According to Amadehe and Asamoah-Gyimah (2016), the state of affairs concerning formative assessment in the country is suggestive of the fact that the Ghanaian educational system is losing out on all the probable gains that formative assessment holds in contributing to improvement in the instructional practices of the teacher in the classroom. The connection between good assessment practices and improvement in instruction has been established locally by research (Oduro-Okyireh & Partey, 2014). According to Nikto (2004), when valid and reliable assessment procedures are used, decision on students' better instructional approach and placement, and among others become feasible.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter describes the methodology of the study. It covers the research design, pre-intervention, intervention and post-intervention activities. It also involves research population, sample and sampling technique as well as instrumentation. Other issues considered in this chapter are validity of the instrument, data collection procedure, and method of data analysis.

3.1 Research Design

The research design used in this study was action research design (theory of change, ToC) which only involved the experimental group that aimed at improving students' learning and conceptual understanding of selected topics in chemistry. ToC depicts logical programme (Clark &Taplin, 2012) which illustrates how particular inputs are expected to lead outputs, intermediate and final intended outcomes (Rogers, 2014). Action research was chosen because it improves teacher's classroom practise and enhances student's learning, and also promotes personal and professional growth of the teacher (Michelle, 2018). Amedahe (2002) clarified that the research design is potentially useful in that it controls all threats to validity and all sources of bias such as history and maturation. According to Martyn (2001), research design allows the researcher to compare the final results between the pre-intervention and post-intervention activities of the experimental group giving the researcher an idea of the overall effectiveness of the intervention or treatment. This study was carried out in three major phases. The first phase consisted of pre-intervention activities, the second phase was the implementation of intervention and the third phase was the post-intervention activities.

Figure 2 shows the systematic approach of which the study was carried out. The study began a week's revision of some topics learnt in the previous semester. This was followed by analysis of students' workbooks in the classroom. Lesson plans were then developed and used in teaching students electrolysis for five (5) weeks and at the end of each week students were made to take an essay-type test. Students' outputs in class were measured.

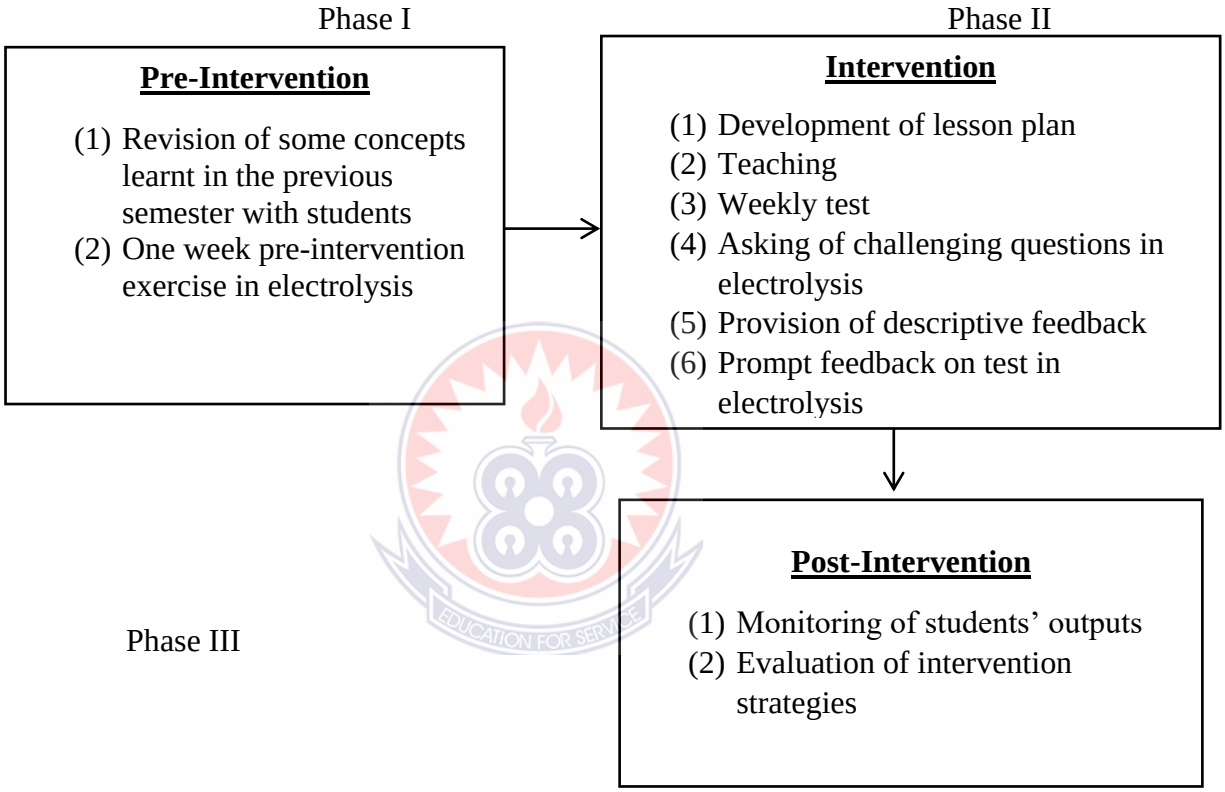

Figure 2: The Design of the Study (Theory of Change)

3.1.1 Pre-intervention

This phase comprised of two activities which were done to ascertain the level of students' performance and understanding of topics in chemistry. The first activity was the revision of some of the topics learnt in the previous semester. The topic was redox reaction. The lesson took place in the first week of the study with most of the learning activities being oral interactions of the researcher with the students. Students were made to describe redox reaction. They described redox reaction in terms of change of

oxidation number of the reacting species. They were made to explain reducing agent and oxidizing agent from a given redox reaction. Again, students determined oxidation number from a given compound. At the end of the week, the second activity was carried out. Thus, students were made to answer questions in the pre-intervention stage. This focused on the researcher context for the vital intervention. Data on pre-intervention activities are presented in chapter four.

3.1.2 Intervention

Weekly lesson plans were developed with respect to the Senior High Schools curriculum for second semester. According to the chemistry syllabus for Senior High Schools in Ghana. Students were supposed to learn electrolysis in the second semester of the second year. Therefore, teaching and learning activities about the topic was developed systematically specifying the instructional objectives to be achieved each week. The lesson plans incorporated in the test to be administered for the week. Samples of the weekly lesson plans prepared can be found in Appendix A. Test items which were used in the weekly tests were constructed based on the activities and topics which were treated within the week and the previous weeks. The test items consisted of essay type question. Essay type question was chosen because it measures complicated learning outcomes and also stresses on the integration and application of thinking and problem-solving skills Liptak (2016). According Dennis (2012) students preparing for essay tests focus on general knowledge broad issues and interrelationships rather than on specific details and this studying results in better students' performance. The constructed essay tests were administered to the students at the end of each week. The duration of each test was thirty minutes (30). The tests were marked and distributed to students before the next election. Descriptive feedbacks were provided on each wrong response provided by the students. This was

done to enable students identify specific strength and areas needing improvement. Thus, students' weakness and misinterpretation of concepts showing less knowledge and understanding were addressed in the classroom.

3.1.3 Post-intervention

This phase of the study involved monitoring the effects of the intervention strategies on the students' learning and evaluation of the intervention strategies. Results from post-intervention exercise are analysed at each week. This can be seen from Table 2 to Table 7. This was done by monitoring students' work output at the end of each week. Students' work outputs were monitored by the researcher based on their responses to the questions in the weekly tests as well as during lessons. Moreover, their responses were judged whether they were related to the questions asked as well as with good explanation and reflected understanding of topics learnt. The findings from this series of observations were used to modify and adjust the interventional strategies to achieve the desired learning outcomes. Results from this activity served as a basis for evaluating the performance of students and the intervention strategies implemented.

