

**EFFECTIVENESS OF DIFFERENTIATED INSTRUCTION IN ENHANCING
STUDENTS' ACADEMIC ACHIEVEMENTS, SELF-CONCEPT OF ABILITY
AND MOTIVATION TOWARDS LEARNING OF CHEMISTRY IN
SECONDARY SCHOOLS IN MAARA SUB-COUNTY, KENYA**

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Requirements of the Award of the Degree of Masters of Education (Science
Education) of Chuka University**

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DECLARATION AND RECOMMENDATION

Declaration


This is my original work and has not been presented for the award of a degree or a diploma in this or any other university or institution.

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DEDICATION

This work is dedicated to my husband James Mwitari whose loving heart and practical assistance have sustained me in research and who has given my life a new dimension. To my great son Jerry Kenya and daughter Sharon Kagendo, in whom I strongly believe, will become researchers.

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ABSTRACT

Students perform poorly in Kenya Certificates of Secondary Education Chemistry examinations in Kenya. Chemistry is important for understanding composition, properties and behavior changes of matter that form the environment. The teaching of Chemistry aims at developing scientific attitudes, concept, principles and skills in learners. Differentiating instruction means tailoring instruction to meet individual needs of learners. Differentiating instruction consists of efforts of teachers to respond to the variance among learners in the classroom. This study investigated the effectiveness of differentiated instruction in enhancing students' academic achievements, self-concept of ability and motivation towards learning of chemistry. The study was guided by Howard Gardner Theory of multiple Intelligence. Quasi experimental research design was employed and in particular Solomon's four group design was used. The research was carried out in Four Day co-educational secondary schools in Maara sub-county, Kenya. The target population was 12,187 chemistry students. The accessible population was 1,242 form two chemistry students in Day co-educational secondary schools. A purposive sampling technique was used to draw the participating schools. Simple random sampling was used to select and to assign participating schools in Experimental and Control groups. The sample size was 165 form two chemistry students. The research instruments used were Chemistry Achievement Test, Students' Self Concept of Ability Questionnaire and Students' Motivation Questionnaire. The instruments were piloted to determine their reliability, while validity of the instrument was ascertained by experts' opinions from Department of Education and Resource Development of Chuka University. Reliability coefficient for CAT, SSCAQ and SMQ was 0.74, 0.80 and 0.77 respectively. The experimental groups (E1 and E2) were taught using differentiated instruction teaching approach while the control groups (C1 and C2) were taught through conventional teaching approach. Statistical Package for Social Sciences (SPSS) version 21 was used for data analysis. The raw data obtained was analyzed using descriptive statistics (Mean, Standard deviation, percentages) and inferential statistics (One-way ANOVA, ANCOVA and t-test). The level of significance for acceptance or rejection of null hypotheses was at $\alpha = 0.05$. The findings of the study indicated that differentiated instruction significantly improved the students' achievement, self-concept of ability and motivation towards learning chemistry. It was also found out that when students were taught using differentiated instruction, gender did not affect their achievement in chemistry. The findings are expected to form a frame of reference for further research on innovative teaching strategies in chemistry education as well as in science education in general.

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ACRONYMS/ABBREVIATIONS

ASC	– Academic Self Concept
ANCOVA	– Analysis of Covariance
ANOVA	– Analysis of Variance
CAT	– Chemistry Achievement Test
CCE	_ Cooperative Class Experiment
CTA	_ Convectional Teaching Approach
DEO	– District Education Officer
DI	– Differentiated Instruction
KCSE	– Kenya Certificate of Secondary Education
KICD	– Kenya Institute of Curriculum Development
KIE	– Kenya Institute of Education
KNEC	– Kenya National Examinations Council
NACOSTI	– National Commission for Science, Technology and Innovation
SMQ	– Students Motivation Questionnaire
SPSS	– Statistical Package for Social Sciences
SSCAQ	– Students’ Self-concept of Ability Questionnaire
UNESCO	– United Nations Educational Scientific and Cultural Organization

CHAPTER ONE INTRODUCTION

1.1 Background of the Study

Education is an important component for achievement of sustainable economic development. Education prepares and equips the youth of a country so that they can play an effective role in the life of a nation. Education ensures that opportunities are provided for the full development of individual talent and personality. Science is an economic force that together with land, labour, capital and managerial capacity, contributes to social and economic growth and development of nations (Tsuma, 1998).

Science is recognized widely as being of great importance internationally both for economic well-being of nations and because of the need for scientifically literate citizens (Fraser & Walberg,1995). The importance of science education in different educational systems all over the world include, the effective use of scientific information in basic science, transmission of knowledge to school and university students and familiarity with correct inquiry methods and principles of dealing with problems and problem solving. There are many challenges requiring knowledge of science and technology, therefore a requirement in all countries and all people globally. Science as an instrument of development plays a dominant role by advancing technological development, promoting national wealth, improves health and industrialization (Validya, 2003).

In Kenya, Science Education is expected to impart on the student the necessary knowledge and skills required for national development as well as inculcate the right attitude to work and administrative skills necessary for a smooth transitional process of developing country (Republic of Kenya , 1981 , KIE, 1992). In the Kenyan Education system, Science subject is split into three main branches, that is, Biology, Chemistry and Physics at the secondary level. Chemistry provides the means by which the individual can organize his or her concepts and attitudes, classify experiences and communicate with others (Wellington, 1989). Chemistry is also important for understanding composition, properties and behavior changes of matter that form the environment (Barchok, 2011).

Chemistry contributes greatly to other fields of study such as Medicine, Engineering, Agriculture and technological areas for the improvement of the quality of life and generation of wealth for the good of the entire human life. The government of Kenya unveiled its grand plan (Vision 2030) for changing the country into a newly industrialized, middle income country, providing high quality life for its citizen by the year 2030 (Republic of Kenya, 2007), thus, there is need to lay a strong foundation in science and technological Education to achieve the projected developmental goals.

In Kenyan secondary school Education, Chemistry is an optional science subject in form three and four. According to Arimba (2012), compared to physics and biology in KCSE examinations, the candidature in chemistry is very large and has continued to grow over the years. Despite the students' higher preference for Chemistry, their performance in KCSE Examinations has remained below 40% which is considered below average (KNEC, 2010). According to Maara Sub-County Education office, since the inception of Maara Sub County in 2008, the average percentage score in chemistry has been below 37% (Maara Sub County Education office, 2015). This shows that there is need to improve performance in chemistry. The performance in chemistry in Maara Sub County is shown in Table 1.

Table 1

Performance in Chemistry in K.C.S.E in Maara Sub County Between 2010 to 2014.

Year	Candidature	Percentage Mean Score
2010	2296	28
2011	2888	42
2012	3095	31
2013	2739	37
2014	3168	43

Source: Maara Sub County Education Office, 2015

The highest mean score was in the year 2014 whereas the lowest mean score was in the year 2010. A close analyses of questions performed poorly by the candidates show that students have weakness in answering questions which include poor interpretation of questions; poor scientific language; poor understanding of scientific concept; inability to relate chemistry knowledge to real life situations and inappropriate

teaching strategies (KNEC 2007, 2009, 2010). These weaknesses are probably derived from poor teaching and learning approaches employed. According to Muthomi (2013), the teaching approach that a teacher adopts is one of the factors that may affect students' achievement. Therefore, use of appropriate teaching method is critical to successful teaching and learning of chemistry. Teaching approach has an effect on affective domain such as student motivation and self-concept (Arimba, 2012). The teachers should develop positive relationship with student and stress classroom activities that involve active teaching-learning process and students participation in the classroom (Muthomi,2013).

Most researches that has been done on factors that influence academic achievement concentrates more on the cognitive factors, while affective factors are ignored (Sikhwari, 2004). The affective aspect of the students should receive as much attention as the cognitive aspect in academic investigation and endeavors (Sikhwari, 2004). Variance in academic achievement can be related to affective variables, of which self-concept and motivation are the most important (Areepattamannil & Freeman, 2008). According to Dambudzo (2009) research study academic self-concept and academic motivation have the most potentials of being directly influenced by the regular classroom teacher, and should therefore be of primary concern.

According to Barchok (2011), learning is considered to be active, constructive, and cumulative, self-regulated and goal oriented process in which the learner plays a critical role. Hence teachers need teaching strategies that engage learners actively in the process of acquisition of knowledge. Research on Differentiated Instruction teaching approach done in other subjects has shown that it improves students' performance. Muthomi (2013) found a positive effect on student's performance when instructed through differentiated Instruction teaching approach. McAdamis (2001) reported a significant improvement in the test scores of low scoring students following the use of Differentiated instruction.

Differentiated Instruction, according to Allan and Tomlinson (2008) is the process of ensuring what a student learns, how he or she learns it, and how the student

demonstrate what he or she has learned is a match for that students readiness level, interest and preferred mode of learning .Therefore , differentiation is an organized, yet flexible way of proactively adjusting teaching and learning methods to accommodate each child's learning needs and preferences in order to achieve his or her maximum growth as a learner (Tominson,1999). Differentiated Instruction teaching approach assumes that there is a diversity of learners in every classroom and that all learners can be reached if a variety of methods and activities are used. All students are not alike, that is, students learn in different rates. Over the years, chemistry has continued to show downward trend in Mara Sub-County. Based on the ideal that a change in method of instruction can help overcome the ineffectiveness of educational systems and their malfunction in corresponding to students' needs, there is need to investigate if using the teaching learning approach of Differentiated Instruction can improve students' academic achievement, self-concept of ability and motivation towards learning chemistry in Maara Sub County, Kenya.

1.2 Statement of the Problem

Learners' achievement in Chemistry has been low in KCSE examinations in Maara Sub County. Poor performance in Chemistry is likely to undermine attainment of development goals which are projected under Vision 2030 in Kenya. Research findings indicate that teaching methods is important factor affecting students learning and achievement. A good teaching approach promotes development of both cognitive as well as affective characteristics of learners. It is on this basis that the study investigated the effectiveness of differentiated instruction in enhancing student's academic achievement, self-concept of ability and motivation towards learning chemistry to fill the knowledge gap.

1.3 Purpose of the Study

The purpose of the study was to determine the effectiveness of differentiated instruction in enhancing student's academic achievement, self-concept of ability and motivation towards learning of chemistry in secondary schools of Maara Sub County.

1.4 Objectives of the Study

In order to achieve the stated purpose the following objectives guided the study;

- i. To determine whether there is difference in academic achievement in chemistry between students taught using differentiated instruction and those who are not exposed to it.
- ii. To determine whether there is difference in self-concept of ability in chemistry between students taught using differentiated instruction and those who are not exposed to it.
- iii. To determine whether there is a difference on student's level of motivation to learn chemistry between students taught using differentiated instruction and those who are not exposed to it.
- iv. To determine whether there is a difference in student's academic achievements in chemistry by gender among students exposed to differentiated instruction approach.

1.5 Hypotheses

The following hypotheses were tested at 0.05 level of significance.

- H₀1:** There is no statistically significant difference in academic achievement in chemistry between students who are taught using differentiated instruction and those who are not exposed to it.
- H₀2:** There is no statistically significant difference in self-concept of ability in chemistry of the student taught using differentiated instructions and those who are not exposed to it.
- H₀3:** There is no statistically significant difference in the level of motivation to learn chemistry between students who are taught using differentiated instructions and those who are not exposed to it.
- H₀4:** There is no statistically significant difference in achievement in chemistry by gender among students exposed to differentiated instruction approach.

1.6 Significance of the Study

The findings of the study will play an important role in formulation of policies and strategies aimed at reversing the general negative trends in chemistry education instructions, particularly the issue of achievement. The positive effect of DI teaching approach on students achievement demonstrated by this study, will help in sensitizing policy makers and curriculum developers formulate relevant policies that advocates

for teaching approaches that promotes active teaching and learning process. Teacher training colleges and universities will use this teaching methods hence produce effective chemistry teachers capable of using teaching methodology that may enable students to be actively involved in learning. The study will help and re-direct teachers on ways of assisting students develop and maintain positive self-concept. The study will sensitize the teachers to pay more attention to the affective domain of objectives just as much as they do for the cognitive domain. The study will form a frame of reference for further research on innovative teaching strategies in chemistry education as well as science and technology education in general.

1.7 Scope of the Study

The study was conducted in Day co-educational secondary schools in Maara sub-county, Kenya. The subjects of the study were form two students. Form two students are chosen because the topic in chemistry, structure and bonding is taught at this level. The study focused on the effectiveness of differentiated instruction approach on students' academic achievement, self-concept of ability and motivation towards learning chemistry.

1.8 Limitation of the Study

Teachers' presentation of chemistry content may vary from teacher to teacher. The variations were minimized by teachers' induction of the teachers during a pre-experimental training workshop.

1.9 Assumptions of the Study

The study was carried out under the following assumptions;

- i. Teachers in the experimental group used differentiated instructions teaching approach throughout the study period as instructed by the researcher.
- ii. The respondents of the study provided honest responses.

1.10 Definition of Terms

Academic achievement: In this study, academic achievement is the numerical scores of a student knowledge, which measures the degree of students' adaption to academic work.

Co-educational: In this study, it referred to schools which have boys and girls in the same environment.

Conventional Teaching Approach: Instructional Approach in which the teacher controls the lesson and learner to learner interaction is minimal or entirely missing. In this study, it is the mode of instruction to which the control group was exposed to.

Differentiated Instruction: In this study, it referred to all aspects of teaching including planning, which instructional approaches to use, activities, materials, products and environmental arrangement that best meet the learning needs of all students. It is the mode of instruction to which the experimental group was exposed to.

Effectiveness: In this study, this refers to the ability of differentiated instruction to improve students' achievement, self-concept of ability and motivation that was measured quantitatively.

