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## **Integration of Information Communication Technology Instructional Resources on Students' Motivation and Achievement in Chemistry Practical in Secondary Schools in Kenya.**

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### **Abstract**

**Purpose:** The purpose of this study was to investigate the influence of integration of ICT instructional resources on learners' motivation and achievement in chemistry practical in secondary schools in Kenya. The objective of this study was to establish the perception of teachers and learners towards use of ICT instructional resources in teaching and learning of chemistry practical in secondary schools;

**Methodology:** Descriptive survey design and quasi experimental research design were utilized in this study. The target population was teachers of chemistry; form three learners and heads of institutions in the secondary schools in the Bungoma County. Stratified random sampling was used to select the schools from which respondents were chosen, the main stratum was the category of schools according to the Ministry of Education, Science and Technology. Simple random sampling was applied to select chemistry teachers, and learners in the sampled schools. Data was collected using questionnaires, and work sheet. Data was analyzed using descriptive and inferential statistics.

**Findings:** It was perceived that integration of ICT resources led to motivation of both teachers and learners in classroom instruction. There was improved performance in chemistry practical with the use of ICT resources. The teachers and learners were motivated when ICT was utilized in teaching and learning of chemistry practical

**Unique Contribution to Theory and Practice:** The conclusion drawn from these findings is that integration of ICT has led to increased teachers' and learners' motivation and achievement. Moreover, the policy makers would be informed by this research to formulate the policies that will provide direction and ensure quality of application of ICT to knowledge and practice. The Competency Based Curriculum would apply ICT which then be used to replace the need for realia. The recommendations made from this study are that heads of institutions should be good managers of ICT to ensure that they benefit both teachers of chemistry and learners.

**Keywords:** *Perception, achievement, hardware, software and real titration.*

## INTRODUCTION

Integration of ICT is the process of incorporating ICT in the instruction or usage of technology seamlessly for instructional purposes like transacting curricular content and students working on technology to do authentic tasks. Like management, integration involves organizing, handling and administration of materials or operations of instructional use and value according to the established standards.

Computer technology started in 20<sup>th</sup> century; the first functional computer was commissioned on 15<sup>th</sup> February 1946 at the University of Pennsylvania in the United States of America (Crawford, 1999). The computer was named ENIAC (Electronic Numerical Integrator and Calculator). Macaulay and Eckert designed it in 1946, which initially was called computer room because it was too big and it was characterized by big physical size with very little memory (Belcher & Olbert, 2003). It has evolved into handheld ICT tools such as microcomputers which are used today such as laptops, ipads and other mobile phones. This process is called miniaturization, which is the gradual reduction in the physical size of the computers. The first computer used electronic tubes instead of chip, which was cooled by water running through tubes to prevent overheating thus resulting into a lot of power use (Murdock 2007). It formed the first generation computers different from the fifth generation computers in use. The fifth generation computers are used for networking and programing it can support high level multitasking and management of huge data. According to Aniemeka (2013), computers came to Africa in 1980 and this technology was first integrated in military in France, the corporate world, then homes and personal computers some of which are integrated in education. Generally, integration of ICT instructional resources involves organizing, developing and administering media resources. The focus of this operation is proper planning, development, acquisition and use of appropriate experts such as teachers in the institutions, development and use of suitable instructional systems in place to realize the set objectives in education. Educationists have clearly distinguished integration process from utilization in that, integration is well organized and result oriented while utilization is related to application of media principles in education (Hammond, 2013). Application of Information Communication Technologies in secondary schools in Kenya has one major aim, to improve the quality in education (Onchwari, 2009). It is viewed as a major tool for building knowledge societies (UNESCO, 2003) and, particularly as a mechanism at the school education level that could provide a way to rethink and redesign the educational systems and processes, thus leading to quality for all.

In Europe, appropriate use of ICT in secondary school education is considered a key factor in improving quality at this educational level (Sahlberg 2007). The European Community is promoting the utilization of ICT in learning processes through its e-learning Action Plan, one of the aims of which is to improve quality of learning by facilitating access to resources and services as well as remote exchange and collaboration (Commission of European Communities, 2001:2). To be able to understand the implication of this report to secondary school education, the report

outlines several aspects to be observed and promoted, such as widespread access to broadband technologies, professional development support policies for teachers, more research into how people teach and learn utilizing ICT, development of new high-quality online content and adaptation of current regulations to make the use of ICT at schools easier, as more recent UNESCO publications also highlighted (UNESCO, 2008).