3.2 Research Population

A research population is a well-defined collection of individuals or objects having similar characteristics (Pober, 2012). Pober distinguishes between two types of population; the target population and the accessible population. The target population which is also as the theoretical population refers to the group of individuals to which researchers are interested in generalizing the conclusion. However, the accessible population which is also known as the study population is the population in research to which the researcher can apply conclusion. The target population for this study was

all students of Winneba Senior High School in Effutu Municipality in the Central Region of Ghana. But the accessible population was science students in Winneba Senior High School. This school was chosen due to availability of science teaching materials in the school as well as being a science resource center. Moreover, it was also considered to its proximity to the researcher and the willingness of the science department and the school accommodate the study.

3.3 Sample and Sampling Technique

A sample is a finite part of statistical population whose attributes are studied to gain information about the larger population (Boddy, 2016). According to Pober (2012), sampling techniques are the strategies applied by researchers during the sampling process. The sample for the study was a class of second year science '2' (2SC1) students of Winneba Senior High School. Moreover, second year science '2' students were chosen through purposive sampling technique. The students were chosen because they were not new in the school and they were also not under pressure to any external examination. Again, they had been introduced to some to some basic scientific concepts in year one, and at least some fundamental principle in chemistry. This class was also purposely chosen because of fair representation of both boys and girls in the class. The total sample was thirty-five out of one hundred and eleven students, twelve (12) girls and twenty-three (23) boys.

3.4 Instrumentation

The researcher used both qualitative and quantitative data gathering instruments. The quantitative data was collected by using Pre-intervention test items, Intervention, and Post-intervention test items. The researcher also employed the use of students' monitoring book as well as the teaching, learning record book and interview to co.

The pre-intervention test items contain four questions. The pre-intervention test exercise was done for one week, focusing the establishment of the research context for the necessary intervention.

3.4.1 Students' learning progress monitoring book

The purpose of this book was to collect information on students' outputs in the pre-intervention exercise and weekly classroom tests. The data collected was used to ascertain the performance of students from the beginning of the study till the end of the implementation of the intervention. This form consists of criteria on which students' responses to questions in the pre-intervention exercise and weekly tests were examined. Students' responses to question were examined whether they relate to the questions asked, include explanations, describe the situation demanded by the questions and reflect understanding of the topic learnt. A detail of this book is found in Appendix B.

3.4.2 Teaching and learning documents record book

This book was designed purposely to record data from subject teacher's note book as well as students' work books in the previous semester. The data which was recorded include scheme of work, lesson plan, instructional objectives, teaching and learning activities and the evaluation exercises. The rest include the number of class tests done, home works performed and project work done for the previous semester. Detail of this book is found in Appendix C.

3.5 Validity of the Instrument

According to Blumberg (2005), validity describes whether the means of measurement are accurate and whether they are actually measuring what they are intended to measure. A test is valid if its results are appropriate and useful for making decisions

and judgment about an aspect of students' achievement (Robson, 2011). The test items used was validated by two experienced teachers who have taught for 15 years in the school. The items were examined based on the cognitive level of the students and the instructional objectives stipulated in the Chemistry Syllabus for Senior High School in Ghana (MOESS, 2008). The face validity of students' learning progress monitoring book and teaching and learning record book were ascertained by two senior lecturers, chemistry Education Department of University of Education, Winneba who have enormous experience in research in assessment and evaluation.

3.6 Reliability of the Instrument

Reliability is clarified by Kirk and Miller (1986) as the extent to which a procedure produces similar results under constant conditions on all occasions. In order to ensure the reliability and effectiveness of the instruments used, they were piloted with form two science students in Apam Senior High School in elective chemistry. This school is chosen because it offers the elective science programme just as students at Winneba Senior High School. Proximity is another reason why Apam Senior High School was chosen for the exercise. The internal consistency of the study was determined using the Statistical Package for Social Science (SPSS), version 20 for windows. The Cronbach alpha coefficient of reliability was measured. The reliability coefficient of the tests is summarised and presented in Table 1: According to Borg and Gall (1993) coefficient of reliability values above 0.75 are considered reliable. Therefore, the above reliability indices gave an indication that the instruments were substantially reliable.

Table 1: The Reliability Coefficients of the Various Instruments

Instrument	Reliability coefficient
Pre-test	0.78
Post-test	0.77

The interview protocol was also piloted with the same sample used in piloting the test. The reliability of the interview was then assessed using inter-rater reliability. The transcriptions of the audio recordings of the interviews were given to different experts to determine the inter-rater reliability of the data. These experts agreed that the interview protocol could be used to undertake the substantive study. The reliability of the interview protocol was also enhanced by the fact that the interviewer held one-no-one interview sessions with the various respondents using almost the same questions. Agreeing to Nugba (2009), one-on-one interviews with standardized questions appear to have the highest reliability.

3.7 Data Collection Procedure

Data collection is the process in which data of a study is gathered (UNECCE, 2000; Robinson, 2004). Data of this study was collected in three stages. The first stage was collected of teaching and assessments information from the teacher's note book and students' work books. The teacher's note book was examined to ascertain the contents of his lessons preparations whilst students' workbooks were examined to find out kinds and frequency of tasks performed in the previous semester. Data from these activities was collected with the use of teaching and learning record book. The second stage involved data on the pre-intervention exercise. Before the implementation of the intervention, topics learnt by students in the previous semester were revised, and at the end of the revision, students were made to answer four essay type questions in

their work books. This pre-intervention exercise was marked and data was collected with the use of students' learning progress monitoring book.

The final stage involved data on students' outputs in the weekly tests. After the pre-intervention exercise students were introduced to the intervention weekly tests. Students were made to understand that the weekly tests were to help them learn and improve their understanding of the topics they were about to do in the semester. Students were taught for seven weeks and at the end of each week an essay was administered to them. The tests were marked and data collected on students' responses to each test item were recorded with use of students' learning progress monitoring book.

3.8 Method of Data Analysis

Data analysis is the process of converting raw data collected into usable information (Shamoo, & Resnik, 2003). This study employed both qualitative and quantitative methods of data analysis. Data from pre-intervention exercise and students' outputs in the weekly tests were analysed qualitatively and quantitatively. Students' responses to questions in pre-intervention exercise in the weekly tests were analysed whether they reflect the understanding of topics learnt. Therefore, answers with correct explanations and examples showing application of principles learnt were classified as 'understanding of topics' (U). Responses that were related to questions but with incorrect explanations, together with wrong answers were classified as 'no understanding' (NU). Students were expected to include explanations in the answers they provide in the tests. Hence responses that included explanation were classified as 'with explanations' and those without explanation were classified as 'no explanation' (NE). The results from these analyses were expressed in percentages and tabulated

with samples of students' responses to the test questions. Frequency distribution was also used to analysed the data.

3.9 Ethical Consideration

Ethical issues such as students' name to remain unanimous as well as students' consents were considered. Permission was sought from the headmistress before embarking on the study.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

In this chapter the data gathered during the study have been presented. Data were collected from students' workbooks. Students' responses to questions in the intervention exercise and the weekly tests are also presented. The analyses of the data gathered are summarized and presented in the tabular form.

4.1 Pre-intervention Exercise

This exercise was done for one week with students with the intention to adopt better instructional approach to meet students' need as far as their learning in chemistry is concerned. Therefore, concepts taught by the subject teacher in the previous semester were reviewed with students for one week and at the end of the week students were made to answer four questions. The concept involves redox reaction. This activity was done to find out the level of students' understanding of concepts they had learnt in the previous semester. Thus, concepts of reducing agent, oxidizing agent and balancing of redox reaction were discussed with students. They were also taken through the identification of reducing agent and oxidizing agent. Samples of the students' responses to the questions asked in the pre-intervention exercise were analysed and presented as follows:

Question 1: Identify the reducing agent and the oxidizing agent in the equation below. Explain your answer.

$Fe^{2+} + Cl_2 \rightarrow Fe^{3+} + 2Cl^-$

Student 1: "*reducing agent = Cl_2, oxidizing agent = Fe^{2+}*"

The response provided by the student relates to the question asked but it is incorrect. This is because iron (II) loses an electron to form iron (III) thus, $Fe^{2+} \rightarrow Fe^{3+} + e$. Since Fe^{2+} is an electron donor it is referred to as the reducing agent. Chlorine gains an electron to become a chloride ion. Cl_2 is an electron acceptor therefore the oxidizing agent.