Gender: In this study, it referred to social perception of boys and girls towards achievement in chemistry in secondary school.

Intelligence: In this study, it referred to the ability to learn or understand thing or deal with new or difficult situations.

Learning: In this study, it referred to the process of acquiring permanent change in chemistry knowledge, skills and understanding through experience.

Motivation: In this study, it referred to efforts which the learner put into learning as a result of their need or desire to learn. In this study, it referred to students' effort put in as a result of their desire to learn chemistry as a subject.

Self – Concept: In this study, it referred to the personal beliefs students develops about their academic abilities.

Schema: In this study, this referred to a drawing that represents an idea or a theory and makes it easier to understand.

CHAPTER TWO LITERATURE REVIEW

2.1 Introduction

The chapter reviewed literature with regard to differentiated instruction in teaching and learning, teaching approaches in chemistry, students' achievement in chemistry, students' self-concept in chemistry, students' motivation in learning chemistry and gender issues in chemistry learning, the chapter presents theoretical framework that guides the study. The conceptual framework is presented at the end of the chapter.

2.2 Differentiated Instruction in Teaching and Learning

Tomlinson (2001) defines differentiation as the right of each pupil to be taught in a way specifically tailored to their individual learning needs. In differentiated instruction students are placed on the centre of teaching and learning (Tomlinson, 2001). Each learner comes to school with a different set of learning needs, including differing educational, personal and communal contexts (Taylor, Lorraine & Catherine, 2003) and varying degree of academic skill development (Levine, 2002). Therefore, differentiated instruction advocates that the educator proactively plans a variety of instructional methods so as to best facilitate effective learning experiences which are suited to the various learning needs within the student (Tomlinson, (2001). In its pursuit of this foundational goal, differentiated instructional methods attempt to qualitatively, as opposed to quantitatively, match learners abilities with appropriate material, include a blend of whole-class group and individual instruction; use numerous approaches of facilitating input, processing, and output; and constantly adopt to learners needs based upon the teachers constant assessment of all students (Tomlinson, 2001).

The chemistry content in a lesson may be differentiated based on what students already know. The most basic content of a lesson should cover the standards of learning set by ministry of education. Some students in a class may be completely unfamiliar with the concepts in a lesson; some students may have a partial mastery of the content, or display mistaken ideas about the content, and some students may show mastery of the content before the lesson begins.

According to Muthomi (2013), the teacher may differentiate the content by designing activities to groups of students to cover different areas of Bloom's Taxonomy, for example, students who are unfamiliar with the concepts may be required to complete tasks on the lower levels of Bloom's Taxonomy: knowledge, comprehension and application. Students with partial mastery may be asked to complete tasks in the application, analysis and evaluation areas, and students who have high levels of mastery may be asked to complete tasks in evaluation and synthesis (Muthomi, 2013).

When teachers differentiate content, they may adapt what they want the students to learn or how the students will gain access to the knowledge, understanding and skills (Anderson, 2007). In these instances, educators are not varying student's objectives or lowering performance standards for students. Teachers can use flexible groups and have students assigned to like groups listening to books on tapes or accessing specific internet sources. Students can have a choice to work in pairs, groups, or individually, but all students are working towards the same set objective.

Differentiating by process refers to how a student comes to understand and assimilate facts, concepts and skills (Anderson, 2007). After teaching a chemistry lesson, a teacher might break students into small "ability" groups based on their readiness. The teacher would then give each group a series of questions, based on each group's appropriate level of readiness-skills, related to the objectives of the lesson. According to Tomlinson (2001), another way to group the students could be based on the students learning styles. The main idea is that students are at different levels and learn in different ways, so a teacher can't teach them all the same way. The process of how the material in a lesson is learned may be differentiated for students based on their learning styles, taking into account how standards of performance are required for the age level (Anderson, 2007). This stage of differentiation allows students to learn based either on what method is easiest for them to acquire knowledge, or what may challenge them most. Some students may prefer to read about a topic (or may require practice in reading), and others may prefer to listen (or require practice in listening), or acquire knowledge by manipulating objects associated with the content. Information may be presented in multiple ways by the teacher, and may be based on any available material or materials.

The product is essentially what the student produces at the end of the lesson to demonstrate the mastery of the content: tests, evaluations, projects, reports and educational standards (Allan & Tomlinson, 2008). Teachers, may assign students to complete activities that demonstrate mastery of an educational concept (writing a report), or in a method the student prefers (composing an original song about the content, or building a 3-dimensional object that explains mastery of concepts in the lesson or unit). The product is an integral component of the differentiated model, as the preparation of the assignments will primarily determine both the ‘what’ and ‘how’ instruction will be delivered (Muthomi, 2013). In differentiated instruction, teachers respond to students’ readiness, instructional needs, interests and learning preferences and provide opportunities for students to work in varied instructional formats. A classroom that utilizes differentiated instruction is a learner-responsive, teacher facilitated classroom where all students have the opportunity to meet curriculum foundation objectives. Lessons may be an inquiry based, problem based and the project based instruction (Tomlinson, 1999).

Differentiating through the environment is important as it creates the conditions for optimal learning to take place. According to Tomlinson (2003), environment will support or deter the students’ quest for affirmation, contribution, power, purpose and challenge in the classroom (Tylor, Lorraine & Catherine, 2003). The learning environment includes physical layout of the classroom, the way that the teacher uses the space, environmental elements and sensitivities including lighting, as well as the overall atmosphere of the classroom (Muthomi, 2013). The teacher’s goal is to create an environment that is positive, structured and supportive for each student. The physical environment should be a place that is flexible with varied types of furniture and arrangements, and areas for quite individual work and collaboration. Teachers should employ classroom management techniques that support a safe and supportive learning environment.

Another reason for differentiating relates to teacher professionalism. There is no recipe for differentiation. Rather, it is a way of thinking about teaching and learning that values one individual and can be translated into classroom practice in many ways (Anderson, 2007).

To cultivate individuality, differentiated instruction is first and foremost good instruction (Tomlinson, 1999). Children have to attend school and as such school populations are inclusive. Teachers need to make these accommodations for each student as they cannot modify themselves to fit the curriculum (Tomlinson, 1999). Differentiated instruction is teaching philosophy based on the premise that teachers should adopt instructions to student's differences rather than matching students through the curriculum (Willis & Mann, 2000). Differentiation is how teachers need to approach their job today. This is not only applicable to the teaching of science but also across the board.

Gaffey, (2006) reported that knowing students personally and guiding them through academics was a good way to teach effectively. The results of this suggest that it is imperative to gain insight into variables that contribute to student learning. Such information can transform an ordinary classroom into an environment that taps into individual learning potential, the value of this statement has resulted in a close teacher student bond, a dynamic classroom environment, and a greater sense of how student learn. Result showed that, although differentiated instruction may take extra time and effort, it had a positive impact on student learning. To differentiate instruction is to recognize students varying background knowledge, reading language, preferences in learning, interests and to react responsively (Tomlinson, 2001). Differentiated instruction is a process to approach teaching and learning for students of differing abilities in the same class. The interest of differentiating instruction is to maximize each student's growth and individual success by meeting each student where he or she is and assisting in the learning process (Muthomi, 2013).

The perfect model of differentiated instruction rests upon an active, student centered, meaning-making approach to teaching and learning. The theoretical and philosophical influences embedded in differentiated instruction support the three key elements of differentiated instruction itself: readiness, interest and learning profile (Allan and Tomlinson, 2000). First, readiness refers to a student's ability or an appropriate entry point of learning and processing new material (Muthomi, 2013). Lev Vygotsky, a Russian psychologist, provide evidence that individuals learn best in accordance with their readiness to do so (Allan & Tomlinson, 2008).

This theoretical influence provides a concrete foundation for differentiated instruction. The readiness of the individual should match what a student learns, how they learn it and how the student demonstrates what they learned when using differentiated instruction.

Second, interest is what an individual student would prefer to learn (Muthomi, 2013). The philosophical idea that interest based options seized an intrinsic motivation support the second key element of differentiated instruction, student interest. According to Allan and Tomlinson (2000) when interest is tapped, learning is more likely to be rewarding and the student becomes more autonomous learner.

Third, learning preference encompasses both individual learning styles and preferences (Muthomi, 2013). An American psychologist, Howard Gardner, states that people have different intelligences and learn in many different ways. Gardner suggests that schools should offer individual centered education, having curriculum tailored to a child's intelligence preference (Allan & Tomlinson, 2000). Essentially, Gardner supports the third key element of differentiated instruction, which accounts for different student learning profile.

2.3 Teaching Approaches in Chemistry

Teaching approaches refers to laboratory instruction and interdisciplinary teaching approaches. Examples of interdisciplinary teaching approaches positively influencing students' attitudes and enhancing their motivation to learn chemistry and science in general have been reported by Baratsi-Baraku (2009). These methodologies are based on problem-based learning, discovery and science –society interaction (Baratsi-Barakou, 2009). The relevance of chemistry, need to embrace relevant teaching approaches to the teaching of chemistry in schools (Holbrook, 2005). Karr, Makher and Son (2006) consider the teaching method of an instructor of the chemistry as based on the facilitation of the student's understanding in the learning process. An instructor makes much effort to make his or her students to comprehend the subject matter. An instructor tries to cause the student to be involved in the teaching process so that he or she might become sure of this fact that student are able to reproduce the knowledge and reasons of chemistry.

A useful part of instruction in Chemistry is the performing of experiments. This can be done by demonstrations when the teacher actively carries out the experiment in front of the class or demonstrate some materials (Banya, 2005) or by the student who learn about a subject by carrying an experiments in the laboratory or classroom , in which case the role of the teacher is to guide and help them where necessary. In respect to laboratory instruction, a recent study by Kotsis (2011) showed that it motivates primary school students to learn science. In addition, a study by Liapi and Tsaparlis (2007) points to the significance of the experimental work performed by the students themselves, in order to stimulate their interest toward chemistry and positively affecting attitude. The same study concludes that students show a strong preference for conducting experiments that have a direct connection with everyday life. A connection between a performance of laboratory tasks in a cooperative environment with positive attitudes and students' motivation has also been pointed out (Tsaparlis, 2009).

Wong and Fraser (1996) found significant associations between the nature of the chemistry laboratory, classroom environment and student's outcomes. Tai, Sadler and Loehr (2005) uncovered several interesting high school pedagogical experience that appeared to be linked with varying labs for understanding was associated with higher students grades. Whereas over emphasis in labs procedure in high school chemistry, was associated with lower grades in college. The results suggest that high school teachers' pedagogical choices may have a link to future student performance. Students reporting more instances of repeating labs to enhance their understanding earned higher chemistry grades than their peers who reported few or no instances of repeating labs for understanding (Tai, Sadler & Loehr, 2005). Therefore laboratory work holds greater promise in helping to prepare student for college-level studies.

In computer –assisted Instruction (CAI), the teacher can use computer at different times and places according to the characteristics of the subject matter, the students and the available software and hardware. Computer programs can be used for practice, revision, one-to- one instruction, problem solving or simulation during the application. In a study that was conducted by Jackson (1988) to find out the effects of the computer on attitudes, motivation on learning, and the possible advantages of

computers assisted test program secondary school, students were distributed into control and experimental group. The assessment of the experimental group was done using computers, whereas that of the control group was done through a written test. The statistical evaluation displayed a higher achievement rate for the experimental group that received a computer – assisted test.

Levine and Donitsa – Schmidt (1996) compared the traditional learning strategies with computer based activities. Applications and the assessment were administered after the students were distributed into control group and experimental groups. The results of the evaluation showed that the experimental group was more successful at answering the questions of the chemistry achievement test than the control group. In another study, Demircioglu and Geban (1996) compared CAI with the traditional teaching method on 6th grade students in science classes. The students of experimental group were taught with the CAI in addition to the traditional teachers' methods. The students of the control group were taught through problem solving. The topics were static electricity, electrical transmission, electrical wires and ohm's law. The science achievement rates of the two groups were compared through a t-test and the group that was taught through CAI was found to be more successful.

Wachanga and Mwangi (2004) investigated the effects of cooperative class experiment (CCE) teaching method on high school students' educational achievement in Nakuru District. The result of the research showed that CCE caused the facilitation in learning chemistry. Researchers examining different approaches for teaching at the college and university level have observed positive result from the use of co-operative learning and through the use of internet. Hinde and Kovac (2001) report higher test scores in co-operative learning (active learning) classes in comparison to traditional lecture classes. According to Anderson (2008) to reach diverse audiences of learners, science teachers must differentiate and diversify their own teaching styles and the pedagogical approaches used in science courses. What is essential, however, is that an instructor's teaching style may provide for students with different learning style during the experiences of a science course.

The key to avoiding instructional selection and retrieving a broader swath of students interested in science is differentiated instruction, a teaching style that derives from multiple pedagogical approaches and not a singular approach

2.4 Students' Achievement in Chemistry

Dambudzo (2009) defines academic achievement as the numerical scores of a student's knowledge, which measure the degree of student's adaption to academic work and the education system. Khadivi-zand (1982) suggests that academic success is reliance upon the student's attitudes towards his/her academic achievement and depends on him or herself. Chemistry is one of the most important branches of science; On the other hand chemistry proves a difficult subject for many students (Sirhan, 2007). In Kenya, the performance of learners at the end of secondary school course in Chemistry National Examination levels is poor. The results are shown in Table 2.