In China, integration of ICT was first initiated in the 1990s (JIAO et al, 2014). After 10 years, the ministry of education of the People's Republic of China made important reforms called Chinese New Basic Curriculum Reforms. Just like Kenya's Ministry of Education, China gave priority to Development of ICT in Basic Education considering the ever-increasing population of up to 107.5 million primary school pupil and about 90.8 million secondary school students by the year 2020 (MOE, 2020). Since 1998, China has issued many projects such as Rural Elementary and Secondary School Distance Education Project that played a big role as a guide to promoting ICT integration in Basic Education (Wang, et al, 2017; Zhong, et al, 2017).

However, despite the large-scale implementation of China's Policy on integration of ICT and numerous descriptions of its contributions, little research has examined its pattern and intention, especially in an empirical way. Considering the country's large scale basic education system and ICT integration projects, giving a policy scenario of it would add an essential part for global experience.

Integration of ICT in China has seen robust growth of virtual classroom interaction between teachers and students in teaching and learning of science (Keengwe, 2009). While examining previous research on policy for ICT integration in basic education in China, education administrators, scholars and teachers all over the world are increasingly interested in integration of ICT in basic education (Onchwari, 2009). Just as alluded by Sahlberg (2007), global educational innovation is symbolized by ICT, which is often presented as both the cause and consequence of educational innovation and change (Clegg et al, 2003).

India has equally ever increasing population like China. Integration of ICT is not a substitution of the teachers in classroom teaching and learning. According to Manas (2016), learning is not learning if a formative shift in one's cognitive schema has not occurred and teaching is not teaching if one has not learned.

In 21<sup>st</sup> century, technology is considered a potential instrument for bringing revolution in social and cultural lives of the human society (Hargreaves, 2003). India's education system has empowered teachers to interact with learners at an individual level using technology on social platform (Toony, 2001). Statistics from UNESCO, 1998 & 2002 respectively indicate clearly that India has made very significant strides in integration of ICT in its education system. Students and teachers have sufficient access to digital technologies and the internet in their classrooms, schools and the teachers have knowledge and skills to use the new digital tools and resources to help all the students achieve higher academic standards (Takwale et al, 2014). In spite of all these, the

teacher education in institutions in India and in many Asian countries are yet to explore its advantages just as noted by Mishra in his study( Mishra et al, 2006).

Study of Indian education programs reveal quite interesting facts, implementation of ICT integration and its effectiveness in the teaching and learning process and approaches to learning and teaching has been changed dramatically; there is increasing pressure on teachers to prepare them to acquire the needed competencies in ICT as well as professionalizing the teaching service. Students learn to incorporate technology into their own learning process.

Integration of ICT in United Kingdom is positioned as a mechanism for educational reform via transformation of teacher practice. Digital technologies are positioned as Vygotskian mediating tools to facilitate change in the schools, improving standards and facilitating personalized learning (Fullan, 2013). Integration of ICT in UK has been given priority in the planning, process and implementation of the curriculum in the schools and colleges (Hammond, 2013). Research conducted in 2008 to 2011 reveal that since the Educational Reform Act of 1988, ICT has been compulsory in UK for pupils from age 5 to 16 years in the maintained schools. The report further draws evidence from the inspection of ICT in primary, secondary and special schools between 2008 and 2011([www.ofsted.gov.uk/070035](http://www.ofsted.gov.uk/070035)). ICT tools like films, radio and television, digital technologies are positioned as important tools for reformation and transformation of schooling (Howard & Mozejko, 2015). The major reason for integration of ICT in teaching and learning in the UK schools is improving the standards of education, teaching and learning in the schools, increasing vocational relevance, contributing to knowledge-based economies, enriching the learning experiences, transforming pedagogy to make it more student centered, constructivist in nature and with a focus on higher order learning and facilitating personalized learning.

Teachers use ICT with diverse competencies, classroom practices, conceptions and beliefs (Mama& Hennesy, 2013). Ensuring that teaching quality of inside-school ICT use for desirable learning outcomes needs teacher ICT accessibility, competences, self-efficacy, adaptive teaching goals and creative pedagogies, school technical and political support and the ecological system support (Farina et al, 2015). Other sources recommend and suggest that student learning outcomes may be affected by educational provisions linking inside-out school educational ICT use (Kent&Facer, 2004). The teachers need further professional development to integrate ICT into curricula, address course objectives and link student inside-out school ICT use for educational purposes (Barrera-Osori &Linden, 2009, Wang et al, 2014). In this same vein therefore, integration of ICT in teaching and learning in the schools depend entirely on the subject teachers and the attitudes of the students who in this case are the main consumers of the ICT.