Student 2: "*reducing agent = Fe^{3+}, oxidizing agent = $2Cl^-$*"

The response provided relates to the question asked but it is incorrect. This is because the reducing agent and the oxidizing agent are identified in the reactants side of the equation. About 75% of the students could not identify the reducing agent and oxidizing agent correctly. This shows that the students had difficulties in identifying reducing agent and oxidizing agent. Reducing agent is the substance that releases electrons in a redox reaction. Thus, electron donor. Oxidizing agent is the substance that accepts electrons in a redox reaction. Thus, electron acceptor. Therefore, the reducing agent is Fe^{2+} and the oxidizing agent is Cl_2.

Question 2: Find the oxidation number of the underlined atom in $\underline{Mn}O_4^-$

Student 1: "*Mn + 4(-1) = -1*

Mn = -1 +4 = +3"

The response relates to the question but it is incorrect. This is because the oxidation number of oxygen is -2 not -1. Therefore, the oxidation number of manganese is +7 from MnO_4^-

Student 2: "*Mn + 4 = -1,*

Mn = -1 -4 = -5."

The response is incorrect though the response relates to the question. This is because the oxidation number of oxygen is omitted hence the oxidation number for manganese

is not -5 rather +7. About 72% of the students provided similar answers to the question which were not correct.

Mn + 4(-2) = -1,

Mn -8 = -1,

Mn = 8-1= +7 therefore the oxidation number of manganese is = +7 from MnO_4^-

Question 3: Identify the spectator ions in the equation below and explain why?

$KMnO_4 + H_2SO_4 + Na_2SO_3 \rightarrow MnSO_4 + K_2SO_4 + Na_2SO_4 + H_2O$

Student 1: "*Mn and S because they have different oxidation numbers, +7 and +4 respectively".*

The response provided relates to the question asked but it is incorrect. Moreover, explanation given is incorrect. This is because spectator ions do not have different oxidation numbers. They have the same oxidation number.

Student 2: "*K and Na are the spectator ions because they have charges".*

The response provided relates to the question asked but it does not describe the situation demanded by the question. The students were not able to write how spectator ions are determined in a redox reaction. About 80% of the students provided similar responses to the question asked. This indicates that majority of the students have difficulties in understanding the concept of redox reaction. Spectator ions that do not involve electron transfer or there is no change in oxidation number of the species involved in the reaction.

$K^+ + MnO_4^- + H^+ + SO_4^{2-} + Na^+ + SO_3^{2-} \rightarrow Mn^{2+} + SO4^{2-} + K^+ + SO_4^{2-} + Na^+ + SO_4^{2-} + H_2O$

Therefore, the spectator ions are K^+, Na^+ and SO_4^{2-} because these ions have the same charges on both sides of the equation. Thus, oxidation number of the species does not change hence remain the same.

Question 4: Explain why the equation below is termed as disproportionation reaction in a redox reaction. $3HNO_2 \rightarrow HNO_3 + 2NO + H_2O$

Student 1: "*The reaction is disproportionation reaction because it has only one reactant.*"

The answer provided by the student is incorrect because disproportionation reaction depends on same substance being reduced and oxidized in the same reaction. HNO_2 is reduced and oxidized in the same reaction.

Student 2: "*The reaction is disproportionation reaction because it has one reactant and three products in the reaction*."

The answer provided by the student relates to the question but it is incorrect because disproportionation reaction is not about the number of reactants and products. About 68.8% of the students could not explain disproportionation reaction in redox reaction. Disproportionation reaction is a rection in which the same substance is reduced and oxidized in the same equation of a redox reaction. From the equation; $3HNO_2 \rightarrow HNO_3 + 2NO + H_2O$ the oxidation number of N in HNO_2 is decreased from +3 to +2 in NO. Therefore, HNO_2 is reduced. Moreover, the oxidation number of N in HNO_2 is increased from +3 to +5 in HNO_3. Hence, HNO_2 is oxidized. Since HNO_2 is reduced and oxidized in the same equation, the equation is termed as disproportionation reaction.

Table 2: Post-analyses of Students' Conceptual Understanding of Pre-intervention Exercise

Question	Response Categories (%)			
	WE	**NE**	**U**	**NU**
1	0.0	100.0	25.0	75.0
2	78.2	21.8	28.3	71.7
3	50.0	50.0	19.0	81.0
4	100.0	0.0	30.5	69.5

WE = with explanation; NE = no explanation; U = understanding; NU = no understanding

In Question 3 about 50% of the responses included explanation with about 50% of the responses without explanation. Again, about 19% of the responses reflected understanding whilst 81% of the responses did not reflect understanding of the concept. Moreover, in Question 4 all the responses students provided were with explanation; about 30% of the responses reflected understanding whilst 70% did not reflect understanding of the concept. This presupposes that student have less knowledge of concept learnt in chemistry. Hence, the introduction of regular explanatory classroom tests as intervention strategy. Table 1 shows the analyses of students' responses in the pre-intervention exercise. Data from Table 1 shows that most of the responses students provided did not reflect understanding of the concept learnt. In Question 1 all the responses students provided were without explanation. 25% of the responses reflected understanding whilst 75% did not reflect understanding of the concept. In Question 2 about 78% of the responses included explanation with 22% of the responses without explanation. Again, about 28% of responses reflected understanding whilst 72% of the responses did not reflect understanding of the redox reaction.

Table 3: Pre-intervention Frequency Distribution of Pre-test Scores of Students in the Explanatory Test

Scores	Frequency	Percentage (%)
10-20	8	22.9
21-30	12	34.3
31-40	10	28.6
41-50	5	14.3
51-60	0	0.0
61-70	0	0.0
71-80	0	0.0
81-90	0	0.0
91-100	0	0.0
Total	**35**	**100**

Table 3 shows frequency distribution analysis of pre-test scores of students in the explanatory test. From Table 2, 14.3% of the students scored marks less than 51. 22.9% of the students had marks ranging between 10 and 20. Again, none of the students had marks between 51 and 100.

4.2 Intervention Results

It was observed clearly from Table 1 and 2 in the pre-intervention exercise that student have less knowledge in explaining concepts learnt in electrolysis. Therefore, regular explanatory classroom was used to assist students, learn and understand electrolysis in chemistry, students were taught for four (4) weeks and at end of each week, students were made to answer questions on the concepts learnt within the week and previous weeks. Questions asked were constructed with increasing cognitive demand to challenge students to reason and apply the principles learnt in solving them. The test results were given to students before the lesson of the week. This helped students to get enough time to do remediation on the concepts they could not provide valid responses to. Descriptive feedback in the form of written comments was provided against any incorrect responses which did not reflect understanding of

concept learnt. This assisted students to know the mistakes they committed and how to overcome such mistakes in subsequent tests. Feedbacks on tests were discussed with students for them to know what were expected as responses to the questions asked. This strategy assisted students to use the best and correct approach in finding solution to the questions asked in the subsequent tests. Moreover, these strategies adopted improved the performance of students in the weekly tests. Data collected on students output in the weekly tests are analyzed and presented weekly as follows:

4.2.1 Week One

Research Question One: What impact does regular explanatory tests have on students' learning in chemistry?