Table 2
National Chemistry Performance in KCSE from 2010 to 2014

Year	Candidate	Percentage Mean Score
2010	347364	24.90
2011	427303	27.93
2012	403107	23.66
2013	439941	24.83
2014	477393	32.16

Source: KNEC (2014)

The results in Table 2 show that the candidature in chemistry is very large and has continued to grow over the years. The Table 2 also shows that performance in chemistry is very poor. Although there have been curriculum changes the performance in science subjects is still poor compared to other subjects in National examination (Changeinywo, 2002). Some of the causes of poor performance are contributed to the poor instructional approaches used by teachers, in which over 85% of the instruction consists of lecture or conventional hence giving students less chance to interact (Jonson & Johnson, 1991). The teaching of chemistry in secondary schools just like any other subject depends on the demands of the society.

The centrality of chemistry in the curriculum is evident from the concern shown in the policy reports such as in the Koech Commission report of 1998 which notes that:

‘science teaching and the examinations should be oriented to problem solving approach. Children should be exposed to scientific concepts from an early age (Republic of Kenya, 1998).

A steady decline in academic achievement scores in science of high school students have caused a deep concern in many African countries (Ogunniyi, 1996). According to Tsuma (1998) the most serious problem in Africa today is deterioration in the quality of education in science and mathematics that has continued to get worse. Attention to student’s preferred mode of learning promotes improved achievement (Tomlinson, 2003). Modifying instruction to draw on students’ interest is likely to result in greater students’ engagement, higher levels of intrinsic motivation, higher students’ productivity, increased achievement and improved sense of self competences. Through differentiated instructions teachers provide opportunities for students to explore, interpret, apply, shifts perspectives, emphasis and self-assess.

Davinson (1985) reviewed studies that compared students achievements in small group setting with traditional whole class instruction. In more than 40% of these studies, students in the classes using small group approaches significantly outscored control students on measures of student performance. In only two of the 79 studies did control group students perform better than small group students. Using small group of students to work on activities, problems and assignment can increase students’ chemistry achievement. According to Colangelo, Assourline and Gross (2004), research indicates that keeping all students engaged including those that are gifted is key to school success. The intentional use of differentiated strategies is highly effective in meeting diverse needs and positively impacting students’ achievements. According to Grigorenko and Sternberg (1997) the students achieved significantly better when classroom instruction was matched to their preferred learning patterns, that is, when differentiation was used.

Further, studies by Muthomi (2013) indicates that students in differentiated classrooms achieved better outcomes than students in classrooms with one single-sized approach to instruction in study habits, social interaction, cooperation, attitude towards school and general mental health. In a dissertation studies, Brimijoin (2001)

reported achievement gains for students in effectively differentiated classrooms. Teaching to children's strengths is supported by the work of Tomlinson (2003), who reported increased academic performance for students whose learning style were accommodated within classroom. Different learners can benefit most from varied form of instruction due to the fact that all individuals possess different strengths in different areas.

2.5 Students' Self Concept in Chemistry

One's self-concept (also called self-construction, self-identity or self-perspective) is a collection of beliefs about oneself (Leflot, Onghena & Colpin, 2010) that includes elements such as academic performance, gender role, sexuality and racial identity. Generally, self-concept embodies the answer to "who am I" (Myres, 2009). Self-concept is made up of one's self-schemas. At first one's self concept is very general and changeable. As people grow older, these self-perceptions become more organized, detailed, and specific (Pastorino & Doyle-portillo, 2013).The individual self-consist of attributes and personality traits that differentiate people from other individuals (for example, introverted).The relational self is defined by relationships with significant others (for example, sister). The collective self reflects membership in social groups (for example, British) (Crisp &Turner, 2007).

Dambudzo (2009) states that educators generally believe that an understanding of self-concept and what it involves is essential if education is to achieve its ultimate goal of developing the individual's highest possible potential. In addition, an awareness of the role self-concept plays in human behavior and development will enable educators to deliberately introduce ways of maximizing self-concept as an integral part of whatever they do in their interactions with learners. Marsh (2008) declares that a higher self-concept is associated with greater academic achievement among students.

Burns (2004) concludes that not only is self-concept present in all learning but is also a major outcome of all learning situations, though its presence might pass unnoticed by teachers intend on the inculcation of academic knowledge and skills. McCoach and Siegle (2007) research, suggests that as much as one third of the variance in

achievement can be accounted for by academic self-perceptions. This highlights the importance of self-concept in both education and academic achievement.

Academic self-concept (ASC) refers to the personal beliefs someone develops about their academic abilities or skills (Trautwein, Ludtke, Nagy & Marsh, 2009). Lent, Brown and Gore (2008) defines academic self-concept as a set of attitudes, beliefs and perceptions held by the students about their academic skills and performance. A person's ASC develops and evolves as they age. Some research suggests that ASC begins developing in early childhood, from age 3 to 5, due to parental/ family and early educator's influences (Tiedemann, 2000) while other research contends that ASC does not develop until age 7 or 8, when children begin evaluating their own academic abilities based on the feedback they receive from parents, teachers and their peers (Leflot, Onghena & Colpin, 2010). By age 10 or 11, children view their academic abilities by comparing themselves to their peers (Rubie-Davies, 2006). These social comparisons are also referred to as self-estimates. Preckel and Brull (2010) suggested that self-estimates of cognitive ability were most accurate when numerical ability was estimated. Furthermore, research shows that self-estimates were more likely to be poor in other areas of cognitive ability such as reasoning speed that are considered less frequently.

Dambudzo (2009) suggests that it is important to investigate the relationship between self-concept and academic achievement in order to rescue those students who may be victims of their own negative beliefs about themselves. This statement is emphasized by Hamachek (1995) when he states that academic achievement may not simply be an expression of the students' abilities but also of their perceptions of their abilities, which may help them to feel confident and able, but when negative, cause them to feel hesitant and uncertain. Brogan (1998) pointed out that how learners feel about their abilities may, for better or for worse, consciously or unconsciously, influence their academic achievement.

Sanchez and Roda (2003) concluded a research study on 245 primary school students in Spain, and found that academic self-concept powerfully and positively predicts both general achievement, as well as achievement in mathematics. They also found that non-academic self-concepts negatively predict school achievement.

There are a variety of social factors that contribute to development of an ASC and developing a positive ASC has been related to people's behaviors and emotions in the domains of their life influencing happiness, self-esteem and anxiety levels to name a few (Tiedemann, 2000). He further points out that due to the significant impact ASC has on a person's life, it has been argued that educational systems should foster positive self-concept development in children. Research indicates that parents and teachers need to provide children with specific feedback that focuses on their particular skills or expressed abilities in order to increase their ASC (Craven, Marsh & Debus, 1991). Other research suggest that learning opportunities should be conducted in a variety of mixed-ability and like ability groupings that down-play social comparison because too much of either type of grouping can have adverse effects on children's ASC in the way they view themselves in relation to their peers (Preckel & Brull, 2010).

2.6 Motivation to Learn Chemistry

Motivation to learn refers to the disposition of students to find academic activities relevant and worthwhile and to try and derive from them the intended benefits (Glynn, Taasobchirazi & Brickman, 2009). Motivated students achieve academically by strategically engaging in behaviors such as class attendance, class participation, question asking, advice seeking, studying and participating in study groups (Pajares, 2001). Sanfeliz and Stalzer (2003), like many high school science teachers, believe that one of their most important instructional responsibilities is to foster students' motivation to learn. Motivated students enjoy learning science and believe in their ability to learn and take responsibility for their learning. Students are motivated by the relevance of science to their education and career interests.

This implies that science teachers should make a special effort to connect science concepts to students' current and future lives by explaining the importance of science literacy, describing the many career opportunities in science, and inviting scientists from the community to participate regularly in science activities (Aschbacher, Lee & Roth, 2010). Motivation to learn chemistry benefits all young students by fostering their chemical literacy, which is the capability to recognize chemical concepts as such, define key-concepts, identify important scientific questions, use their

understanding of chemical concepts to explain phenomena, use their knowledge in chemistry to read a short article, or analyze information provided in commercial adverts or internet resources (Shwartz, Ben-zui & Hofstein, 2006). Chemical literacy is considered as a component of scientific literacy and the importance of all students becoming scientifically literate is advocated internationally (Robert, 2007) and (Fienstein, 2011).

There are two main types of motivation, intrinsic and extrinsic, that can affect learning process. In the present study intrinsic motivation was given priority over extrinsic motivation. Intrinsically motivated students tend to employ strategies that demand more efforts which enable them process information more deeply (Lepper, 1988). Condry and Chambers (1978) found out that when students were confronted with complex intellectual tasks those with an intrinsic orientation used more logical information gathering and decision making strategies than did students who were extrinsically oriented. Students with an intrinsic orientation also prefer tasks that are moderately challenging, while extrinsically oriented students gravitate towards tasks that are low in degree of difficulty. These findings suggest that when teachers capitalize on existing intrinsic motivation, there are several potential benefits.

Existing theory and research of Mnyandu (2001) have shown that self-determination (intrinsic motivation, extrinsic motivation and amotivation) plays a prominent role in the academic performance of learners. Broussard (2002) declares that a high level of motivation and engagement in learning has consistently been linked to a reduction in the number of drop-outs, and to increased levels of student's success. In academic setting, whether it is elementary, secondary or higher education, a student's motivation for learning is generally regarded as one of the most important determinant of success and quality of the learning outcomes (Broussard, 2002).

Spinath and Stenmayr (2007) point out that perhaps more than anything else, to be well equipped for life-long learning, individuals need a high, sustainable motivation to learn. There exists general consensus that a distinct learning motivation promotes academic performance in all students (Schick & Phillipson (2009). Therefore motivation is an important contributor to variance in academic achievement. It is

imperative that educators within the classroom setting have a good understanding of the motivational aspect of their learners (Mnyandu, 2001). In contrast, students who are unmotivated to learn are not as systematic in their learning efforts, they may be inattentive during the lessons, and not monitor their level of understanding, or ask for help when they do not understand what is being taught (Sikhwari, 2004). Nelsen found that motivation to learn is independent of intellectual giftedness, since scores in general intelligence plays a minor role in predicting learning motivation especially for achievers.

2.7 Gender Issues in Chemistry

Gender refers to traits and behavior that a particular culture judges to be appropriate for men and women. Gender role identity is the image each individual has of herself as masculine or feminine in characteristic a part of self-concept. Through interaction with family, peers, teachers and the environment, children begin to form schemas or organized networks of knowledge about what it means to be male or female. Gender differences in sciences have been widely investigated, female are found to be less interested in science as opposed to male (Osborne, Simon & Collins, 2003). However, there are some subject areas in science that are more interested by females such as human biology, human health and botany (Elster, 2007). It is observed in the professional literature that female students are less active in the laboratory practices, using laboratory tools and appliances than male students are (Tobin & Garnette, 1987), and male students show more success in laboratory classes (Lee & Burkam, 1996).

According to Trowbridge, Bybee and Powel (2004) under performance of girls in science is partly due to teacher's bias. Teachers pay more attention to boys who appear more difficult to manage than girls who appear to have a good behavior. As a result girls receive less attention, less help and fewer challenges. However Rennie, Parker and Hildenorands (1991) suggest that girls and boys are more likely to perform equally in science when cultural norms and values reflect a society in which women traditionally have played an important economic role.

Tsuma (1998) points out that there is need to device mathematics and science curriculum that are accessible to girls, where they will feel less strange, hence

perform like male counterparts. Teachers should come up with instructions and techniques that involve students, which will encourage and excite young women to study science. According to Manzanares (2010), boys learn better when there is movement involved while girls have better ways of storing memory that makes it easier to keep details and therefore better listening skills, which give them more tools for writing tasks. These differences widen the gaps between careers, likes and dislikes. To help boys focus more on lessons in class the teacher should allow movement before log classes, vary the sitting arrangement and have a variety of tasks for students to complete (Manzanares, 2010). According to Changeinywo (2002), in developing countries, girls have less access to education than boys.

In Kenya, female candidates perform poorer than their male counterparts in national examinations. Table 3 shows performance in KCSE chemistry examination according to gender nationally (KNEC, 2014).

Table 3
The National KCSE Chemistry Gender Performance from 2010-2014

Year	Female Mean percentage	Male Mean percentage
2010	22.80	26.62
2011	21.47	25.42
2012	25.95	29.54
2013	23.08	26.30
2014	30.18	33.88

Source: KNEC (2014)

The results in Table 3 show that the means score for boys from 2010 to 2014 are higher than for girls. This indicates that boys perform better than girls in chemistry. Gender differences are reason for teachers to embrace differentiated instruction within schools. According to Tomlinson (1999) teachers providing differentiated instruction offer specific ways for each individual to learn as deeply as possible as quickly as possible without assuming one student road map, for learning is identical to anyone else's. Tomlinson indicates that teachers in differentiated classroom, accept, embrace and plan for the fact that learners bring many commodities to school but that learners also bring the essential differences that make them individuals. These aspects of differentiated instruction make it an ideal way to reach the different needs of boys and girls in school chemistry classroom.

Equity in education has become a common concern with a focus on positive attempts to achieve equity in different educational systems (Moreno & Francia, 2004). Equity in education can be achieved by teaching students corresponding to their levels of readiness, their interest and their learning styles, maximizing their opportunities for personal learning and growth (Mclaughlin & Talbert, 1993). Thus equity in education and social justice can only be met if teachers find the way to correspond to the diversity of their students through differentiated instruction. The aspects of differentiated instruction make it an ideal way to reach the different needs of boys and girls in school chemistry classroom.

2.8 Theoretical Framework

The study was guided by Howard Gardner (1983) Theory of Multiple Intelligence which suggests that all people have different kinds of “intelligences” and learn in many different ways. The theory suggests that school should offer individual centered education, having curriculum tailored to child’s intelligence preference. Gardner’s theory of multiple intelligence identified seven distinct intelligences; linguistics, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal and intra-personal (Gardner, 1983). This is important when looking at how students possess different kinds of minds, and therefore learn, remember, perform and understand in different ways.