Digitalization of schools in UK has attracted a number of new stakeholders influencing policy processes and school governing, thus raising questions of appropriate forms of government policy making. School policy adherence in general has been found challenging due to variations in the school context and complexity of policy translation of which it is said there is lack of understanding among policy-makers( Cuban,2013). Another excerpt drawn from digitalization of schools in UK

is that pre-service teachers justify the use of particular technology initiative in the schools and has shone light on how they view technology. Teachers appear to take a very techno-centric view focusing on technological artifacts as opposed to the types of learning environment they could facilitate. However, students recognize technology as an artifact as opposed to the human activities they facilitate.

In comparison to African countries, India has considered the great importance of ICT integration in teaching and training. Adequate emphasis is not placed on it; teacher training is often neglected as a traditional practice here without accepting its latest innovations in the face of more immediate visible recent educational goals and objectives (Panigrahi, 2016)

It's much easier to build a gleaming new school than to successfully train a cadre of teachers who are willing to work in challenging situations in this digital era, in poor, rural areas, far from the centers of social and commercial life of a country. The scholars have identified a major shift in emphasis from teaching to learning that created a more interactive and engaging learning environment for teachers and learners. Due to this shift, students navigate through large amounts of information to analyze and make decisions and to master new knowledge domains in an increasingly technological society like the Indian society (Dwyer, 1997, Harris & Hofer, 2011).

The efforts of different governments and administrations have been focusing on providing the schools with good equipment. In 2013 for example, the Jubilee administration hinted to supplying laptops to all public primary schools purposely to equip learners with skills in ICT. However, analysis of educational uses of ICT has been lacking. Therefore, this research will focus on the need to develop appropriate strategies to face this new teaching role and additionally, the learners' role when integrating ICT in the teaching and learning processes in secondary schools in Kenya. The role and the perspective of teachers have become highly relevant, highlighting them as crucial players in the process. Particularly, teachers use technology depending on their perceptions and trust in the way it can contribute to the teaching and learning process (Hoffer, 2011). It will be imperative to be closer to teachers in order to understand what they do with the ICT equipment supplied or what they might do with technology in their classrooms and in relation to their work. Integration of ICT instructional resources in secondary education is connected to achievement in education; the main reason in utilization of the same resources by teachers and learners is to objectively produce the desired results. Studies by Nachmiasis et al, (2008); Somekh (2008) and Webb (2002), reveal very interesting facts about utilization of ICT educational resources in secondary education, they contend that ICT integration strengthens the traditional lecture method and practices. They found out that it is possible for teachers to develop innovations by taking advantage of what technology has to offer. There is quite a number of software available for utilization by the teachers of chemistry to interact with the students; there is virtual laboratory that is a web-based software for interactive learning based on simulation of the real phenomena. It allows learners to explore a topic by comparing and contrasting different scenarios, to pause and to restart application for reflection and do note taking, to get practical experimentation over the

internet. It is actually laboratory facility that is on virtual space to be accessed through platforms like Zoom, YouTube and others that are developed. In addition, other studies by (Kirkpatrick and Peck, 2001); show that technology is mainly used to develop low-level teaching and learning processes, suggesting that teacher- centered approaches are a setback. The platforms allow the learners to manipulate this laboratory with little instruction from the teachers of the subject. The Education sector in Kenya takes a huge share of government expenditure, which goes to equip schools with ICT educational resources to boost teaching and learning of science subjects in both primary schools and secondary schools. These instructional resources are materials or events that create the conditions necessary for learning to occur. Bruce *et al*, (2009) posit that education's central goal should be to build the learning capacity as well as developing knowledge and skills that are integrated seamlessly, to do this, the education stakeholders should be ready to spend.

Kenya Vision 2030 envisages creating a globally competitive and prosperous Nation with a high quality of life by the year 2030. The objective of the social pillar is investing in the education of the people of Kenya in order to improve the quality of life specifically through education and training. It was upon this basis that ICT equipment was released to Kenyan public schools to achieve these set objectives (The Republic of Kenya 2008).

Learners are taught chemistry through various teaching techniques. The major objective for learning chemistry in secondary schools is to acquire relevant technical and scientific skills necessary for economic development and to apply in secondary education KICD (2010). Thus, teachers are supposed to design the learning environment that can provide the experiences and lessons that respond to the students' prior knowledge in chemistry. According to Aggarwal (1995), a teacher of chemistry should maximize the practical study by controlling relevant factors such as; educational purposes, educational context, teaching materials, educational environment, conduct of the students, behavior of the instructors and interrelations between the students and the instructors in practice, the school classroom management and the network of instruction such as intellectual education, moral education and counseling. The teacher of chemistry should therefore consider utilizing the ICT instructional resources available to enhance understanding of the subject. According to Otunga (2011), Utilization of these resources enhances effective teaching and learning of science to boost performance in the National Examinations. In this case, good performance in chemistry is a clear indicator of learning that occurred because of the teacher investing in thorough preparation before instruction. All the above teaching and learning resources encourage the hands-on active teaching and learning that can bring about effective and efficient instruction in the subjects. There is a connection between the presence of ICT instructional resources in an institution of learning and the actual utility where the learners to bring about learning utilize the same resources (Ozmen, 2008). The ability to search for information using the ICT equipment available in secondary schools, download the information, observe the diagrams and scientific processes using ICT media keenly, and recreate the mental images produced through observation of these features allows them to process the information and apply it in answering the questions in chemistry (Chang, 2002).