To assess the impact of regular explanatory classroom tests on students' learning in chemistry, students were taken through series of regular explanatory tests after each lesson. Hence, the first lesson was on electrolytic cell and electrochemical cell as illustrated in figure 3

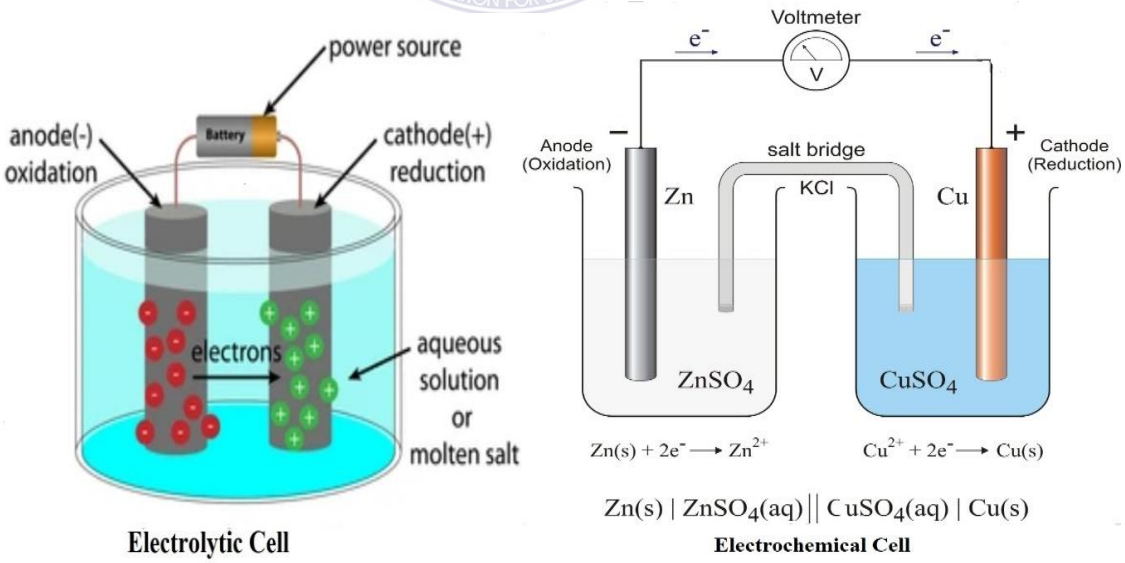

Figure 3: Comparing Electrochemical cell and Electrolytic Cell

Students were called to clearly distinguish between electrolytic cell and electrochemical cell using galvanic cell and electrolytic cell set-up. Students were then guided to clearly distinguish between the two. Students did not have any difficulty with the electrolytic cell and electrochemical cell. The term electrolysis was introduced and discussed with students with help of electrolytic cell set-up. Students were able to identify the anode and cathode from the cell. Students' participation in the class became immense when how electrolytic cell operates was introduced. Majority of the answers students provided were related to questions asked. Students explained what occurs at the cathode in an electrolytic cell. Moreover, they explained how electrolytic cell operates. Most of the explanations students gave reflected understanding of what they have learnt. At the end of the week the first explanatory test was administered and marked. Descriptive feedback provided on each test item was discussed with students. Samples of responses students provided to the questions in the regular explanatory test in the first week are analyzed and presented as follows;

Question 1: Briefly explain what occurs at the cathode in an electrolytic cell.

Student 1: "*At the cathode, the metal ion in the solution will release one or more electrons from the cathode."*

The response provided by the student relates to the question asked but it is incorrect the metal ion rather accepts electrons from the cathode.

Student 2: "*Reduction occurs at the cathode. At the cathode, the metal ion in the solution will accept one or more electrons from the cathode and the ions oxidation state will reduce to 0."*

The response provided by the student is correct and related to the question asked. The answer reflects understanding of the concept learnt.

Question 2: Write the half equation for the copper cathode.

Student 1: "$Cu \rightarrow Cu^{2+} + 2e$"

The equation provided by the student is incorrect. This is because the copper ion (Cu^{2+}) will rather gain two electrons to become copper metal (Cu).

Student 2: "$Cu^{2+} + 2e \rightarrow Cu$"

"Reduction occurs at the cathode hence the copper ion (Cu^{2+}) will gain two electrons to become copper metal (Cu)."

The equation provided by the student is correct and related to the question asked. It includes valid explanation showing understanding of the concept. The equation given by the student shows understanding of the half equation of copper metal at the cathode.

Question 3: Briefly explain what occurs at the anode in an electrolytic cell

Student 1: "*At anode, the metal ion in the solution will gain one or more electrons".*

The response provided by the student relates to the question asked but it is incorrect the metal rather lose electrons to become positively charged.

Student 2: "*Anode is where oxidation occurs and is the positive polarity contact in an electrolytic cell. At the anode, anions (negative ions) are forced by electrical potential to react chemically and give off electrons".*

The response provided by the student relates to the question asked. The answer describes the situation demanded by the question. Anode is where oxidation occurs. Electrons are given off at the anode because anions are forced by electrical potential to react chemically. The explanation shows understanding of the what occurs at the anode.

Question 4: Write the half equation of zinc anode

Student 1**:** "$Zn^{2+} + 2e \rightarrow Zn$"

The equation provided by the student is incorrect. This is because the zinc metal will rather release two electrons to become zinc ion (Zn^{2+}).

Student 2: "$Zn \rightarrow Zn^{2+} + 2e$"

"Oxidation occurs at the anode hence the zinc metal will release two electrons to become zinc ion (Zn^{2+}). Electrons are released from the anode."

The equation provided by the student is correct and related to the question asked. It includes valid explanation showing understanding of the concept. The equation given by the student shows understanding of the half equation of zinc metal at the anode. The Table 4 shows percentage of students' understanding of concept in chemistry.

Table 4: Post-intervention analyses of impact of regular explanatory tests on students learning chemistry concepts

	Responses Categories (%)			
Question	**WE**	**NE**	**U**	**NU**
1	100.0	0.0	69.7	30.3
2	9.1	90.9	70.0	30.0
3	100.0	0.0	72.3	27.7
4	0.0	100.0	62.3	37.7

WE = with explanation; NE = no explanation; U = understanding; NU = no understanding

Table 4 shows the analyses of students' responses in the first test. Data from table 2 shows that the responses students provided for question 1 and 3 were with explanation. In Question 1, all the responses students provided were with explanation, thus about 70% of the responses shows understanding of the concept whilst 30% of the responses did not reflect understanding of the concept. In Question 2, about 9% of

the response included explanation with 91% of the responses without explanation; about 70% of the response students provided reflected understanding whilst 30% of the responses did not reflect understanding of the concept. In Question 3, all the responses students provided were with explanation; 70% of the responses reflected understanding whilst 30% of the responses did not reflect understanding. In Question 4, all the responses students provided were without explanation; about 62% of the responses students provided reflected understanding of the concept whilst 38% of the responses did not reflect understanding of the concept.

Concerning the impact of regular explanatory tests on understanding of concepts in chemistry the quality of students' responses in the pre-intervention exercise and the weekly tests were compared. Before the introduction of the intervention students could not explain most of the concepts they had learnt in the previous term. Data from Table 1 shows that most of the responses students provided to the questions in the pre-intervention exercise did reflect understanding of the concepts they learnt. About 75% of the students could not identify reducing agent and oxidizing agent from a given redox reaction. About 71% of the students could not determine oxidation number of an atom. Again, 81% of the students could not identify spectator ions from a given redox reaction and about 70% of them could not explain disproportionation reaction in reaction redox. This result indicated that students were having little or no understanding of the concept they learnt in the previous semester.

4.2.2 Week Two

Research Question Two: What is the impact of regular explanatory test on the students' conceptual understanding of electrolysis?

Assessing the impact of regular explanatory tests on students' conceptual understanding of electrolysis, students were taken through series of regular explanatory tests. For this reason, the second lesson was on electrolyte. The lesson began with the revision of previous lesson on anode and cathode of electrolytic cell. Majority of the responses students provided to the questions asked showed that they understood what they learnt in the previous week. The concept strong electrolyte, weak electrolyte and non-electrolyte were introduced and students were brainstormed to come out the definition and the explanation of the concepts. The concept of strong electrolyte, weak electrolyte and non-electrolyte is illustrated in figure 3.