The theory argues that students would be better served if teachers could teach in a number of ways and learning could be accessed through a variety of means (Gardner, 1983). Essentially, Gardner supports the third key element of differentiated instruction, which accounts for different student learning profile.

Accepting Gardner (1983) Theory of multiple intelligence has several implications for teachers in terms of classroom instruction. The theory states that all seven intelligences are needed to productivity function in society. Teachers, therefore, should think of all intelligences as equally important. This is in great contrast to traditional education system which typically place a strong emphasis on the development and use of verbal and mathematical intelligences. Thus, the Theory of multiple Intelligences implies that we recognize and teach a broader range of

talents and skills which is emphasized in the three element of differentiated instruction teaching approach.

Another implication is that teachers should structure the presentation of material in a style which engages most or all of the intelligences. This will not only excite students about hearing, but it also allows a teacher to reinforce the same material in a variety of ways. By activating a wide assortment of intelligences, teaching in this manner can facilitate a deeper understanding of the subject material. As children do not learn in the same way, they cannot be assessed in a uniform fashion. Therefore, it is important that a teacher create an “intelligences profile” for each student. Knowing how each student learns will allow the teacher to properly assess the child’s progress (Muthomi, 2013). This individualized evaluation practice, will allow a teacher to make more informed decisions on what to teach and how to present information. Traditional test (Multiple choices, short answers and essay) require student to show their knowledge in a predetermined manner. Supporters of Gardner (1983) theory claim that better approach to assessment is to allow students to explain the material in their own ways using the different intelligences. Preferred assessment methods include student portfolios, independent projects, student journals and assigning creative task. The product is an integral component of differentiated instruction model, as the preparation of assignments will primarily determine both the ‘what’ and ‘how’ instruction will be delivered.

Gardner (1983) Theory of multiple intelligences provide a theoretical foundation for recognizing the different abilities and talents of student. This theory acknowledge that while all student may be verbally or mathematically gifted, children may have an expertise in other areas, such as music, spatial relations, or interpersonal knowledge. Approaching assessing and learning in this manner allows a wider range of student to successfully participate in classroom learning. This might reach more students and improve content retention. Learning preferences extends these ideas, by effectively instructing a larger number of students to encourage development of the less preferred styles.

Brophy (1987) states that motivation to learn is a competence acquired through experience but immediately encouraged through modeling and instruction by significant others. What is taught and how it is taught exert tremendous influence on students' motivation to learn. According to De cecco (1968) the teacher must help the students who lack the desire to achieve to acquire the desire or the motive. Repeated success will build confidence and the urge to move on and discover but repeated failure kills the morale to proceed especially where the students lacks support of the colleague, teacher, and even the parent. Within this frame work, the study investigated the use of differentiated instruction as a pedagogical, instrument to facilitate the learning process.

2.9 Conceptual Framework

Conceptual framework is a diagrammatic representation showing interaction between independent and dependent variables. The researcher sought to investigate the impact of differentiated instruction in teaching and learning structure and bonding in the experimental group while controlling through the teaching with conventional teaching approaches. Independent variable is a variable that a researcher can manipulate in order to determine its effect or influence on another variable and example in this study was differentiated instruction and the conventional teaching approaches. The dependent variable attempts to show the total influence resulting from the effects of independent variable and example in this study was achievement in chemistry, student self-concept of ability in chemistry and motivation in learning chemistry. Extraneous variable are those factors which have influence on both the independent and dependent variables and example in this study was teachers and learners characteristics.

The variables are interrelated in the conceptual framework shown on figure 1.

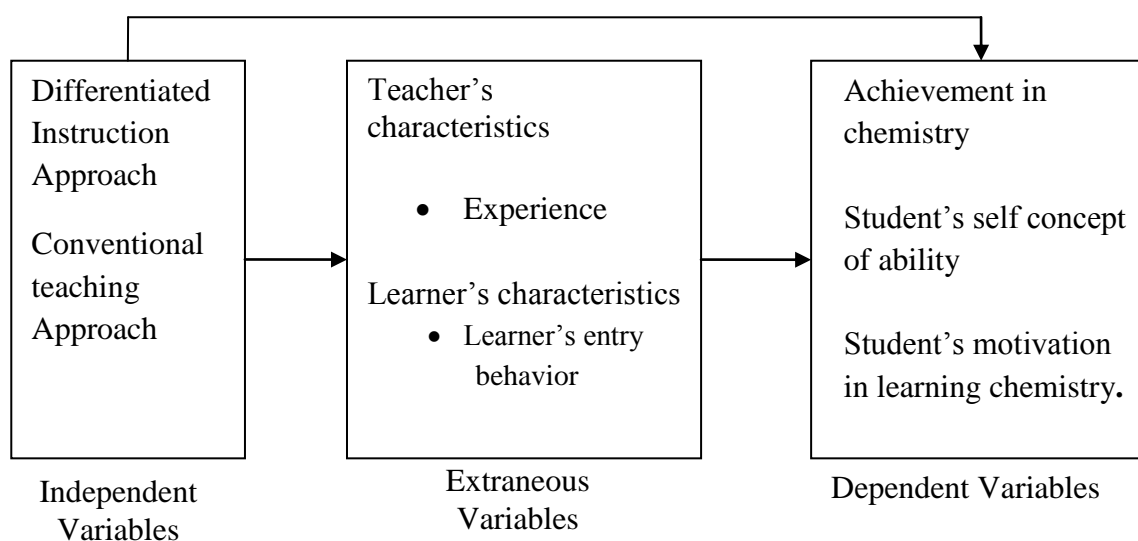


Figure 1: Conceptual Framework on Differentiated instruction

This study used qualified teachers with at least three years teaching experience in chemistry at secondary schools level to control the teacher variable. Learner's entry behavior was controlled by basing the study on the form two level of education that ensured a common entry level for the respondents.

CHAPTER THREE METHODOLOGY

3.1 Introduction

The chapter presents the research design, population, sampling procedures and sample size, research instrument, validity and reliability, data collection procedure, ethical considerations and data analysis.

3.2 Research Design

The study used Quasi-experimental design, particularly Solomon four-group design. The design enables the researcher to control and measure the main effects of testing. It also allows the researcher to carry out studies in natural and real life setting. Solomon four-group design involves four groups (Ogunniyi, 1992). The design guards against both threat of internal and external validity. Solomon four-group design enables the researcher to make a more complex assessment of the cause of the change in the dependent variable and even tell whether changes in the dependent variable are due to interactions effect between the pretest and treatment. It allows the researcher to exert complete control over the variables and to test that the pretest will not influence the results, (Shuttleworth, 2009). The Solomon four-group design is represented below:

E1	..O1	XO2
C1	..O3	-O4
E2	..-	XO5
C2	..-	-O6

Figure 2: The Solomon's Four Group design

Source: Shuttle worth, (2009).

Experimental group E1, was pretested (O1), received treatment (X) and post tested (O2). Control group C1, was pretested (O3), no treatment and received posttest (O4). Experimental group E2 received treatment (X) and posttest (O5). Control group C2, only received posttest (O6). C1 and C2 were taught using conventional teaching approach. Posttest O5 and O6 eliminated the interaction between testing and treatment.

According to Spector (1981), the various combinations of testing and untested groups allow the researcher to ensure that extraneous factor did not influence the result. The pretest was administered to students to determine the entry behavior before the experiment started. The students were taught by their teachers so that were not aware of the experimentation. The experimental and control groups were from different schools to avoid interaction of subjects.

3.3 Target Population of the study

A Population refers to all the elements in a well-defined collection or set of values. Target population is the population to which the researcher intends to generalize findings (Nkapa, 1997). Maara Sub-County has 49 secondary schools. The target population was 12,187 chemistry students in secondary schools in Maara Sub-County, Kenya. The accessible population was 1,242 Form Two chemistry students in Day co-educational secondary schools where the study sample was drawn because these schools contain adequate resources. The topic of Structure and bonding is taught at form two. The topic is poorly performed in chemistry KCSE national examinations (KNEC, 2012).

3.4 Sampling Procedures and Sample Size

Sampling is a technique employed by the researcher in selecting actual individuals who participated in the actual research. The units for sampling in this study were schools and not individual student. The Ministry of Education Science and Technology recommends 40 students per class giving an approximate sample size of study as 160 students. The actual sample size for this study was 165 students. Frankel and Wallen (2000) recommend at least 30 cases per group for experimental research. A total of four schools were drawn using purposive sampling technique. Purposive sampling was used to identify the schools with the desired characteristics from the list of schools in Maara Sub County. The desired features for the schools that qualified for the study were: a class size of more than thirty form two chemistry students, chemistry teachers with at least 3 years teaching experience and Day co-educational secondary schools. The assignment of selected schools to either experimental or control group was done by simple random sampling. This was done to reduce the possibility of bias entering the selection of schools sampled.

In case a school had more than one stream taking chemistry, all the streams were subjected to the study using similar method of teaching but only one stream was considered for analysis. Table 4 shows the summary of the sample size indicating the number of the students in the four groups.

Table 4
Summary of the Sample Size

Group	Number of Students
Experimental one (E1)	43
Control one (C1)	39
Experimental two (E2)	42
Control two (C2)	41
Total	165

3.5 Research Instruments

The instruments that were used are: Chemistry Achievement Test (CAT), Student Self-Concept of Ability Questionnaire (SSCAQ) and Students Motivation Questionnaire (SMQ).

3.5.1 Chemistry Achievement Test (CAT)

The chemistry achievement test was used to measure student's achievement in chemistry in the topic Structure and Bonding. CAT consisted of items in the topic of structure and bonding that was taught during the study. The total number of items was 15 containing a total of 40 marks. The items tested knowledge, comprehension, application and analysis levels. The numbering of the test items was re-organized to be used as a post-test.

3.5.2 Students' Self Concept of Ability Questionnaire (SSCAQ)

SSCAQ was used to measure students' self-concept of ability in chemistry. The items were 20 and were constructed on a five point likert scale. The maximum score was 100 points, ranging from Strongly Agree to Strongly Disagree with 5= Strongly Agree, 4= Agree, 3=Undecided, 2=Disagree and 1=Strongly Disagree. Negative statements were scored in a reverse order.

3.5.3 Students Motivation Questionnaire (SMQ)

SMQ was used to measure students' level of motivation toward learning chemistry. The items were 40 and were constructed on a five point Likert-scale. The maximum score was 200 points, ranging from Strongly Agree to Strongly Disagree with 5= Strongly Agree, 4= Agree, 3=Undecided, 2=Disagree and 1=Strongly Disagree. Negative statements were scored in a reverse order.

3.6 Validity

Validity refers to the degree to which an instrument measures exactly what it purports to measure and nothing else (Nkapa, 1997). Face validity was the likelihood that a question was misunderstood or misinterpreted. To ensure face validity, the SSCAQ and SMQ was presented to experts from the Department of Education and Resource Development for validation. The language and other noticeable problems were corrected. Content validity refers to whether an instrument provides adequate coverage of a topic. To achieve content validity CAT was presented to a Head of Department of chemistry in secondary schools to judge the extent to which the test items present a representative sample of the universe of the content that the test was designed to measure. The feedback was used to improve the CAT items.

3.7 Reliability

Reliability is a measure of the degree to which research instrument yields consistent results or data after repeated trial (Mugenda & Mugenda, 1999). Reliability allows the researcher to identify whether respondents understand the questions and instructions and whether the meaning of questions is the same for all respondents. Pilot study was used to identify those items that were misunderstood then modified accordingly. The instrument was piloted in a school in Meru South Sub-County with similar characteristics in the population. The reliability of CAT was tested using the Kuder and Richardson formula 21 (KR-21). KR-21 is simpler and may be used for instrument developed by individual researchers. This method is suitable when test items are scored correct or incorrect. The reliability of SSCAQ and SMQ was tested using the kuder and Richardson Formula 20 (KR-20). KR-20 can handle both dichotomous and continuous variables. The reliability coefficient of the CAT, SSCAQ and SMQ instruments was 0.74, 0.80 and 0.77 respectively.

A reliability coefficient level of at least 0.7 is considered sufficient and acceptable for social sciences (Fraenkel & Wallen, 2000). Thus the instruments were reliable.

3.8 Data Collection Procedures

The researcher sought clearance from Chuka University Ethics committee, which was used to obtain research permit to conduct research from the National Commission for science, Technology and Innovation (NACOSTI). The researcher then informed the principals of sampled schools the objectives of the study as well as sought permission to allow participation of their schools in the study. The researcher trained all the form two chemistry teachers in the experimental groups for two days on the use of differentiated instruction, using training manuals for the teachers. This ensured that the instruction was given in similar way. The researcher was meeting with chemistry teachers in experimental group on weekly basis to discuss contents, problems encountered as well as instructional approaches applied, this minimized differences in teacher's teaching approaches and ensured that emphasis was given to certain aspects of teaching.

Teachers in the experimental group were issued with instructional manual specifically designed for the topic of structure and bonding, this enhance adherence to treatment conditions set for the study. The teachers in the control group were not trained but used the conventional teaching approach. Data was collected using Chemistry Achievement Test (CAT), Students' Self-concept of Ability Questionnaire (SSCAQ) and Student Motivation Questionnaire (SMQ). The two experimental schools (E1 & E2) were taught using differentiated instruction approach. One experimental school (E1) and one other control (C1) received a pretest to enable the researcher to facilitate instruction grouping and for differentiation of instruction. The treatment ran for 24 lessons, a duration which is recommended for the coverage of the topic of structure and bonding in chemistry syllabus. CAT for the topic was used as posttest measures and was taken by all students in all the groups the last two lessons followed by administration of SSCAQ and SMQ. The chemistry teachers in the respective schools assisted the researcher to administer the instruments. The research scored the test to get quantitative data to use for data analysis.