## Objectives of the Study

The objective of this paper is to; establish the perceptions of teachers and learners towards use of ICT instructional resources in teaching and learning of chemistry practical in secondary schools in Bungoma County.

## Theoretical Framework

This study was pegged on Jerome Bruner's theory of instruction. The instruction consists of leading the learner through a sequence of statements and restatement of a problem or a body of knowledge that increase the learner's ability to grasp, transform and transfer what is learned. In short, the sequence in which a learner encounters materials within a domain of knowledge affects the difficulty that will be experienced in achieving mastery. If it is true that the usual course of intellectual development moves from enactive through iconic to symbolic representation of the world, it is likely that an optimum sequence will progress in the same direction.

The optimal sequence cannot be specified independently of the criterion in terms of which final learning is to be judged. A classification of such criteria will include at least the following;

- a) The speed of learning
- b) Resistance to forgetting
- c) Transferability of what has been learned to new instances
- d) Form of representation in terms of which has been learned in terms of cognitive strain imposed
- e) Effective power of what has been learned in terms of its generativeness of new hypotheses and combinations.

Instruction is provisional state that has as its object to make the learner of problem- solver self-sufficient. The tutor must correct the learner in a fashion that eventually makes it possible for the learner to take over the corrective function himself. Otherwise, the result of instruction is to create a form of mastery that is contingent upon the perpetual presence of the teacher.

Bruner further proposed three models of representation as discussed in this framework. This suggests that it is effective when faced with new material to follow a progression from enactive to symbolic representation, this holds true even for adult learners. Bruner also suggests that a learner even of very young age is capable of learning any material so long as the instruction is organized appropriately; in sharp contrast to the belief by other theorists like Piaget and other stage theorists. The five representations are explained as follows:

- **Enactive mode of representation**

Thinking is based on the physical action, an infant learns by doing, rather than by internal representation or thinking. It also involves encoding the physical action based information and storing in the memory; for example, in the form of movement as in muscle memory: a baby might remember the action of shaking a rattle. This mode continues later in many physical activities like



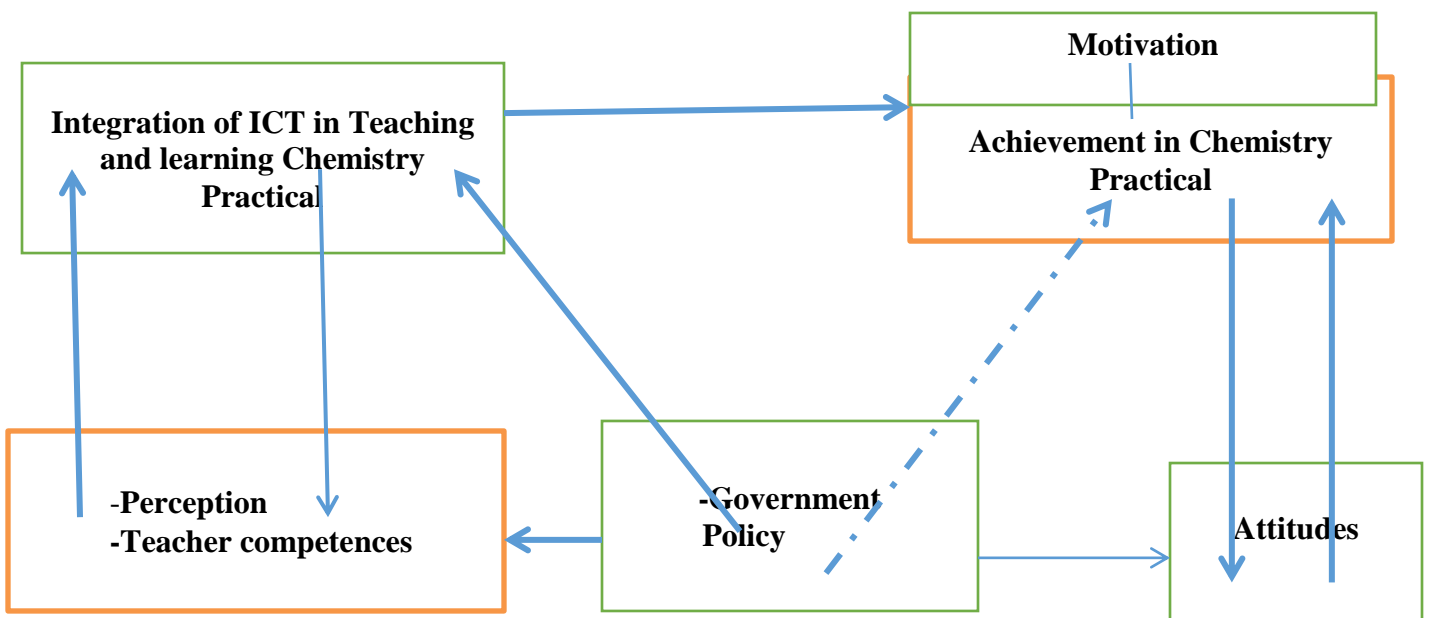
learning how to ride a bicycle, playing the keyboard and rudimentary skills in typing on the computer keyboard. Many adults can perform a variety of motor tasks like typing, sewing a shirt, operating a lawn mower and so on. This would be difficult to describe in iconic or symbolic form.