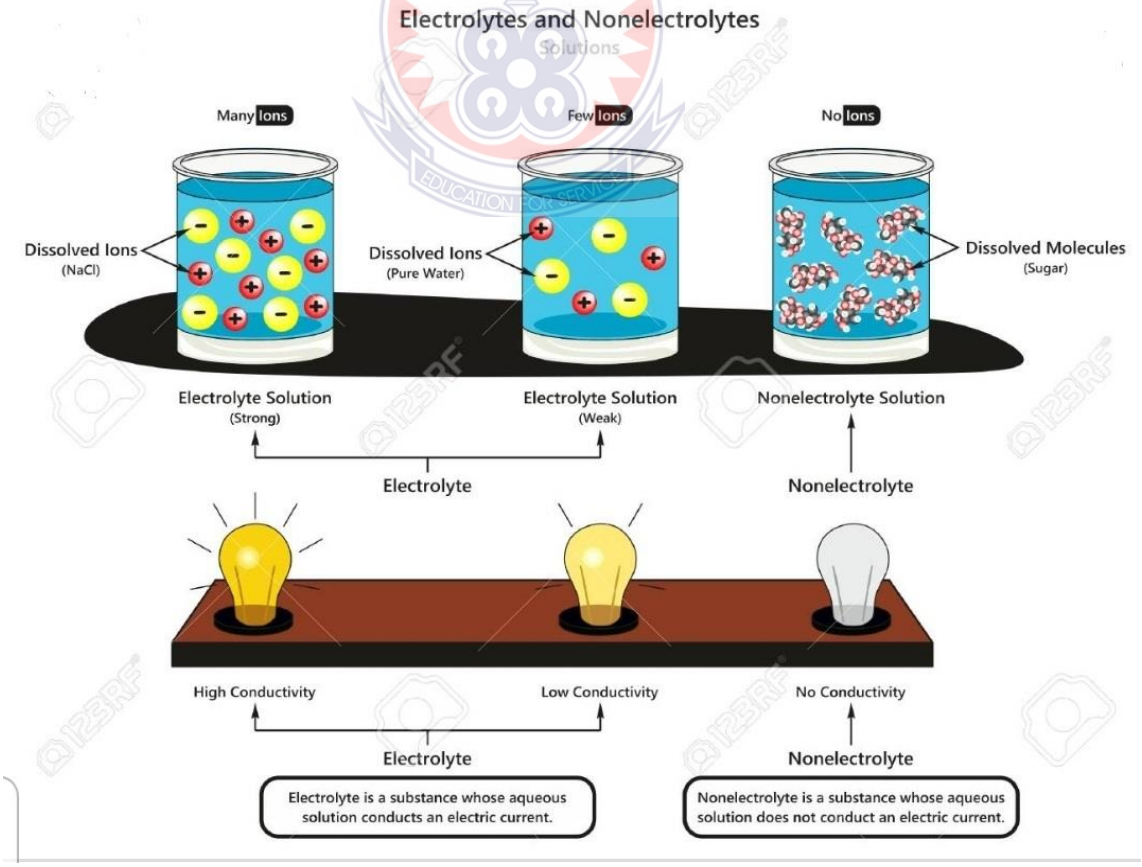

Figure 4: Comparing Strong Electrolyte, weak Electrolyte and Non-electrolyte

Most of the responses students gave related to the concepts and were valid. Students' participation in the discussion of the concept was good. Students were able to explain the terms; 'strong electrolyte', 'weak electrolyte' and 'non-electrolyte'. At end of the week, the second-class test was administered and marked. Students' performance in the test was quite good. Feedback on each question was discussed with students. Samples of responses students provided to the questions in the regular explanatory test in the second week are analyzed and presented as follows;

Question 1: Explain the term electrolyte in an electrolytic cell.

Student 1: "*Electrolyte is a substance that contains ions."*

The response provided by the student did not reflect understanding of electrolyte. This is because electrolyte is a substance contains ions in solution or molten and conducts electricity.

Student 2: "*An electrolyte is a medium containing ions that are electrically conducting through the movement of ions. This is because it ionizes in solution."*

The response provided by the student relates to the question asked and includes explanation. The explanation given explains the situation demanded by the question. The explanation shows understanding of the concept.

Question 2: Explain the term strong electrolyte

Student 1: "*Strong electrolyte is a chemical that ionizes partially in an aqueous solution. Therefore, it contains a smaller number of ions."*

The response provided by the student is incorrect. This is because strong electrolyte contains ions in an aqueous solution. Hence, conduct electricity.

Student 2: "*Strong electrolyte is a chemical that when in aqueous solution is a good conductor of electricity. Thus, it ionizes completely in aqueous solution".*

The response provided by the student relates to the question asked and includes explanation. The answer describes the situation demanded by the question. The explanation given reflects understanding of the concept.

Question 3: Explain the term weak electrolyte in an electrolytic cell.

Student 1: "*Weak electrolyte is a chemical that dissociates completely in an aqueous solution.*"

The answer provided by the student is incorrect because weak electrolyte does not dissociate completely in an aqueous solution.

Student 2: "*A weak electrolyte is an electrolyte that does not completely dissociate in an aqueous solution. The solution will contain both ions and molecules of the electrolyte.*"

The response provided by the student relates to the question asked and includes explanation. The answer describes the situation demanded by the question. The explanation given reflects understanding of the concept.

Question 4: NaCl and CH_3COOH are strong electrolyte and weak electrolyte respectively. Describe a simple experiment to differentiate between NaCl and CH_3COOH

Student 1: "*The experiment is illustrated as follows;*

(i) Prepare concentration solution of NaCl

(ii) Put the sodium chloride solution in a glass container

(iii) Connect two carbon electrodes to battery and ammeter (or bulb)

(iv) Insert the electrodes in the solution to complete circuit.

(v) Take the readings on the ammeter"

The answer provided by the student relates to the question asked but does not compare NaCl and CH_3COOH. Hence, the answer provided by the student is incorrect. This is because the student should have prepared concentration of CH_3COOH and then compare the conductivity between the two solutions in terms of readings on the ammeter or the brightness of the bulb.

Student 2: "*The experiment to differentiate between NaCl solution and CH_3COOH as strong electrolyte and weak electrolyte respectively. The procedure is as follows;*

(i) Prepare equal concentrations of NaCl and CH_3COOH solution

(ii) Put CH_3COOH in a glass container

(iii) Connect two carbon electrodes to battery and ammeter (or bulb)

(iv) Insert the electrodes in the solution to complete circuit

(v) Take the readings on the ammeter (or bulb)

(vi) Repeat the experiment using aqueous NaCl electrolyte.

Conclusion

NaCl solution gives brighter bulb than CH_3COOH solution. Strong electrolyte ionized completely in solution and therefore has high conducting of electricity. Therefore, NaCl solution is strong electrolyte."

The response provided by the student relates to the question asked and includes explanation. The answer describes the situation demanded by the question. The explanation given reflects understanding of the concept. Students knowing their performance in the test within the shortest possible time each week stimulated them to learn more and hence improved their understanding in concepts learnt in the classroom. Descriptive feedback given on students' responses in the tests provided students the opportunity to realize their mistakes and what they were expected to

provide as responses. It helped the students to learn how to answer questions in class and also in the tests. Table 5 shows students' conceptual understanding of electrolysis in test 2.

Table 5: Post-intervention analyses of impact of regular explanatory tests on students' conceptual understanding of electrolysis in class test 2

	Response Categories (%)			
Question	**WE**	**NE**	**U**	**NU**
1	100.0	0.0	83.4	16.6
2	95.1	4.9	68.6	31.4
3	86.3	13.7	53.2	46.8
4	97.1	2.9	57.8	42.2

WE = with explanation; NE = no explanation; U = understanding; NU = no understanding.

Table 5 shows the analyses of students' responses in the second test. Data from table 5 showed that most of the responses students provided included explanation and reflected understanding of the concepts learnt. In Question 1, all the responses student provided included explanation, about 83% of the responses reflected understanding whilst 17% of the responses did not reflect understanding of the concept. In Question 2, about 95% of the responses included explanation with 5% of the responses without explanation; about 67% of the responses reflected understanding whilst about 31% of the responses did not reflect understanding of the concept. In Question 3, about 86% of the responses included explanation with 14% of the responses without explanation; about 53% of the responses reflected understanding whilst 47% of the responses did not reflect understanding of the concept. In Question 4, about 97% of the responses included explanation with 3% of the responses without explanation; 58% of the responses reflected understanding whilst 42% of the responses did not reflect understanding of the concept. The introduction of the intervention improved students

understanding of concepts learnt in the classroom. The weekly tests administered to students provided students the opportunities to learn for understanding as questions asked demanded students to give an account or explanation to a situation. According to Clark (2012) students who are actively engaged and provided with frequent opportunities to respond to academic tasks demonstrate improved academic skills. Data from Table 2 to Table 7 clearly shows that most of the responses students provided in the weekly tests reflected understanding of concept learnt. Most of the students exhibited sounding of concepts chemical electrolysis. Students explained explain electrolysis of concentrated NaCl solution. Again, they described the electrolysis of dilute H_2SO_4. Based on the quality of responses students provided for the questions in the weekly tests it became clear that regular or continuous explanatory tests result in deeper understanding of concepts. Thus, the intervention regular explanatory classroom tests help students to learnt and understand concepts taught in the classroom.