3.9 Ethical Considerations

Ethical issues in educational research ensure that the rights and welfare of persons and communities that are subject of the study are protected and guarded. The purpose of the research was explained thoroughly to the head teachers and Chemistry teachers in the participating schools after which their consent was sought in order to have full cooperation. The SMQ, SSCAQ and the CAT had a short introduction to assure the respondents that the information that was sought was only meant for research purposes. The instruments did not require the responding students to write their names or that of their school and admission number. In case a participating school had more than one stream taking Chemistry, all the streams was subjected to the study using similar method of teaching but only one stream was considered for analysis.

3.10 Data Analysis

The researcher scored the pretest and posttest, organized, coded and entered in the computer for the analysis using the statistical package for social sciences (SPSS) version 21. Descriptive statistics and inferential statistics were used for data analysis. Descriptive statistics which include mean, percentage and standard deviation was used to summarize raw data. Descriptive statistics enables researcher to describe a distribution of measurements (Mugenda & Mugenda, 1999). Inferential statistics deals with analysis, interpretation and decision on the basis of results (Nassiuma & Mwangi, 2004). One way ANOVA was used to determine if the four groups differed significantly among themselves on variable studied. In order to ascertain the initial differences among the groups in CAT, an analysis of Covariance (ANCOVA) was carried out using KCPE marks as covariates in all the four groups. Independent samples t-test was used to test if there was statistically significant difference between the mean scores of experimental and control group. This is because of its superior quality in detecting differences between two means (Borg & Gall, 1996).

Table 5
Summary of Methods used to Test Hypotheses

Hypotheses	Independent variable	Dependent variable	Statistical procedure
H ₀ 1: There is no statistically significant difference in academic achievement in chemistry between students who are taught using differentiated instruction and those who are not exposed to it.	Differentiated instruction Conventional teaching approach	Achievement	ANCOVA
H ₀ 2: There is no statistically significant difference in self-concept of ability in chemistry of the students taught using differentiated instruction and those who are not exposed to it.	Differentiated instruction Conventional teaching approach	Self-concept	ANOVA
H ₀ 3 There is no statistically significant difference in the level of motivation to learn chemistry between students who are taught using differentiated instruction and those who are not exposed to it.	Differentiated instruction Conventional teaching approach	Student motivation	ANOVA
H ₀ 4: There is no statistically significant difference in achievement in chemistry by gender among students exposed to differentiated instruction approach.	Gender	Achievement	t-test

CHAPTER FOUR DATA REPRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents the analysis of data and discussions of the results. The findings are presented in tables and figures.

4.2 Results of the Pre-test

The experimental group (E1) and control group (C1) were exposed to pre-test before the start of the treatment. Pre-test was carried to ascertain whether the students selected to participate in the study had comparable characteristics before the study. The independent samples t-test was used to analyze whether there were significant differences in the mean scores of experimental group (E1) and the control group (C1). Table 6 shows the t-test results of the pre-test Mean scores in CAT for E1 and C1.

Table 6
t-test Results of the Pre-test Mean Scores on CAT

Group	N	Mean score (%)	SD	df	t-value	p-value
E1	43	15.53	3.718	80	2.67	0.36
C1	39	13.44	3.378			
Total	82					

E1 had a higher mean score (15.53%) than C1 (13.44%). The standard deviation of E1 was 3.718 while that of C1 was 3.378. The results indicates that the difference in the means was not statistically significant at $\alpha=0.05$ significant level ($t(80) = 2.67, p > 0.05$). Thus experimental group (E1) and control group (C1) were similar on CAT measure, this implied that the level of achievement prior to administration of the intervention of the two groups were similar; that is the groups were equivalent before administration of treatment.

Experimental group (E1) and Control group (C1) were also exposed SSCAQ pre-test. In order to determine whether there was significant difference between mean scores in SSCAQ of E1 and C1, independent samples t-test was used.

The results are as shown in the Table 7.

Table 7
t-test Results of the Pre-test Mean Scores on SSCAQ

Group	N	Mean	SD	df	t-value	p-value
E1	43	15.35	4.235	80	1.75	0.82
C1	39	14.99	4.241			
Total	82					

E1 had a mean score of 15.35 while C1 had of a mean score 14.99 out of a maximum score of 100 points. E1 had a standard deviation of 4.235 while C1 had a standard deviation of 4.241. The results indicates that the difference in the means was not statistically significant at $\alpha=0.05$ level ($t(80) = 1.75, p > 0.05$). The result suggests that the level of students' self-concept of ability toward chemistry in the two groups were the same before exposure to the intervention. In order to determine whether there was significant difference between mean scores in SMQ, Experimental group (E1) and Control group (C1) were exposed to pre-test. Independent samples t-test was used. The results are as shown in Table 8

Table 8
Means of Pretest Mean Scores on SMQ

Group	N	Mean	SD	df	t-value	p-value
Experimental (E1)	43	101.4	14.05	80	0.915	0.375
Control (C1)	39	102.3	17.65			

The means were 101.4 for Experimental group (E1) and 102.3 for control group (C1) out of a maximum scores of 200 points. E1 had a standard deviation of 14.05 while C1 had a standard of 17.65. The t-test analysis in Table 8 reveals that pre-test of SMQ mean score of both groups E1 and C1 were not significantly different at 0.05 alpha level ($t(80) = 0.915, p > 0.05$). The two groups had comparable characteristics hence homogenous.

4.3 Effects of Differentiated Instruction on Students' Academic Achievement in Chemistry

All the four groups took post-test CAT. Achievement was measured by use of CAT post-test. Experimental groups (E1) and (E2) were exposed to differentiated

instruction approach. Control groups (C1) and (C2) were exposed to conventional teaching approach. The results of the students CAT post-test scores were as shown in Table 9.

Table 9
CAT Post-test Mean Scores Obtained by Students in the Four Groups

Group	N	Mean Score (%)	SD
C1	39	21.56	5.665
C2	41	23.37	5.576
E1	43	32.33	9.987
E2	42	33.67	8.502
Total	165	27.90	9.326

The mean scores of the E1 (32.33%) and E2 (33.67%) were higher as compared with those of the C1 (21.56%) and C2 (23.37%). This shows that experimental groups had higher scores than the control groups in CAT. The standard deviation of E1 was 9.987 while that of E2 was 8.502. The standard deviations of the control groups C1 and C2 were 5.665 and 5.576 respectively. The findings indicate that students taught using DI achieved higher in CAT as compared to those students taught using CTA. Further illustration of the CAT means scores for the four groups are shown in Figure 3.

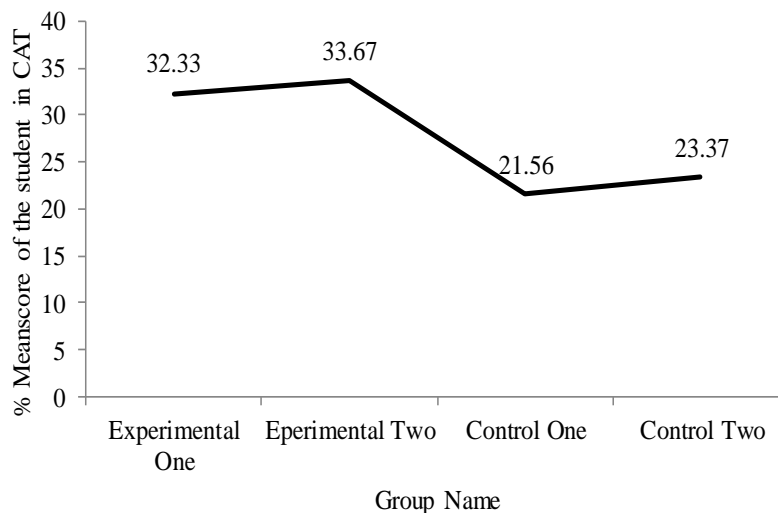


Figure 3: Relationship between Post-test Mean score in CAT in the four Groups

The highest mean score was attained by Experimental group (E2) followed by Experimental group (E1) then Control group (C2) and finally Control group (C1). Analysis of covariance of the post-test mean scores in CAT using KCPE as the covariates is shown in Table 10.

Table 10
Analysis of Covariance (ANCOVA) of the Post- test Mean Scores on CAT using KCPE marks as the Covariates

Source	Sum of squares	df	Mean	F	Sig
KCPE	183.23	1	183.23	0.62	0.39
Group	38471.18	3	246.21	4.32	0.01
Error	3162.32	160	998.37		
Total	158750	162			
Corrected Total	42733.12	163			

The ANCOVA results presented in Table 10 indicate that the differences between the post-test mean scores are statistically significant ($F(3,162) = 4.32, p < 0.05$), therefore, H_0 is rejected, which stated that there is no statistically significant difference in academic achievement in chemistry between students who are taught using differentiated instruction and those who are not exposed to it. To determine where the difference existed, a post-hoc analysis using Least Significant Difference (LSD) was run. The results are shown in Table 11.

Table 11
Post Hoc Comparisons of Post- test of CAT Mean Scores for the Four Groups

Group Name(i)	Group Name (j)	Mean difference(i-j)	Significance
E1	C1	10.82*	.000
	C2	9.12*	.000
	E2	-1.49	.425
C1	C2	-2.03	.299
	E1	-11.21*	.000
	E2	-12.79*	.000
E2	C1	12.46*	.000
	C2	9.88*	.000
	E1	1.02*	.425
C2	C1	4.23	.299
	E1	-7.62*	.000
	E2	-6.38*	.000

* Significant at 0.05 confidence level. Weighted by KCPE scores

The results indicate that the differences in mean scores of groups E1 and C1, groups E1 and C2, C2 and E1, C2 and E2, E2 and C1 were statistically significant at 0.05 levels. The mean scores of E1 and E2 and C1 and C2 were not statistically significant. This suggests that DI teaching approach had a significant and positive effect on students understanding among the students.

The results suggest that the use of differentiated instruction promotes students achievement in that the students exposed to it performed higher than those that were exposed to CTA. The results agree with those of Muthomi (2013) in secondary schools in Meru county research findings, which provided evidence for positive effects on students' achievement when exposed to differentiated instruction. The findings of the study are also consistent with the findings of Goddard and Goddard (2007) who demonstrated that differentiated instruction when fully implemented, can significantly improve student achievement in statewide study of fourth grade students in United States. The results coincide with Lewis and Batts (2005) findings, whose research revealed that more students have the chance to achieve academic success in classroom when instructions are differentiated. The results also concur with the findings of Ferris (2007) whose research revealed that students in differentiated instructional classes were found to score significantly greater than their traditionally instructed peers in second-grade science classroom in elementary school located in a middle class neighborhood in Midwestern United States.

4.4 Effects of Differentiated Instruction on Students' Self Concept of Ability in Chemistry

Hypotheses two (H_02) of the study sought to find out whether there was any significant difference in self-concept of ability in chemistry learning between students exposed to DI teaching approach and those not exposed to it. Self-concept of ability is a collection of believe about oneself. In this study, self-concept of ability was taken to mean personal beliefs students develops about academic abilities in chemistry. Operationally, Students self-concept of ability was defined as a composite variable derived from mean scores of non-missing students response on 20 items measuring construct on a five point-likert scale out of a maximum scores of 100 points, that is Strongly Disagree (SD) =1; Disagree (D)=2; Undecided (U)=3; Agree (A)=4 and

Strongly Agree (A)=5. Negative statements were scored in a reverse order. The mean scores on post-test measurement for the four groups in self-concept are presented in Table 12.

Table 12
SSCAQ Post- test Mean Scores Obtained by Students in the Four Groups

Group	N	Mean	SD
C1	39	70.34	6.378
C2	41	71.56	6.368
E1	43	76.23	7.987
E2	42	77.42	8.232
Total	165	73.89	7.243

Groups E1 and E2 had mean scores of 76.23 and 77.42 respectively. C1 and C2 had mean scores of 70.34 and 71.56 respectively. The standard deviations for groups E1, E2, C1 and C2 were 7.987, 8.232, 6.378 and 6.368 respectively. The experimental groups had higher mean score than control groups. The results showed that the students in all the four groups have moderately favorable self-concept of ability (means > 50). Table 13 shows the ANOVA of post-test scores on SSCAQ.

Table 13
Analysis of Variance (ANOVA) of the Post- test Mean Scores on SSCAQ

	Sum of Squares	df	mean square	F	sig
Between Groups	560.234	3	186.14	10.21	0.00
Within Groups	2952.652	162	18.23		
Total	3512.886	165			

The findings in Table 13 show that the differences between the post-test mean scores on SSCAQ were statistically significant ($F(3,162) = 10.21, p < 0.05$). Therefore, H_0 is rejected, which stated that there is no statistically significant difference in self-concept of ability in chemistry of the students taught using differentiated instructions and those who are not exposed to it. The results suggest that DI teaching approach as an intervention had effect on student self-concept of ability on experimental groups E1 and E2.

To determine where the difference existed, a post-hoc analysis using least significant Difference (LSD) was run. The results are shown in Table 14.

Table 14
Post Hoc Comparisons of Post test of SSCAQ mean scores for the Four Groups

Group Name i	Group Name J	Mean Difference	Significance p-value
E1	E1	5.60*	0.00
	E2	-2.27	0.30
	C2	3.58*	0.02
C1	E1	-5.60*	0.00
	E2	-7.87*	0.00
	C2	-2.22	0.25
E2	E1	2.27	0.30
	C1	7.87*	0.00
	C2	5.85*	0.00
C2	E1	-3.58*	0.02
	C1	2.22	0.25
	E2	-5.85*	0.00

* Significant at 0.05 confidence level

The results indicates that the differences in mean scores of groups E1 and C1, groups E1 and C2, C2 and E1, C2 and E2, E2 and C1 were statistically Significant at 0.05 alpha levels.