- **Iconic mode of representation**

This mode of representation is based on the sensory images or icons, usually visual ones like pictures in the minds, for some this is the conscious while for others say they do not experience it. In this study, the learners were required to carry out some tasks on the computers using the icons of the apparatus used in titration to get the same results like in real titration that involve use of conventional apparatus. When learning a new subject, it is often helpful to have diagrams or illustrations to accompany the verbal information. Thinking is based on the use of other mental images such as hearing, smell or touch. ICT allows the learners to interact with virtual apparatus and in combination with the enactive mode, can carry out tasks and capture the same data required in answering questions in chemistry practical, after all, the examiners in chemistry practical only require the data collected during the practical session to measure achievement in chemistry practical.

- **Symbolic mode of representation**

The symbolic or word representation is the last development in the learner. This is where the information is stored in the form of a code or symbol such as language. This mode is acquired around six to seven year-olds according to Piaget's concrete operational stage. In the symbolic. In the symbolic stage, knowledge is stored primarily as words, mathematical symbols, or in other symbol systems such as music. Titration part of the practical examination carries the heaviest mark in comparison to ionic determination in the qualitative analysis, to be able to have learners enjoy doing titration in the daily practice, there must be additional representation like words for instruction to the candidate, sound to add flavor to the mundane task of titration and mathematical symbols to direct the learners in analysis of the results of virtual titration done. Symbols are flexible in that they can be manipulated, ordered, classified and so on. So that the user is not constrained by the actions or images which have a fixed relation to that which they represent.

**CONCEPTUAL FRAME WORK****Independent variables****Dependent variables**

**Source: The Author**

From the above conceptual framework, integration of ICT instructional resources in teaching and learning of chemistry practical constitute the independent variable as it can be manipulated by both the students and teachers to be able to achieve the desired results in chemistry practical. As independent variable, integration of ICT allows the teachers and learners to be the masters of what they do while ICT becomes the tool in their hands to be utilized in any direction that achieves the best output in chemistry practical.

Integration of software such as chemdraw allows the teachers and learners to identify and draw all the shapes of chemistry apparatus that are used in carrying out practical activities. On the other hand, chemix is an application which provide the platform for the teachers and learners to virtually add one chemical substance to another to get the expected compounds and record the results in the form of data. The visual codes offer the opportunity for teachers and learner to have additional components to chemdraw and chemix to allow learners chance to interact with any chemistry practical session. All the above described components when integrated produce the learning experiences which then change the way teachers and learners interact with the universe using the senses. Changes in attitude of learners towards chemistry and particularly chemistry practical is the cardinal and ultimate goal of teachers and learners.

Achievement in chemistry practical is the main dependent variable, but motivation also leads to the confidence needed to achieve the desired goals in teaching and learning chemistry. Other intervening variables like government policy provide direction such as regulating how ICT is used

in education and content that is available to learners for consumption. Government policy influences the attitudes of teachers and learners towards use of ICT instructional resources. Punitive policies create negative attitudes that will affect motivation and eventually achievement in chemistry practical. Good policies change attitudes, reinforce motivation, and boost achievement. These intervening variables act as the gear of integration of ICT instructional resources which when properly engaged changes the direction and shortens time taken to achieve the goals of education. Similarly, government policy alters the way teachers and learners perceive ICT, perception and teacher competences determine the extent of integration and therefore, very important tenets in chemistry practical.

The learners store all the information acquired from the practical activities in the memory which then can be retrieved anytime to be used by the learners in solving the subsequent problems. Finally, the sum of all the aspects demonstrated in the conceptual framework constitute quality in learning and achievement in chemistry practical.