4.2.3 Week Three

Research Question Three: What is the impact of regular explanatory tests on the motivation of students in learning electrolysis?

To assess the impact of regular explanatory tests on motivation of students in learning in electrolysis, students were taken through series of regular explanatory tests to motivate students' learning in electrolysis. In view of this, the third lesson was on the discharge of ions in solution in electrolysis. The lesson began with the revision of the previous lesson. Students explained electrolyte and non-electrolyte. Students explained with illustrations the difference between strong electrolyte and weak electrolyte. The concept of discharge of ions in solution in electrolysis was introduced and students were brainstormed to come with principles concerning discharge of ion

in solution. Most of the explanation students provided were related to the concept. Moreover, they described and explained how the ions are discharged in solution based on key principles or factors. Most of the explanations students gave during the lesson showed that students prepared well before coming to class. At end of the week the third test was administered and marked. Students' performance in the test was good. Feedback on the test was discussed with the students. Samples of responses students provided to the questions in the regular explanatory test in the third week are analyzed and presented as follows;

Question 1: Explain the principle of electrolysis

Student 1: "*During electrolysis, positively charged ions move to the negative electrode. This is because positive ions are attracted by negative charges".*

The response provided by the student relates to the question asked and included explanation. The explanation given does not accurately describe the situation demanded by the question. This is because during electrolysis positively charged ions migrate to the negative electrode whilst negatively charged ions migrate to the positive electrode.

Student 2*: "During electrolysis, positively charged ions move to negative electrode and the negatively charged ions move to the positive electrode. This is because positive ions are attracted by negative electrode and negative ions are attracted by positive electrode".*

The response provided by the student relates to the question asked and includes explanation. The response describes the situation demanded by the question. The explanation given reflects understanding of the principle of electrolysis.

Question 2a: Explain why Cu^{2+} is preferably discharged than Na^{+} in electrolysis.

Student 1: "*Cu^{2+} is preferably discharge than Na+ because Cu^{2+} is above N_a^{+} in electrochemical series. Hence Cu^{2+} is preferably discharged.*"

The response provided by the student relates to the question asked but the explanation given by the student is incorrect. This is because the lower the cation in the redox series, the more easily it is discharged.

Student 2: "*For cations, the lower the ion in the electrochemical series the more easily it is discharged. Therefore Cu^{2+} is preferably discharged than Na^{+} at the cathode*"

The response provided by the student relates to the question asked and includes explanation. The answer describes the situation demanded by the question. The explanation given reflects understanding of the concept.

Question 2b: Explain why Cl^{-} is preferably discharged than SO_4^{2-} in electrolysis.

Student 1: "*Cl^{-} is preferably discharged because it is lower in redox series.*"

The explanation given by the student reflects understanding of the concept.

Student 2: "*Cl^{-} is preferably discharged than SO_4^{2-} in series because for anions the lower the ion in the series the more easily it is discharged at anode. Since Cl^{-} is lower in the series than SO_4^{2-}, it is more easily to be discharged at the anode.*"

The response provided by the student relates to the question asked and includes explanation. The response describes the situation demanded by the question. The explanation given reflects understanding of discharge of ions.

Question 3: Why discharge of ions depends on its concentration.

Student 1: "*Increase in concentration of an ion tends to promote its discharge. For instance, in concentrated NaCl (Brine) containing OH^- and Cl-, the concentration of OH^- is overwhelming greater than that of Cl^- hence OH^- is discharged".*

The response provided by the student relates to the question asked but it is incorrect. This is because for concentrated NaCl the preferred ion discharged is Cl^- not OH^- in electrolyte. For concentrated electrolyte, the anion above the other is discharged.

Student 2: "*Increase in concentration of an ion promotes its discharge. In concentrated NaCl containing OH^- and Cl^-, the concentration of Cl^- is preferably discharged. This is because for concentrated electrolyte, the ion above the other in the series is discharged.*

The response provided by the student relates to the question asked and includes explanation. The response describes the situation demanded by the question. The explanation given reflects understanding of discharge of ions. Table 6 shows the impact of regular explanatory test on students' motivation in learning electrolysis in test 3

Table 6: Post-intervention analyses of impact of regular explanatory tests on motivation of students in learning electrolysis in class test 3

	Response Categories			
Question	**WE**	**NE**	**U**	**NU**
1	100.0	0.0	90.9	9.1
2a	100.0	0.0	83.8	16.2
2b	100.0	0.0	94.8	15.2
3	85.7	14.3	64.5	35.5

WE = with explanation; NE = no explanation; U = understanding; NU = no understanding

Table 6 shows the analyses of students' responses in the third test. Data from Table 6 shows most of the responses students provided included explanation and reflected understanding of the concept learnt. In Question 1, all the responses students provided included explanation, 91% of the responses reflected understanding whilst 9% of the responses did not reflect understanding of the concept. In Question 2a, all the responses students provided included explanation, 84% of the responses reflect understanding whilst 16% of the responses did not reflect understanding of the concept. In Question 2b, all the responses students provided included explanation, 95% of the responses reflected understanding whilst 15% of the responses did not reflect understanding of the concept. In Question 3, 86% of the responses included explanation with 14% of the responses without explanation; 64% of the responses reflected understanding whilst 36% of the responses did not reflect understanding of the concept.

Concerning the impact of regular classroom tests on motivation of students the number of tasks done by the students in the previous semester and the present semester were compare in relation to their performances in the pre-intervention exercise and the weekly intervention tests. Before the implementation of the intervention students could not explain some concept learnt in the previous semester. Most of the answers students provided were not related to the questions asked in the classroom. Analyses of the pre-intervention exercise revealed low performance of students in chemistry as in Table 1. Most of the responses students provided in the pre-intervention exercise did not reflect understanding of the concept learnt. However, when the intervention was introduced, students were taught and tested weekly for five weeks continuous. Students' performance in chemistry improved drastically as in Table 2 to Table 6. The weekly tests intrinsically motivated students to learn. As

students knew they would be having test at the end of the week, they tried answering more questions asked in class in order to assess themselves and also to remove any doubts in their understanding of concept learnt before the test. Students sustained this attitude throughout the period of the study. (Panadero, E., Brown, G., & Courtney, M. 2014).

The finding is in line with alternative studies of Panaderon, (2014) and Courtney, M. (2014). Panaderon in his study found that students performed better when they took regular explanatory classroom test. Panaderon and Courtney got the same results using similar conditions as Panaderon. Students were motivated to learn the concepts and believed that their classroom work was interesting and important. They were more cognitive engaged in trying to learn and comprehend the concept. An indication of significant progress in students understanding of concepts showed how the intervention regular explanatory classroom tests motivated students to put in much effort in their learning. The regular explanatory classroom tests engage students in productive learning activity.

4.2.4 Week Four

Research Question Four: How can regular explanatory test be used to enhance students' achievement in electrolysis?