The results of this study show that experimental groups had higher scores in self-concept of ability as compared with control groups. Studies by Arimba (2012) in chemistry in Maara sub-county showed that there is a positive and significant correlation between achievement in chemistry and academic self-concept. The findings of the study are consistent with a study by Lau and Chan (2001) who found that students with low or negative academic self-concept were under-achievers. These students had a low attainment value in learning and had deficiencies in using effective learning strategies. The findings of the study also concurs with those of Kumar (2001) who indicated in a study on 318 distance learners that there exists a positive and significant correlation between academic performance and academic self-concept. Damrongpanit (2009) found in a study done in 820 Grade 9 students, an extremely strong relationship between academic self-concept and academic achievement.

The findings of the study also agree with findings of a study by McCoach and Siegle (2003) who found that high and low achievers differ in both their motivational patterns and in their academic self-perceptions. This implies that motivational patterns and academic self-perceptions separate high and low achievers from one another. It can be concluded that variances in students' motivation and academic self-perceptions lead to variance in achievement. The results are also in agreement with those of McCoach (2001) who states that most of the literature on underachievement suggests that underachievers demonstrates lower academic self-perceptions, lower self-motivation and self-regulation, and less goal directed behavior, and consequently more negative attitude towards school. The results also coincides with the findings of Rodriguez (2009) which found that given the role that the expectation and experience of success has on the formation of academic self-concept, educators can do much to make their learners feel successful. There is a popular believe that underachieving students will perform better academically if their self-concept is targeted for improvement (Vialle, Heaven & Ciarrichi, 2005).

4.5 Effects of Differentiated Instruction on Students' Motivation in Chemistry

Hypotheses three (H_03) of the study sought to find out whether there was any significant difference in the level of motivation to learn chemistry between students who are taught using differentiated instructions and those who are not exposed to it. Motivation was taken to mean the effort which the learners put into learning as a result of their need or desire to learn.

In this study motivation to learn was taken to mean students' effort put in as a result of their desire to learn chemistry as a subject. Operationally, motivation to learn chemistry was defined as a composite variable derived from mean score of non-missing students' response on 40 items measuring the construct on a five point-likert scale out of a maximum scores of 200 points, that is Strongly Disagree (SD)=1; Disagree (D)=2; Undecided (U)=3; Agree (A)=4 and Strongly Agree (SA)=5. Negative statements were scored in reverse order.

All the four groups took the SMQ post-test. Table 15 shows the mean score of SMQ post-test.

Table 15
SMQ Post test scores obtained by the four groups

Group	N	Mean score	SD
E1	43	128.50	12.78
C1	39	107.03	19.25
E2	42	129.76	13.77
C2	41	101.74	18.26

The results in Table 15 indicates that the SMQ post test mean scores of experimental group E1 and E2 where 128.50 and 129.76 respectively. They were much higher than that of the control Groups C1 (107.03) and C2 (101.74).

The results showed that the students in all the four groups have moderately favorable motivation to learn chemistry (means > 100). Table 16 shows the ANOVA of Post-test scores on SMQ.

Table 16
Analysis of Variance (ANOVA) of the post –test scores on the SMQ

	Sum of Squares	df	Mean Square	F	sig
Between Groups	6429.417	3	2143.139	7.11	0.000
Within Groups	48823.860	162	301.380		
Total	55253.277	165			

The findings in Table 16 show that the differences between the post-test mean scores on SMQ were statistically significant ($F_{(3,162)} = 7.11, P < 0.05$), thus H_03 is rejected, which stated that there is no statistically significant difference in the level of motivation to learn chemistry between students who are taught using differentiated instructions and those who are not exposed to it.

To determine where the difference existed, a post-hoc analysis using Least Significant Difference (LSD) was run. The results are shown in Table 17.

Table 17

Post Hoc comparisons of post-test on SMQ mean Scores for the four groups

Group Name I	Group Name J	Mean difference (i-j)	Significance p-value
E1	C1	9.08*	0.012
	E2	-1.27	0.740
	C2	13.37*	0.000
C1	E1	-9.08*	0.012
	E2	-10.43*	0.005
	C2	5.07	0.108
E2	E1	1.27	0.740
	C1	10.43*	0.000
	C2	14.37*	0.000
C2	E1	-13.37*	0.000
	C1	-5.07	0.108
	E2	-14.37*	0.000

* Significant at 0.05 confidence level

LSD test shows that the SMQ mean score for group E1 and C1, E1 and C2, C1 and E2, and E2 and C2 were significantly different at 0.05 alpha levels. Group E1 and E2 and C1 and C2 were not significantly differently.

The students taught through DI teaching method obtained higher scores in SMQ than those taught through CTA. This implies that DI teaching method enhanced students' motivation to learn chemistry more than the CTA. The findings are in agreement with those of Keller (1983) argument that strategies which involve learners in active problem solving and divergent thinking, choosing activities that are meaningful and relevant to the student and deciding whether the student may proceed to the next top or not, enhance learners' motivation. The result concurs with Christensen (2007) research findings which indicated that successful implementation of differentiated instruction, has been found to improve student motivation in classroom activities in second grade primary.

The findings of the study is also consistent to those of Tomlinson (2004) who found that differentiation appear to enhance students' motivation to learn while encouraging them to be committed and stay positive in grade k-12. The finding of this study also

agree with findings of Koutselini and Gagatsis (2003) who found that differentiated teaching facilitated to construct students' knowledge by maximizing motivation for cognitive and metacognitive growth that will eventually improve academic outcomes for all students in mixed ability classrooms in Cyprus. .

4.6 Effects of Differentiated Instruction in Achievements of Boys and Girls in Chemistry

Hypotheses four (H₀₄) of the study sought to find out whether there was significant difference in achievement in chemistry by gender among students exposed to differentiated instruction approach. Boys and Girls who were taught using DI teaching approach were exposed to post-test CAT. Independent samples t-test was used to analyze whether there was a significant difference in CAT mean scores between boys and girls who were taught using differentiated instruction. The results are shown in Table 18.

Table 18
t-test results of the post-test mean scores on CAT by gender

Gender	N	Mean scores (%)	S.D.	df	t-value	p-value
Boys	38	29.18	16.18	83	-0.62	0.46
Girls	47	26.30	15.25			
Total	85					

The results in Table 18 indicate that boys had a mean score of 29.18% which was higher than that of the girls' (26.30%). The standard deviation for boys was 16.18 while that of the girls was 15.25. Although boys obtained higher CAT mean scores than girls, the difference was not statistically significant ($t_{(83)} = -0.62, P > 0.05$), hence is H₀₄ accepted, which stated that there is no statistically significant difference in achievement in chemistry by gender among students exposed to differentiated instruction approach.

This study shows that there was no statistically significant difference between achievement of boys and girls when they were taught using differentiated instruction. The findings of this study indicate that gender has no significant effect on chemistry learning. The findings of the study were consistent with Koutselini (2006) research findings, which indicated that differentiation is effective for all students in mixed

ability classrooms in Cyprus. This finding also concurs with Muthomi (2013) findings in secondary schools in Meru county, whose research revealed that differentiated instruction develops an atmosphere for success for all learners in inclusive classroom settings for it allows for the creation of an environment in which all students can succeed and derive benefit. Differentiated instruction promotes equity and quality for all students. The results also coincide with those of Tomlinson (2001) who found out that differentiated instruction raises the bar for all learners in middle school classrooms in United States. The results do not agree with findings of a study by Ethington (1992) who reported that girls in eighth grade level are negatively influenced by their sex role stereotypes in achievement.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of findings and conclusions based on the findings of the study. The chapter also presents the recommendation based on the findings of the study and suggestion for further research.

5.2 Summary of the Findings

The findings of the study showed that students who were taught using differentiated instruction achieved higher in chemistry than those who were not exposed to it. Differentiated instruction is a promising approach for supporting diverse needs for all students for it consistently had positively affected students' achievement.

The result of the study showed that students who were taught using differentiated instruction acquired higher self-concept of ability than those who were not exposed to it. Differentiated instruction was beneficial for student academic achievement if they have a positive academic self-concept. A higher academic self-concept should thus be cultivated in students and encouraged by their teachers, as higher academic self-concept proved to be beneficial to their academic achievement.

The present study showed that students who were taught using differentiated instruction acquired higher motivation to learn chemistry than those who were not exposed to it. Differentiated instruction was effective in enhancing students' motivation to learn chemistry, students were more enthusiastic about their learning about the topic at hand which was structure and bonding, a chemistry topic taught in form two.

The results of the study showed that gender has no effect on students' achievement when students are taught using differentiated instruction. Thus differentiated instruction is a suitable approach for teaching both male and female students. Differentiated instruction allows all students equal access to the curriculum while maintaining high expectations for students.

From the study differentiated instruction is an approach applicable to the diverse students and so it should be used for all students.

5.3 Conclusions

Based on the findings of this study it can be concluded that differentiated instruction facilitates academic achievements, self-concept of ability and motivation towards learning chemistry better as compared to conventional teaching approach. This study encourage the use of differentiated instruction because of its substantial benefit to student who may be struggling in the classroom and is responsible teaching in that it acknowledges not only the strengths and differences among learners, but also the increasing diversity in the modern classroom. Thus, science teachers should use instruction technique that involves students, which will excites and encourage young women to study science.

5.4 Recommendations

Based on the findings of the study, it is recommended that:

- i. Chemistry teachers should give more attention to DI teaching approach as one way of addressing the perennial problem of underachievement in chemistry.
- ii. Chemistry teachers should strive to maintain and enhance development of favorable self-concept of ability by use of effective and efficient teaching approach which encourages students' participation. This includes differentiated instruction teaching approach proposed in this study.
- iii. Curriculum developers should design appropriate instructional strategies involving DI, which would enhance students' motivation to learn chemistry.

5.5 Suggestions for Further Research

Based on the findings, the following suggestions for further research are made:

- i. There is need for more research to test further the effect of DI as a teaching approach on achievement, self-concept of ability and motivation towards chemistry learning using other topics in chemistry other than "structure and bonding" used in the present study.

- ii. There is need to determine the amount of time needed to reap maximum benefit from the use of differentiated instruction teaching approach in a chemistry class setting.
- iii. Studies can be carried out on the challenges that teachers face during the implementation of differentiated instruction.

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APPENDIX A
CHEMISTRY ACHIEVEMENT TEST (CAT)

GENDER **Male ()** **Female () tick appropriately**

Instructions

Do not write your name or that of your school anywhere on this paper.

Read and answer the questions in the space provided.

Answer all the questions to the best of your ability.

Time: 45 minutes

1. Give three properties of substances with covalent bonding. (3marks)

2. In terms of bonding and structure, explain why metals are good conductors of electricity. (2marks)

3. State the type of structures formed when:
 - a) Potassium combine with fluorine (1marks)

 - b) Nitrogen combine with hydrogen (1marks)

4. Explain why solid sodium chloride does not conduct electricity but molten and aqueous sodium chloride conduct. (2marks)

5. The tables below give the atomic numbers of some elements (the letters do not

represent actual symbols).

ELEMENT	ATOMIC NUMBER
A	1
B	7
C	11
D	17

Identify two elements which will combine to give:

a) An ionic compound. (1 mark)

b) A covalent molecule (1mark)

6. Using a dot (.) and cross (×) diagram, show how coordinate bond is formed in an ammonium ion (N=7 H=1) (2mark)

7. An atom of element X (atomic number 11) and an atom of element Y (atomic number 9) combine to form a compound

a) Write the formula of the of the compound. (1mark)

b) State the type of bond present in the compound. (1mark)

c) Identify the type of structure formed. (1mark)

8. Element M relative atomic mass 40 and atomic number 20, react with cold water to liberate hydrogen gas . The element forms a chlorides which conducts electricity in solution.

a) Show the difference between *M* atom and *M* ion (2mark)

b) Determine the valency of M (1mark)

- c) Write an equation to for the reaction between M and water (1mark)
9. Diamond and graphite have a giant covalent structure because of strong covalent bond between their atoms,
- a) Explain why graphite is soft whereas diamond is the hardest known substance (2marks)
- b) Explain why graphite has a much lower density than diamond (2marks)
10. Element X (atomic number =11) and element Y (atomic number =17) combine to form a compound. Give three properties of the compound formed (2marks)
11. The properties of substances P, Q, R and S are shown in the table below

SUBSTANCES				
	P	Q	R	S
MELTING POINT ($^{\circ}\text{C}$)	1020	1728	1500	-117
SOLUBILITY	soluble	insoluble	Insoluble	soluble
ELECTRICAL CONDUCTIVITY	solution conduct	does not conduct	conduct at room temperature	solution does not conduct

From the above, identify a substance which:

- a) Is an ionic solid (1mark)
- b) Is a metal (1mark)
- c) Has a giant covalent structure (1mark)
12. Distinguish between a covalent bond and co-ordinate bond. (2marks)
13. In terms of structure and bonding, explain why the melting point of oxygen is much lower than that of sodium (3marks)

14. The table below gives information about element A₁, A₂, A₃, and A₄

ELEMENT	ATOMIC NUMBER	ATOMIC RADIUS	IONIC RADIUS (nM)
A1	3	0.134	0.074
A2	5	0.090	0.012
A3	13	0.143	0.050
A4	17	0.099	0.181

a) In which period of the periodic table is element A₂? Give a reason (2marks)

b) Select the element which is in the same group as A₃ (1mark)

15. The table below gives some information about the electrical conductivity and the likely bonding in substances N, P and Q. Complete the table by inserting the missing information in the space numbered i, ii, iii (3marks)

substance	Likely types of bond present	Electrical conductivity in solid form	Electrical conductivity in molten form
N	Metallic	i _____	conduct
p	ii _____	does not conduct	conduct
q	iii _____	does not conduct	does not conduct

APPENDIX B
STUDENT'S SELF CONCEPT OF ABILITY QUESTIONNAIRE (SSCAQ)

This questionnaire is meant to assist the researcher to investigate the effects of self-concept of ability and achievement in chemistry. The information that will be obtained will be treated with outmost confidentiality and help teachers to enhance self-concept of ability in chemistry.