### **Literature review**

ICTs are of the major contemporary factors shaping the global economy and producing rapid changes in the society (KICD, 2013). They can transform the nature of education where and how learning takes place and the roles of students and teachers in the learning process (Chijioke, 2007). There is no doubt to this fact that traditional learning environments have been impacted by the internet, social media, and smart phones (Wekesa, 2003). The traditional classrooms now have to compete with the independent writers and bloggers as well as social media websites, and other users-generated content venues have influenced the way in which students are willing to learn (Aniemeka, 2013). According to Wayne (2000), Individuals, institutions, economists, business leaders, and Government officials from the public, private, and non-profit sectors are looking to ICT for better, more efficient and safer ways of providing services. The educational use of computer technology continues to grow worldwide with integration of ICTs in schools having been made compulsory in the developed world since the beginning of 1980 (Cotton, 1997).

While ICT in developed countries is compulsory, in Kenya and other developing nations, ICT integration in education is considerably more recent, small-scale and experiment (Wekesa, 2008). The adoption of computers in education in Kenya is deemed to increase due to acquisition of basic computer skills. The integration of computers in education began in early 2000s in Kenya and this has gone all the way to aid in teaching, communication, and research. Right now, every subject has a computer application and currently the deliberate efforts by the government to provide laptops to every class one in public schools has made this venture successful.

Teaching of chemistry in secondary school aims at imparting certain skills to the learner that makes him/her equipped to exploit the resources in the environment without causing destruction. The teacher of chemistry must understand that he/she must develop scientific skills among the learners. These skills once internalized by the learners, can cause them to make use of scientific

knowledge in their day-to-day life. In each of the topics in chemistry, the teacher will find that certain skills are developed more than others. He/ she must be careful not to ignore any of them all through the teaching process. The skills include but not limited to; observing, recording of data, drawing, classifying, communicating, measuring, predicting, inferring, identifying and controlling variables, formulating and testing hypotheses, and defining, interpreting data, experimenting and constructing models. All these skills can be acquired by use of ICT instructional resources available. These skills would only be achieved if the teacher of chemistry adopts an approach that encourages exploration. During the twenty thirteen presidential campaigns the current Kenyan president promised to provide laptops for Kenyan primary school learners, a pledge that has now turned into an ambitious multimillion Digischool scheme. From twenty sixteen about 5000 laptops for primary school pupils and teachers arrived at Jomo Kenyatta International Airport, Nairobi, and the first installment of some 1.2 million devices. The teachers should encourage the learners to consider themselves as scientists. This way, the learners will feel free to point out questions and set out ways of carrying out inquiries that seek answers to the questions. For efficient and effective management of these ICT devices, learners should get used to operating these ICT devices to achieve the objectives of every planned lesson. The teacher should demonstrate what is expected in order for the learner to visualize the expected results. This is how ICT educational resources come on board.

Following this valiant yet risky investment from the government, the teachers of chemistry must identify and assess the benefits and short falls of ICT integration with secondary school curriculum in Kenya. Barasa (2005) commenting on instruction in Kenya, highlights the fact that the learning resources and the teacher awareness of their availability and utility enhance learner performance. He further notes that, situations where there is evidence to show failure by society or government to provide equal access to such learning resources could be seen as denial of a child's right to proper education. This information raises questions than answers; the society in question is the Ministry of Education, Teachers Service Commission, Kenya Institute of Curriculum Development and other groups that support education in this country, without leaving out the political divide; should the ICT instructional resources be supplied to learners through support of these agencies, or should the teacher of chemistry be empowered to develop his/her own software for use in the classroom instruction? The curriculum developer is mandated to design the software part of the ICT instructional resources which should be incorporated in the curriculum implementation process.

The teachers are probably the most important resource that any country has. This is because an efficient human capital development depends on the quality and effectiveness of teachers. One of the reasons for management and utilization of ICT lies in the type of the outcome of instructional process. The quality of doctors, teachers, lawyers, accountants, engineers, and other professionals depends on how well they have been prepared on their various roles in the society by their teachers, therefore, teachers play a key role in the overall human resource. There is however, a strong indication that most teachers in secondary schools in the developing countries have been

conscripted into the teaching profession due to their inability to gain entry other professions. This implies that teaching in developing countries has two lots of teachers: those who chose the profession for intrinsic reasons and those, for reasons beyond their control, have found themselves in the profession. Okumbe J. (2007) argues that the main issue in teacher development is that a good proportion of them enter the teaching profession with low morale. He suggests that a consciously designed teacher development is a must if work, motivation and job satisfaction are to be improved to make teaching a 'Willing profession'. The use of ICT learning resources is influenced by the philosophy of education and learning theories.