Realizing how regular explanatory classroom tests can be used to enhance students' achievement in electrolysis, students were taken through series of regular explanatory tests which involved the electrolysis of dilute tetraoxosulpahte (VI) acid (H_2SO_4) using graphite as electrode, the electrolysis of concentrated brine (NaCl) solution using platinum as electrode and the electrolysis copper (II) tetraoxosulphate (VI) using graphite as electrode. Samples of the procedural steps for regular explanatory classroom tests are that enhanced students' achievement in electrolysis are as follows;

Test 1: *Electrolysis of dilute H_2SO_4 using graphite electrode*

Ions discharged at the;

Anode:

Cathode:

Gas released:

Test 2: *Electrolysis of concentrated NaCl solution using platinum electrode*

Ions discharged at the;

Anode:

Cathode:

Gas released:

Test 3: *Electrolysis of CuSO4 using graphite electrode*

Ions discharged at the;

Anode:

Cathode:

Test 4: *Electrolysis of CuSO4 using copper electrode*

Ions discharged at the;

Anode:

Cathode:

Test 5*: Two electrolytic cells, A and B connected in series contains Ag^+ and Fe^{3+} respectively. If 0.2F of electricity is passed through them and assuming the only cathode reaction in each cell is the reduction of the ion to metal. Calculate the mass of each metal deposited.*

Equation: "$Ag+ + e \rightarrow Ag$

1F deposits 108g of Ag

0.2F will deposit $\frac{0.2*108}{1}$ *= 21.6g*

Fe3+ + 3e → Fe

3F deposits 56g of Fe

0.2F will deposit $\frac{0.2*56}{3}$ *= 3.72g"*

Students' achievement in electrolysis was enhanced as shown in Table 7

Table 7: Post-intervention analyses of impact of regular explanatory tests on students' achievement in class test 4

	Responses Categories (%)			
Question	**WE**	**NE**	**U**	**NU**
1	100.0	0.0	66.5	33.5
2	100.0	0.0	68.6	31.4
3	100.0	0.0	74.4	25.6
4	0.0	100.0	83.7	16.3

WE = with explanation; NE = no explanation; U = understanding; NU = no explanation

It is observed from Table 7 that students' achievement in electrolysis increased from 66.5% in Question 1 to 83.7% in Question 4 which is a clear indication that regular explanatory classroom tests enhanced students' achievement in electrolysis.

Table 8: Post-intervention Frequency Distribution of Post-test Scores of Students in Regular Explanatory Test

Scores	**Frequency**	**Percentage (%)**
10-20	0	0.0
21-30	0	0.0
31-40	0	0.0
41-50	2	5.7
51-60	3	8.6
61-70	5	14.3
71-80	10	28.6
81-90	8	22.9
91-100	7	20.0
Total	**35**	**100**

Table 8 shows that five (5) of the students had marks between 41 and 60 whilst thirty (30) of the students had marks between 61 and 100. This shows that students'

achievement in electrolysis has been enhanced. Frequency distribution of pre -test scores of students as shown in Table

Comparing students' achievement scores in electrolysis in the pre-test and post-test exercises

Table 9: Pre-intervention Frequency Distribution of Pre-test Scores of Students in the Explanatory Test

Scores	Frequency	Percentage (%)
10-20	8	22.9
21-30	12	34.3
31-40	10	28.6
41-50	5	14.3
51-60	0	0.0
61-70	0	0.0
71-80	0	0.0
81-90	0	0.0
91-100	0	0.0
Total	**35**	**100**

Frequency distribution of students' scores in post-intervention exercise as shown in Table 10

Table 10: Post-intervention Frequency Distribution of Post-test Scores of Students in Regular Explanatory Test

Scores	Frequency	Percentage (%)
10-20	0	0.0
21-30	0	0.0
31-40	0	0.0
41-50	2	5.7
51-60	3	8.6
61-70	5	14.3
71-80	10	28.6
81-90	8	22.9
91-100	7	20.0
Total	**35**	**100**

It is observed from Table 9 and 10 that there was a remarkable improvement in the scores of students after the treatment. Thus, Table 2 indicates that none of the students scored marks above 50 in the pre-intervention exercise. However, after the intervention strategy, 33 students had marks above 50 with 91 to 100 marks for 7 students.

Table 11: Paired t-test analysis of pre-test and post-test scores of the students

Compared Scores	N	Mean Score	SD	d.f	p-Value
Pre-test	35	35.73	4.33	33	0.002
Post-test	35	79.43	11.21		

*p < 0.05

Testing Null Hypothesis

A paired sample t-test result conducted to determine the extent of difference between the performance of students in the pre-test and post-test is also shown in Table 7. The generated p-value of 0.002 was less than the probability level of 0.05, thus indicating that there was a significant difference in the performance of students in the pre-intervention test and post-intervention test. Thus, we fail to reject the null hypothesis.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter summarizes the research findings and provides a conclusion to the study. Recommendations and suggestions for further research are also provided.

5.1 Summary

The study was an action research carried out in Winneba Senior High School, Winneba in the Central Region of Ghana. The purpose was to use regular explanatory classroom test to help students learn and understanding some concepts in chemistry. It is believed that students wait until they receive a discriminant stimulus to begin the desired behaviour therefore the study sought to find whether there is an impact of regular explanatory classroom test on students' learning of chemistry and on the understanding of concepts in chemistry. It also sought to find whether there is an impact of regular explanatory classroom tests on motivation of students to chemistry and how regular explanatory classroom tests can be used to motivate students to learn concepts in chemistry. Students were taught for five weeks and at the of each week students were made to take a test composed of essay-type questions. The intervention strategies used to help students learn, included asking challenging questions, and discussing feedback on the tests with students. Students' outputs and understanding of concepts in chemistry were mentioned at the end of each week through the weekly tests.

Analyses of data collected from students' outputs in the weekly tests showed an improvement in students' learning and understanding of concepts in chemistry. Students' performance in the classroom improved drastically from the beginning of

the study to the end. Students provided quality responses in lessons and also in the tests reflecting their understanding of the concept they had learnt as shown in Table 2 to Table 7. Findings from the study showed that students were motivated when the intervention strategies were introduced. The intervention strategies asking of challenging questions, provision of descriptive feedback, prompt feedback and discussion of feedback motivated students to learn. Feedbacks provided quickly were acted upon by students to improve their work or their learning. Results from these weekly analyses provided a solid basis for judging the effectiveness of the weekly tests in improving students learning and understanding of concepts in chemistry.

5.2 Conclusion

Regular explanatory classroom test used as formative assessment for learning improved students' learning outcomes in the classroom. The introduction of the intervention weekly explanatory classroom tests produced a significant improvement in students' learning and understanding of concepts in chemistry. Students understanding' in the concepts taught in the classroom was immense. According to the criteria for assessment, it can be said that the intervention strategies were successful. It can be concluded that regular explanatory tests improve students' learning in chemistry. It helps students to understand concepts in chemistry. Moreover, it also motivates students to learn and retain what they have learnt.

5.3 Implications for Classroom Instruction

The findings of the study have direct implications for optimizing methods of learning and instruction. The results of the study indicate that the use of regular explanatory classroom tests improve students' learning and understanding of concepts in chemistry. Regular provision of prompt and descriptive feedback on classroom tests

motivate students to learn more. Therefore, the study strongly suggest that students should be tested frequently. Class tests stimulate students to learn concept in details, that would not otherwise be learnt for an examination. Regular explanatory classroom tests make the students revise throughout the semester instead of all at end of the semester. Tasks perform by students in the classroom should be challenging. challenging tasks help the teacher to judge a student from his or her performance and can give suggestions accordingly. Feedback on students' work should include written comments. Descriptive feedbacks provide opportunities for students to make adjustments and improvements toward mastery of a specified standard.

5.4 Recommendations

Findings and conclusions of this study are used to support the following recommendations for further studies.

- Students in the Winneba Senior High School should be empowered by their teachers to assume responsibility for their own learning. This can be done when teachers use more innovative teaching methods such as regular explanatory tests at the end of every week lesson to empower them to learn.
- Teachers of Winneba Senior High School should employ regular explanatory classroom tests formatively to enhance students' achievement scores in learning of concepts in chemistry.

Suggestions for Further Research

Based on the findings of this study, the following suggestions for further research works are made.

- This study should be replicated with focus on other chemistry topics.
- This study should be replicated using only pure science students.