Instruction

Gender male [] female [] check appropriately with a tick.

Do not write your name or that of your school anywhere.

Attempt the questions to best of your ability.

Tick (√) each statement that indicates your opinion

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

STATEMENT	SD	D	U	A	SA
When I have a problem in chemistry I ask		√			

ASSESSMENT SCALE TO DEFINE ACADEMIC SELF CONCEPT

NO	STATEMENT	SD	D	U	A	SA
1	I day dream a lot in chemistry lessons					
2	I can follow chemistry lessons and chemistry class easily					
3	I often do my chemistry homework without thinking about it					
4	I am able to help my classmate in their chemistry school work if permitted					
5	If I work hard I think I will go to the college or university to study chemistry					
6	I study hard for my chemistry test					
7	I am usually interested in my chemistry school work					
8	I get frightened when I am asked a question by my chemistry teacher					
9	I am good in chemistry					
10	I always do poorly in chemistry test					
11	I pay attention to the teacher during chemistry					

	lessons					
12	Most of my classmate are smarter than I am in chemistry					
13	My teachers feel that I am poor in my chemistry work					
14	I often forget what I have learned in chemistry					
15	I am willing to do my best to pass in chemistry					
16	I often feel like quitting chemistry class					
17	I am not willing to put in more effort in my chemistry school work					
18	I am able to do better than my friends in chemistry					
19	I do not give up easily when I am faced with a difficult question in my chemistry school work					
20	I am always waiting for the chemistry lessons					

In case you change your mind about an answer cross it neatly and tick another.

APPENDIX C
STUDENT MOTIVATION QUESTIONNAIRE (SMQ)

The purpose of this questionnaire is to find out what you think about learning of chemistry course in high school. Information provided will be treated with confidentiality.

Instruction

Gender male [] female [] check appropriately with a tick.

Do not write your name or that of your school anywhere.

Attempt the questions to best of your ability.

Tick (√) each statement that indicates your opinion

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

(SA) for example :

STATEMENT	SD	D	U	A	SA
Learning chemistry course through the conventional teaching approach method is fun		√			

ASSESMENT SCALE TO DEFINE STUDENTS MOTIVATION TOWARDS LEARNING CHEMISTRY

	STATEMENT	SD	D	U	A	SA
1	Learning chemistry is fun					
2	Learning chemistry is boring					
3	I think the school should have more chemistry lesson every week					
4	Chemistry is my favorite subject					
5	I won't mind if my teacher exceeds normal lesson time in chemistry					
6	I look forward to chemistry lessons					
7	I would enjoy school more if there were more chemistry lesson					
8	Chemistry is an informative subject					
9	I find it difficult to understand chemistry					
10	Trying to solve chemistry problems is interesting					
11	Chemistry is very much related to my daily life					
12	I cannot learn chemistry without a teacher to assist me					
13	Reading chemistry in groups is very interesting					
14	I do like chemistry because it assist me understand other sciences					
15	Chemistry is just a load of technical terms which are hard to recall					
16	I would rather be a member of football club than					

	a member of chemistry club					
17	I do chemistry questions in my spare time					
18	I would prefer to study another subject rather than chemistry during holiday					
19	Chemistry is a subject of gifted people					
20	If any subject should be scrapped away from the syllabus, it should be chemistry					
21	My father wants me to be a scientist					
22	I would specialize in chemistry if I had the chance					
23	I would never like to take chemistry in advance course					
24	Chemistry is an enjoyable school subject					
25	Even if I study hard I do not achieve in chemistry					
26	I work very hard in chemistry to receive gift from my parent whenever I do well					
27	It is practice that makes me pass chemistry					
28	Chemistry lessons are not a waste time					
29	Chemistry is one of my best subject					
30	Chemistry is an interactive subject. It helps me to make friends					
31	I do feel sleepy whenever our chemistry teacher step in class within the first 10 minutes					
32	I cannot try a chemistry problem more than twice failing					
33	Chemistry is a subject for gifted few					
34	I do study chemistry because is part of syllabus and have no choice					
35	I would like a career which does not involve chemistry knowledge					
36	Student who do well in chemistry have the best teacher and facilities always					
37	Learning chemistry through differentiated instruction made me feel confident about chemistry					
38	Leaning chemistry through differentiated instruction made me feel eager to learn chemistry					
39	Learning chemistry through conventional teaching methods made me want to apply my knowledge					
40	Learning chemistry through differentiated instruction made me feel interested in chemistry					

APPENDIX D
IMPLEMENTATION SCHEDULE

LESSON	TOPIC	SUB-TOPIC	OBJECTIVES	LEARNING ACTIVITIES	LEARNING/TEACHING AIDS	REFERENCE	REMARKS
1	Asses the students to identify the readiness of the individual student, interest and learning profile.						
2 & 3	Structure and Bonding	- The role and Significance of the Outer electrons in chemical bonding - Types of bonds	By the end of the lesson, the learner should be able to:- - Define the terms bonding and Structure - Name the three main types of bonding and related structures.	-Flexible grouping -Class Discussion -Notes taking - Asking of questions -Tiered assignment	Models of common Structures e.g. NaCl, Diamond and graphite	KLB BK 2 Pg 38-43 CSC BK 2 Pg 62-66	
4 & 1	Structure and Bonding	Ionic Bond	By the end of the lesson, the learner should be able to:- -Define Ionic bonding -State compounds with ionic bonding - Illustrate ionic bonding by use of dot (.) and cross (x) diagrams of at least Three compounds.	-Acceleration /Deceleration (altering the pace of instruction) -Flexible grouping -Class Discussion -Notes taking -Drawing dots (.) and Cross(x) diagrams.	Dots (.) and cross(x) diagrams on a chart	KLB BK 2 Pg 44-49 CSC BK 2 Pg 67-71	
2 & 3	Structure and Bonding	Giant Ionic Structures	By the end of the lesson, the learner should be able to:- - Show the bonding in an organic compound - Draw the ionic structures of a given Compound - State characteristics of an ionic Compound	-flexible grouping -Class Discussion -Notes taking - Observing the teacher's Illustrations	Charts of dots and Crosses diagrams	KLB BK 2 Pg 50-54 CSC BK 2 Pg 72-74	

4	Structure and Bonding	Covalent Bonding	By the end of the lesson, the learner should be able to:- -Define covalent bonding -List examples of compounds with Covalent bonding - Use dots and crosses diagrams to show the formation of covalent Bonding.	-Acceleration /Deceleration -Class Discussion - Observation of covalent compounds models -Notes taking -Tiered assignment	- Charts of graphite of Diamond, methane, And H ₂ O - Models of water, CH ₄	Explore BK 2 Pg 75-77 KLB BK 2 Pg 55-59 CSC BK 2 Pg 74-75	
1 & 2	Structure and Bonding	Coordinate /Dative Bonding	By the end of the lesson, the learner should be able to:- - Define coordinate bond - Describe how the bond is formed using dots and crosses bonds of: - Ammonium ion - Hydroxonium ion - Carbon (II) Oxide - Phosphonium ion	-flexible grouping -Class Discussion -Notes taking -Drawing the dots and crosses diagrams of compounds with coordinate bond -Tiered assignment	Charts of compounds such as NH ₄ ⁺ , H ₃ ⁺ O	Explore BK 2 Pg 81-82 KLB BK 2 Pg 55-59 CSC BK 2 Pg 76-78	
3 & 4	Structure and Bonding	Molecular structure and their properties	By the end of the lesson, the learner should be able to:- - Draw structures of molecular structure e.g. I ₂ , CO ₂ , H ₂ O. - State and explain properties of Molecular structures in relation to Bonding	-Class Discussion -Notes taking -Acceleration /Deceleration -Flexible grouping	Charts of iodine structure	KLB BK 2 Pg CSC BK 2 Pg 76-78 Explore BK 2 Pg 88-89	

1 & 2	Structure and Bonding	Giant Atomic Structures - Diamond - Graphite - Silicon (IV)oxide	By the end of the lesson, the learner should be able to:- -Define allotropy, allotropes - State the allotropes of carbon - Draw the structures of diamond and Graphite	- Observing the models of graphite & diamond -Flexible grouping -Class Discussion -Notes taking - Drawing of the structures of diamond and graphite	- Models of diamond and graphite -Charts showing structure of diamond and graphite	KLB BK 2 Pg CSC BK 2 Pg 79 Explore BK 2 Pg 89-92	
3 & 4	Structure and Bonding	Types of bonds across Period 3 elements	By the end of the lesson, the learner should be able to:- - Name the elements in period 3 - Explain the nature of oxides across Period 3 - Describe the reactivity of the elements of period 3 with oxygen and water - Explain the physical properties of Oxides across period 3	-Class Discussion -Notes taking -Acceleration /Deceleration -Tiered assignment	Charts of periodic table showing bond type and properties of oxides of period 3 elements	KLB BK 2 Pg 80-82 CSC BK 2 Pg 82 Explore BK 2 Pg 93-94	
1 & 2	Structure and Bonding	Chlorides of elements of period 3	By the end of the lesson, the learner should be able to:- - Explain the nature of chlorides across period 3 - Explain the properties of elements of period 3 - Mp and Bp - Structure - Bond type - PH of solutions formed	-Observation -Notes taking -Acceleration /Deceleration -flexible grouping	- Chlorides of Mg, Na, Si, and S - Litmus paper - Test tubes - water	KLB BK 2 Pg 82-84 Explore BK 2 Pg 95	

3 & 4	Structure and Bonding	Graphite	By the end of the lesson, the learner should be able to:- - Draw the structure of graphite - State properties of graphite in relation to structure and bonding - State the uses of graphite in relation to structure and bonding - Explain the structural differences Between graphite and diamond.	- Discussion -Notes taking - Drawing of the structure of diamond -Flexible grouping	Charts of the structures of diamond and graphite	KLB BK 2 Pg 77- 78 CSC BK 2 Pg 79	
1 & 2	Structure and Bonding	Metallic Bonding	- Describe and explain how a metallic Bonding is formed - State properties of metals	- Discussion -Notes taking - Drawing of the structure of monovalent Metal -Flexible grouping -Tiered assignment	Chart showing metallic bonding in monovale nt metal	KLB BK 2 Pg 78- 81 CSC BK 2 Pg 81- 82	
3 & 4	Test on structure and bonding.						

APPENDIX E

TRAINING MANUAL ON DIFFERENTIATED INSTRUCTION FOR TEACHERS

Elements to be differentiated

Content: What students learn?

Process: Opportunities, through which students makes sense of information,
Understand concepts and gain skills.

Product: How students demonstrate and extend what they have learned.

Goals of Differentiation

- i. To develop challenging and engaging tasks for each learner;
- ii. To develop instructional activities based on essential topics and concepts, significant processes and skills, and multiple ways to display learning;
- iii. To provide flexible approaches to content, instruction, and products.
- iv. To respond to students' readiness, instruction needs, interests and learning preferences;
- v. To provide opportunities for students to work in varied instructional formats;
- vi. To meet curriculum standards and requirements for each learner; and
- vii. To establish – learner responsive, teacher – facilitated classrooms.

Assessment: A requisite to Differentiation

In order to effectively differentiate instruction, a good assessment for students' readiness interests and learning preferences is necessary to avoid a one size fits all approach. You must systematically gather and use information about individual students to make instructional decisions about student strengths and needs. Assess what the students already know so that the teacher individualize and tailor the curriculum to that particular group of students. For example if some students do not know the definitions of terms such as ionic, covalent bonding then the teacher can first give the definitions and examples for them to understand better. In personalization of curriculum, a teacher may choose to modify the curriculum for an individual student as well. By adding or reducing material, altering the pace of instruction or focusing on fewer objectives, students may be able to grasp a subject matter. You can use the usual tools to assess such as pre-tests, quizzes, class discussion, students project and portfolios. To know your students interests simply

ask them. The information will allow you to utilize student interest to differentiate assignment and activities. To determine students' readiness (the skill level and background knowledge) by the pretest, teachers identify the skill level of the individual student to determine the instructional level. The instructional level must match the skill level of the student in order for the student to benefit from the instruction.

Guide students with an assessment that occurs during the lesson. This assessment should create the opportunity to correct any misunderstanding and difficulties students have with the material. Facilitate a post-assessment to find what students learnt. The post assessment can take the form of a test or as an informal activity such as group project or report. Students demonstrate their knowledge in the following ways: the student applies the knowledge given from the lesson, illustrates something from the memory and provides an example of clarity that determines understanding of the material.

Readiness/Ability

To differentiate in response to student readiness, a teacher constructs tasks or provides learning choices at different levels of difficulty. The goal of readiness differentiation is to make the work a little too difficult for students at a given point in their growth and then provide support they need to succeed at the new level of challenge. Teachers can use a variety of assessments to determine a student's ability or readiness. Also, to learn new concepts students may be generally working below or above grade level or they may simply be missing necessary prerequisite skills.