Ancient Greek philosopher Aristotle (384-324 BCE) developed realism. The teaching and learning of science is based upon this philosophy whereby; first the learner perceives an object and records sensory data about the object, in this case the software in the mind, then the mind sorts these data into qualities always present in the object by identifying the necessary qualities, the learner abstracts a concept of the object and recognizes it as belonging to a certain class, Ornstein (2011). From this philosophy, it can be inferred that ICT learning resources can be very useful in transmitting knowledge and skills in science to learners. Barasa (2005) confirms in Otunga (2011) that availability of teaching resources and the teacher awareness of their utility enhances learner attainment. Comenius cited in Daniel.M. (1995) that use of objects to illustrate concepts will enhance assimilation of the lesson. The teacher while preparing the lesson should organize the lesson into easily assimilated small steps that make learning gradual, cumulative, and pleasant, Ornstein (2011). Chemistry is practical in nature and there are a number of learning resources that can reinforce acquisition of concepts that can be used by the learner to solve novel situation.

Johnson (1990) argues that education can no longer be based on a single teacher or a single textbook trying to dispense knowledge, skills, and expertise that children need to know, develop, and learn for the rest of their lives. Hingesel (1989) indicates that teachers need the tools which help children to learn and develop a passion for learning. ICT in schools creates a better environment throughout the school, for example through e-mail, discussion groups and even live chat rooms. The utilization of ICT have extremely beneficial motivational influence on a learners learning capabilities, The learners are proven to express themselves through ICT instructional resources by being able to complete tasks given.

Many teachers of chemistry have been over relying on textbooks as reference materials, but the knowledge is dynamic. To cope with the trend, they should acquaint themselves with information searching skills so as to be ahead of the learner. According to Chia and Duthie (1993), ICT instructional resources are very profound in the social context as they result in cognitive change as analyzed, while Kirkpatrick and Cuban (1998) also confirm that computers in teaching and learning process have very significant effect on cognitive outcomes in learners, particularly in secondary schools. By being ahead, the teacher will be a useful learning resource by planning, organizing, directing, and guiding learners for self-discovery as they interact with teachers. Blok et al (2002) presented some meta-analysis of the effect of use of computers in teaching and learning

processes and in academic results, it could be confirmed from his study that cognitive change occurs when learners are motivated in searching for information to solve scientific questions. The studies previously cited such as use of book and printed materials are no longer the only source of information. The development of educational theories, international trends to self-learning, taking into account differences of individual learners, makes them the axis of the educational process, and the teacher's role changes into a leader and facilitator of the learning process.

Samikwo (2013) concluded that availability and use of teaching and learning resources in schools impacted positively on students' achievement in chemistry examination. Ngaruiya (2012) observed that, the traditional approaches to teaching and learning continues to predominate in the learning institutions and this has hindered utilization of non-book media. Tutors and pupils in the learning institutions have not shown a commitment to the production of their own learning resources preferring to use what is already made.

To conclude, Kafu (2010) suggests that learning resources in particular should always be manipulated to suit all forms of learning situations and styles like interactive learning, problem-based learning (PBL), independent studies, individual and mass instruction. Based on this view, ICT learning resources remain as objects or materials until their value is identified, selected, developed, and utilized in the instructional process. ICT equipment is in this view, the mediator of instruction and is integrated during teaching and learning process to enhance understanding of the content material being taught.

## **RESEARCH METHODOLOGY**

### **Research Design**

The study was conducted through descriptive survey design. The researcher adopted the positivist philosophy; the reality of integration of ICT in teaching and learning of chemistry practical can be quantified empirically. This informed the use of questionnaires to the form three learners, teachers of chemistry. According to Mugenda (2003), descriptive survey involves collection of data in order to determine whether and to what degree a relationship exists between two or more quantifiable variables.

### **Study Population**

The target population for this study were the teachers of chemistry, and form three students. The target population for this study were the teachers of chemistry, form three students and the heads of the institutions who were key informants. The teachers of chemistry have undergone the professional training in ICT through in- service training and therefore could utilize the ICT instructional resources. Form three students are in position to utilize ICT instructional resources, This study was conducted in Bungoma County that according to the Ministry of Education statistics (2019) has about 212 secondary schools, both public and private. It was assumed that the teachers of chemistry have undergone the professional training, while the ICT assistants have the training in their field and form three students are in position to utilize the ICT equipment.

### Sampling Techniques

The schools were selected using stratified random sampling to ensure that there was equal representation of the region. The teachers of chemistry and ICT assistants were selected using simple random sampling technique while purposive sampling was used to select the heads of institutions. The learners were selected using simple random sampling. In the mixed secondary schools, stratified sampling technique was used to ensure gender equality.