- A study should be conducted to relate students' entry characteristics and their performance in chemistry generally.
- Survey of the educational provisions for chemistry teaching should be conducted among senior high schools offering chemistry within the Winneba municipality.
- A study on the intrinsic difficulties that male and female SHS students encounter during chemistry lessons should be conducted in Winneba Senior High School.
- The Curriculum Research Development Division (CRDD) in planning the curriculum should also take into account, the learners' prior knowledge but not only the structure of the subject. This can be done, for instance, by providing opportunities for students to make their own ideas explicit; encouraging the generation of a range of conceptual schemes; introducing discrepant events.
- School authorities of Ghana Education Service must consider splitting large classes into smaller and more controllable units which will enable teachers to be able to conduct lessons more effectively and easily. Consequently, more teachers must also be recruited to handle these new classes.
- The District Director of Education in the Winneba municipality and other related bodies in education should regularly and periodically be organizing workshops or in-service training (INSET) for teachers teaching chemistry at the various second cycle institutions in the country. Such training should cover innovative and assessment strategies to enhance students' learning. This will undoubtedly upgrade the teachers' knowledge and ensure that effective means of instructions are used in teaching science.

- The agencies associated with science education in the Winneba municipality should make certain structural changes in the field of science education in school to encourage the use of regular explanatory classroom test approach in the teaching and learning chemistry.
- Further study be conducted over a longer period of time, because more time could show different results on students' performance in chemistry.
- The sample size of this study was also small; a larger size could result in a different outcome.
- Studies should be conducted to determine if there are additional benefits to regular explanatory classroom testing.

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APPENDICES

APPENDIX A

SAMPLES OF LESSON PLANS

Week One

Topic: Electrolytic cell and electrochemical cell

Previous Knowledge: Students can identify oxidizing agent in a redox reaction.

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

Explain the following terms

1. Electrolysis
2. Anode
3. Cathode
4. electrodes

Teaching and Learning Activities: Teacher reviews previous knowledge of students by asking student to identify oxidizing agent and reducing agent in a redox reaction written on the marker board. Teacher guides students to identify oxidizing agent and reducing agent. Students were brainstormed to come out with the explanation of electrolysis. Students explain the cathode and anode with illustration on the marker board. Teacher discusses with students definition of electrodes. Teacher discusses with students what occurs at anode in electrolytic cell. Students write the half equation of zinc anode on the marker board with teacher's guide.

Formative Assessment/Evaluation

1. Explain the conditions of electrolysis.
2. Explain half equation of an electrolytic cell.
3. Explain the term electrode
4. Explain the term non-electrolyte

Class Test 1

1. Briefly explain what occurs at cathode in electrolytic cell.
2. Write the half equation for copper cathode.
3. Briefly explain what occurs at anode in electrolytic cell.
4. Write the half equation of zinc anode.

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Week Two

Topic: Electrolyte and non-electrolyte

Previous Knowledge: Student can explain the anode and cathode in electrolytic cell.

Objective: By the end of the lesson students should be able to:

1. Explain the term “electrolyte”
2. Distinguish between electrolyte and non-electrolyte.
3. Perform simple experiment to demonstrate weak electrolyte and strong electrolyte.
4. Give examples of weak electrolyte.
5. Explain why electrolyte conducts electricity but non-electrolyte does not.

Teaching and Learning Activities: Teacher reviews previous knowledge of students by calling them to explain the terms anode and cathode in electrolytic cell. Teacher

brainstorms with students to come out with the explanation of electrolyte. Teacher guides students to distinguish between electrolyte and non-electrolyte. Teacher guides students to perform simple experiment for weak electrolyte and strong electrolyte. Teacher discusses with students why electrolyte conducts electricity but non-electrolyte does not.

Formative Assessment/Evaluation

1. Explain the conditions of electrolyte.
2. Explain why electrolyte conducts electricity.
3. Perform a simple experiment to demonstrate weak electrolyte and strong electrolyte.
4. Explain why H_2SO_4 conducts electricity but HCOOH does not conduct electricity.
5. Explain why water is a weak electrolyte.
6. Explain why aqueous NaCl conducts electricity but solid NaCl does not.

Class Test 2

1. Explain the term “electrolyte” in electrolytic cell.
2. Briefly explain (1) strong electrolyte

   (ii) weak electrolyte

3. NaCl and CH_3COOH are strong electrolyte and weak electrolyte respectively. Describe a simple experiment to distinguish between the two.

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Week Three

Topic: Factors that influence the discharge of ions in electrolytic cell.

Previous Knowledge: Students can explain non-electrolyte.

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

explain why the following factors influence the discharge of ions in an electrolytic cell.

(i) concentration

(ii) position of ions in electrochemical series.

(iii) nature of the electrode

Teaching and Learning Activities: Teacher reviews previous knowledge of students by asking them to explain why concentration of ions influences its discharge in an electrolytic cell. Teacher discusses with students other factors such as position of the ions and nature of the electrode that influence the discharge of ion in an electrolytic cell.

Formative Assessment/Evaluation

Explain the ions that would be preferably discharged if:

1. the electrode is made of copper at anode.
2. the electrode is made of graphite at cathode.
3. at anode and cathode electrodes for concentrated solution.
4. at anode and cathode electrode for dilute solution.

Class Test 3

1. Explain the principle of electrolysis.

2a. Explain why Cu^{2+} is preferably discharged than Na^{+} in electrolytic cell.

2b. Explain why Cu^{2+} is preferably discharged than SO_4^{2-} in electrolytic cell.

3. Explain why discharge of ion depends on its concentration.

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Week Four

Topic: Electrolysis of chemical compound

Previous Knowledge: Students can explain why the nature of electrode influence the nature the discharge of ions in an electrolytic cell.

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

explain the following processes

1. electrolysis of dilute NaCl
2. electrolysis of $PbBr_2$ solution
3. electrolysis of concentrated H_2SO_4 solution

Teaching and Learning Activities: Teacher reviews previous knowledge of students by asking them to explain why the nature of electrode influences the discharge of ions in an electrolytic cell. Teachers introduces the concept of electrolysis of chemical compounds such as concentrated brine. Teacher discusses with students the electrolysis of some chemical compounds. Students explain the electrolysis of concentrated H_2SO_4.

Formative Assessment/Evaluation

1. Explain the electrolysis of the following;

a) concentrated H_2SO_4 using graphite as electrode

b) dilute brine

c) $CuSO_4$ using platinum as electrode

2. calculate the quantity of electricity required to form 16g of copper by the electrolysis of cooper (ii) salt.

Class Test 4

1. Explain the electrolysis of the following;

a) dilute H_2SO_4 using graphite as electrode

b) concentrated NaCl solution using platinum as electrode.

c) $CuSO_4$ using graphite as electrode

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APPENDIX B

STUDENTS' LEARNING PROGRESS MONITORING FORM

Weak:

Date:

Task Number:

Criteria

1. Response relates to the question asked
2. Response include explanation
3. Response reflects understanding of concepts learnt (Response describe the situation demanded by the question)

Preamble: Responses which include explanation are tallied and classified as "With explanation" (WE). Responses which do not include explanation are classified as under "No explanation" Responses which relate to the question asked and describe the situation demanded by the question are classified as "Understanding" (U). Responses which relate to the question but do not describe the situation demanded by the questions are classified as "No understanding" (UN).

1. Responses are with explanation

	With explanation (WE) (NE)		No explanation	
Question	**Tally**	**% Frequency**	**Tally**	**% Frequency**
1				
2				
3				
4				

2. Responses reflect understanding of concepts learnt

	Understanding (U)		No Understanding (NU)	
Question	**Tally**	**% Frequency**	**Tally**	**% Frequency**
1				
2				
3				
4				

APPENDIX C

TEACHING AAND LEARNING DOCUMENTS RECORD FORM

1. Teaching prepares scheme of work

……..

2. Lesson are delivered with the use of lesson plan

…….

3. Lesson notes have;

A. instructional objectives

……

B. Teaching and learning activities

……

C. Evaluation exercise

……

4. Activities done by students in the classroom include;

A. Classroom tests

No……

B. Home works

No……

C. Project works

No……

D. Exercises

No……