However, readiness is constantly changing and as readiness changes it is important that students be permitted to move between different groups. Activities for each group are often differentiated by complexity. Students whose understanding is below grade level will work at tasks inherently less complex than those attempted by more advanced students. Varying the level of questioning (and consequent thinking skills) and compacting the curriculum are the useful strategies for accommodating differences in ability or readiness.

Some ways in which teachers can adjust for readiness include;

- i. Adjusting the degree of difficulty of a task to provide an appropriate level of challenge.
- ii. Adding or removing teacher or peer coaching, use of manipulative, or presence or absence of models for a task. Teacher and peer coaching are known as scaffolding because they provide a framework or a structure that support student thought and work.
- iii. Making the task more or less familiar based on the proficiency of the learners experience or skills for the task.
- iv. Varying direct instruction by small-group need. Allow the students to be in small groups so that they can have peer coaching and discuss among themselves.
- v. Flexible grouping based on readiness focusing on what the student can do, knows or understands. The teacher would then give each group a series of questions, based on each group's appropriate level of readiness-skills, related to the objective of the lesson.

Interest

To differentiate in response to student interest, a teacher aligns key skills and material for understanding from a curriculum segments with topics or pursuits that intrigue students. Some ways in which teachers can differentiate in response to student interest include;

- i. Using adults or peers with prior knowledge to serve as mentors in an area of shared interest. For example the students who have mastered ionic bonding can guide others through several exercises in order for them to understand.
- ii. Providing a variety of avenues for student's exploration of a topic as well as expression of learning. For example students could be allowed to make presentations on the chalkboard or among members on the concepts that they have understood.
- iii. Providing broad access to a wide range of materials and technologies.
- iv. Giving students a choice of tasks and products, including student-design options. For example students can take up tasks such as drawing ionic structures.

Learning Profile

To differentiate in response to student learning profile, a teacher addresses learning styles, student talent, or multiple intelligence profiles. Student learning profiles refer to the way students learn including their strengths and weaknesses which may promote or deter learning. Learning profile includes learning style, grouping preferences and environmental preferences. A teacher may consider assigning students to tasks by learning style, such as adjusting preferred environment (quiet, lower lighting, formal/ casual seating etc.) or learning modality; auditory (learns best by hearing information) visual (learns best through seeing information charts or pictures) or kinesthetic preferences (learns best by using concrete examples, or may need to move around while learning) or through personal interests. Since student motivation is also a unique element in learning, understanding individual learning styles and interests will permit teachers to apply appropriate strategies for developing intrinsic motivational techniques. Some ways in which teachers can differentiate in response to student learning profile include;

- i. Creating a learning environment with flexible spaces and learning choices. The teacher could provide learning centers with learning materials.
- ii. Presenting information and encouraging students to explore information and ideas through auditory, visual tactile and kinesthetic modes. The students could have presentations in small groups or to the whole class. The students could be provided with authentic learning opportunities in various intelligence areas.
- iii. Allowing students to work alone or with peers. Students could have flexible groupings (TAPS – Together, alone, partners, and small groups).
- iv. Ensuring a choice of competitive, cooperative and independent learning experience to all students responsive to their needs.

Differentiating Learning Environment

Learning environment: varied resources and grouping structures.

- i. Grouping which are flexible – TAPS – Together, alone, partners, small groups.
- ii. Access to various materials and resources – the teacher may provide various learning centers with different learning materials.
- iii. An atmosphere which encourages expression of new ideas, acceptance of diversity and exploration.

- iv. Experience reflecting learner interests, readiness and learning profiles.
- v. Respect for all learners.

Throughout the topic of study, the teacher should assess students on regular bases. Learning environment – The aim is to create a learning environment which encourages students to engage their abilities to the greatest extent possible, including taking risks and building knowledge and skills in what they perceive as a safe , flexible environment. It should be:

- i. Student – centered – focusing on the student’s interests, input and ideas rather than those of the teacher,
- ii. Encouraging independent – tolerating and encouraging student initiative,
- iii. Open – permitting new people, materials, ideas and things to enter and non – academic and interdisciplinary connections to be made,
- iv. Accepting – encouraging acceptance of others’ ideas and opinions before evaluating them,
- v. Complex – including a rich variety of resources, media, ideas, methods and tasks and
- vi. Highly mobile – encouraging movements in and out of groups, desk settings, classrooms and schools.

Differentiating the Content: (what students learn)

The content of a lesson may be differentiated based on what students already know. The content can be discussed in a general class setting followed by group work on understanding specifics. The groups may be coached directly by teacher or used as a peer learning tool. Some students in a class may be unfamiliar with concepts in a lesson, some student may have partial mastery of content or display mistaken ideas about the content, and some students may show mastery of the content before the lesson begins. The teacher may differentiate the content by designing activities for groups of students that cover different levels of bloom’s taxonomy.

For example students who are unfamiliar with the concept may be required to complete tasks on lower levels of Bloom’s Taxonomy; knowledge comprehension and application. Students with partial mastery may be asked to complete tasks in the application, analysis and evaluation areas, while students who have high levels of mastery may be asked to complete tasks in evaluation and synthesis.

The Strategies for Differentiating Instruction

Adjusting Questions

During large group discussion activities, teachers direct higher level questions to the students who can handle them and adjust questions accordingly for students with greater needs. All students are answering important questions that require them to think but the questions are targeted towards the student's ability or readiness level. An easy tool for accomplishing this is to put posters on the classroom walls with key words that identify the varying levels of thinking based on Bloom's Taxonomy; one for Knowledge, Comprehension, Application, Synthesis and Evaluation. These are useful cues when conducting class discussion and useful for the students when they are required to develop their own research questions. Different students may be referred to different posters at certain times depending on ability, readiness or assignment requirements. With written quizzes the teacher may assign specific questions for each group of students. They all answer the same number of questions but the complexity required varies from one group to another. However, the option to go beyond minimal requirements can be available for any or all students who demonstrate that they require an additional challenge for their level.

Compacting Curriculum

Compacting the curriculum means assessing a student's knowledge, skills and attitudes and providing alternative activities for the student who has already mastered curriculum content. This can be achieved by pretesting basic concepts or using performance assessment methods. Students who demonstrate that they do not require instruction, move on to tiered problem solving activities while others receive instruction.

Tiered Assignments

Tiered assignments are parallel tasks at varied levels of complexity, depth and abstractness with various degrees of scaffolding, support, or direction. All of these activities relate to essential understanding and key skills that students need to acquire. Students work on different levels of activities, all with the same essential understanding or goal in mind. Tiered assignments accommodate mainly for differences in student's readiness and performance levels and allow students to work toward a goal or objective at a level that builds on their prior knowledge and

encourages continued growth. One of the main benefits of tiered assignments is that they allow students to work on the tasks that are neither too easy nor too difficult. They are highly motivating because they allow students to be successful at their level of readiness. Tiered assignments also allow students to work in their specific learning styles or preferences. For example the student could be given various questions on covalent bonding, coordinate bonding at varying complexity levels and be allowed to choose the ones to answer. The students will attempt various questions depending on the readiness. A teacher can tier assignments based on the challenge level of a task, the complexity of the task, the resources used to complete a task, the expected outcome, the process, and the anticipated products. Teachers assign the activities as alternative ways of reaching the same goals taking into account student needs.

Acceleration/ Deceleration

Accelerating or decelerating the pace that students move through curriculum is another method of differentiating instruction. Students demonstrating a high level of competence can work through the curriculum at a faster pace. Students experiencing difficulties may need adjusted activities that allow for a slower pace in order to experience success. For example the students who have mastered the concept of ionic bonding could be given more problems to practice on while to the needy students the teacher could go through the exercises on ionic bonding repeating to the individual students where there is need.

Flexible Grouping

Learners are expected to interact and work together as they develop knowledge of new content. Teachers may conduct whole – class introductory discussions of content followed by small group work. Grouping of students ought not to be fixed. Grouping and regrouping as the teacher keeps on changing content and activities could be embraced. Students work as part of many groups depending on the task or content. Groups will be assigned by the teacher purposefully. The strategy allows students to work with a wide variety of peers and keeps them from being labeled as advanced or struggling.

By instructing in flexible groups, the teacher is able to effectively vary the level and kinds of instructional materials as well as customize learning assignments many of which directly respond to learners interests. A student performance will vary, it is important to permit movement between groups. Student's readiness varies depending on personal talents and interests, so we must remain open to the concept that a student may be below grade level in one subject at the same time as being above grade level in another subject. Flexible grouping allows students to be appropriately challenged and avoids labeling a student's readiness as static. Students should not be kept in a static group for any particular subjects as their learning will probably accelerate from time to time. Even highly talented students can benefit from flexible grouping. Often they benefit from as being a leader. In their case peer-teaching is a valuable strategy for group-work. Decide beforehand how the groups will be made up. Ensure that each group has appropriate resources and activities relevant to the task. Move from group to group ensuring that you are visible to the whole class and watchful of what they are doing. Prepare separate activities for early finishers. Be watchful for signs which show that the pupils are unoccupied like unnecessary movements; too much chat should be discouraged. Have appropriate ending for the lesson by integrating all the activities of different groups.

Peer Teaching

Occasionally a student may have personal needs that require one-on-one instruction that go beyond the needs of his or her peers. After receiving this extra instruction the student could be designated as the "resident expert" for that concept or skill and can get valuable practice by being given the opportunity to re-teach the concept to peers. In these circumstances both the students benefit. Many times, a peer's words are easier to internalize and may be less intimidating than working one-on-one with the teacher.

Learning Centers

The learning centers are equipped with different materials referred to as differentiated resources. Differentiated resources are resources that address wide range of knowledge, ability levels, interests and learning styles that students bring to the classroom and that address different instructional strategies. A learning center is not necessarily differentiated unless activities are varied by complexity taking into

account different student ability and readiness. It is important that students understand what is expected of them at the learning center and are encouraged to manage their use of time. The degree of structure that is provided will vary according to student independent work habits. At the end of each week students should be able to account for their use of time.

Strategies for differentiating content according to student readiness, interest, and learning profile include:

- Readiness – Provide texts at varying levels, offer extensions for advanced students and re-teach,
- Interest – provide interest centers, use students questions to guide lecturers, and provide materials for varying interests, and
- Learning profile – present in visual, auditory, etc. models, use applications and examples, and use examples from a wide range of intelligences.

Strategies for differentiating process according to student readiness, interest and learning profile include:

- Readiness – use tiered activities, give detailed task directions, and provide resources materials at varying levels.
- Interest – use design tasks that require multiple interests for completion, and
- Learning profiles – allow multiple options for expression of learning and encouraging students to work together and alone.
- Strategies for differentiating product according to student readiness, interest and learning profile include:
 - Readiness – use tiered product assignments lead mini-workshops at varying levels, and develop benchmarks for success on grade-level expectations and individual needs,
 - Interest – allow students to use a range of media, and provide opportunities for students to develop independent inquiries, and
 - Learning profiles – provide visual, auditory, and kinesthetic product options, and teach students how to use a wide range of product formats.

Differentiating the Process: (opportunities through which students process, or make sense of, understandings, concept, topics and learn skills). Differentiating by process refer to how a student comes to understand and assimilate facts, concepts and skills. Some students may prefer to read about a topic, and others may prefer to listen or acquire knowledge by manipulating objects associated with the content. Information may be presented in multiple ways by the teacher and may be based on the available methods or materials.

The teacher may differentiate the process by adjusting questions. The teacher directs the higher level questions to students who can handle them and adjust questions accordingly for students with greater needs. Students may learn more efficiently if the material is represented in a different manner. For example some students prefer auditory learning such as lectures, while others learn better through visual aids and graphs. The teachers could use the following to vary the process.

- Similar readiness groups – the students that have not mastered the concepts being taught could be gathered together in groups and be guided by the teacher or other students who have grasped the concept.
- Mixed readiness groups with targeted roles for students who have mastered the concepts could be paired or grouped with those who have not mastered so that they can guide and mentor them.

Differentiating by Product

The product is differentiated by addressing different learning styles and providing choice in variety and different levels of complexity of products. Based on students' skill levels and educational standards, teachers may assign students to complete activities that demonstrate mastery of an educational concept (writing a report) or in a method the students prefers. Teachers may vary the complexity of the work each student does. Teachers must initially and constantly monitor a student growth in order to successfully apply differentiated teaching. A teacher can vary expectations on student's responses on an individual level. Some students could make presentations on the chalk boards, do extra assignments, discuss with others and could also be allowed to express their working in different ways.

- Students should be given a choice of four or five products from which they may select to demonstrate mastery of learning. Students may choose to work alone or in small groups in their products. For example, oral presentations, group discussion on key concepts, drawing illustrational diagrams. Products should be related to real problems concepts and they should synthesize information. The teacher could encourage students to create their own products assignments as long as the assignments contain required elements.

**APPENDIX F
RESEARCH AUTHORIZATION**



**NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION**

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Ref: No.

Date:

6th May, 2015

NACOSTI/P/15/3123/5796

Rose Gatune Mugwiria
Chuka University
P.O. Box 109-60400
CHUKA.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on *“Effectiveness of differentiated instruction on students’ academic achievements, self-concept of ability and motivation towards learning of chemistry in secondary schools in Maara Sub-County, Kenya”* I am pleased to inform you that you have been authorized to undertake research in **Tharaka Nithi County** for a period ending **15th April, 2016**.

You are advised to report to **the County Commissioner and the County Director of Education, Tharaka Nithi County** before embarking on the research project.

On completion of the research, you are required to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.


DR. S. K. LANGAT, OGW
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Tharaka Nithi County.

The County Director of Education
Tharaka Nithi County.