#### Categories of Schools by School Type in Bungoma County

Category of School	Boys'	Girls'	Mixed	Total
National	1	1	-	2
Extra county	8	7	5	20
County	8	7	4	19
Sub-County	4	5	9	18
Private	3	3	3	9
<b>Total</b>	<b>24</b>	<b>23</b>	<b>21</b>	<b>68</b>

**The total number of schools sampled was 68**

#### Sample Size

A sample is a smaller group selected from the target population; 34 teachers of chemistry were used in this study, 14 ICT assistants were used and 282 form three students in Bungoma County.

#### Table Showing the Sample Size

Respondents	Target Population (N)	Sample population(n)	Percentage (%)	Sampling Technique
Teachers	91	34	37.4	Purposive
Students	1258	282	22.4	Simple Random

<b>ICT Technicians</b>	<b>34</b>	<b>14</b>	<b>41.2</b>	<b>Purposive</b>
<b>Total Sample Size</b>	<b>1383</b>	<b>330</b>	<b>100</b>	

### Data Collection Instruments

This study used questionnaires as the main tool for collecting data. Work sheet was availed to the students for the experimental research; the work sheet contained simple questions in chemistry practical.

### Data Analysis Procedure

Quantitative data was collected from 282 students, 34 teachers of chemistry, and 14 ICT assistants from 34 secondary schools. The data was collected by the researcher as he was moving from one school to the next. He was assisted by the subject teacher who administered questionnaires to students because the students were well known to him or her and therefore collected reliable information. The researcher also connected with ten teachers of chemistry online to administer the work sheet to students to perform a simple chemistry experiment and answer three questions which were marked and the results relayed to the researcher online for analysis. The KCSE document and analyzed KCSE results were obtained from the deputy principal's office or the principal's office.

## DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION

### Demographic Characteristics of Teachers

The teachers were asked to describe their personal profile including gender, age, years of experience teaching Chemistry, and training capacity. The findings were as shown below.

#### Gender of the Respondents

<b>Gender</b>	<b>Count</b>	<b>Percentage</b>
Male	18	52.9%
Female	16	47.1%
<b>Total</b>	<b>34</b>	<b>100.0%</b>

*Source: Field Data*



The findings of table above show that majority of the respondents, 52.9% (18) were male while 47.1% (16) were female. The findings show that most of the teachers of Chemistry in the schools were male. Similarly, the researcher demonstrated gender inclusivity in the study by ensuring that both male and female participated in the study. The findings by Tanui (2003) show that ICT can help teachers to do better than what they already know and act as amplifiers of the existing practice. This means that ICT is a tool in the hands of the teacher of chemistry practical that should help the teacher achieve the desired end with ease. According to Wasike (2013), the manner in which the learning environment is organized is critically important because learners might not learn all that is taught in a single exposure to teaching using conventional methods. The teachers of chemistry should be proficient enough in using ICT instructional resources that are currently fitted with enough applications, which can aid in the process of teaching chemistry practical. Using ICT in teaching and learning chemistry practical would favour those who are used to them.

### **Age of the Teachers**

<b>Age in Years</b>	<b>Count</b>	<b>Percentage</b>
25-35 years	23	67.6%
36-45 years	8	23.5%
46-55 years	3	8.8%
56-66 years	0	0.0%
above 66 years	0	0.0%
<b>Total</b>	<b>34</b>	<b>100.0%</b>

### **Source: Field Data**

The findings of Table show that majority of the respondents, 67.6% of the respondents were of the age between 25 to 35 years, 23.5% were of the age between 36 to 45 years, and 8.8% were of the age between 46 to 55 years. None of the respondents was above the age of 55 years. The findings show that most of the study participants were young and energetic to participate in the teaching activities. All the participants were mature enough to be able to give reliable information to the study. Teacher's experience is very significant, the teachers who have been in the field for long can create very conducive environment for learners (Migraine, 2013). Besides, the experienced teachers have the ability to create interesting and interactive learning environment that facilitates a pedagogical shift entailing an educational interaction between teachers and learners. Furthermore, experienced teachers are able to do an orderly presentation of digital content that can help the learners interact and achieve the learning experience.

### Level of Training in Teaching Chemistry Subject in Secondary School

Level of Training	Count	Percentage
Certificate	0	0.0%
Diploma	5	14.7%
Degree	28	82.4%
Post Graduate Degree	1	2.9%
<b>Total</b>	<b>34</b>	<b>100.0%</b>

*Source: Field Data*

The study findings of Table show that 82.4% of the selected teachers were having University undergraduate degree training in teaching Chemistry Subject at secondary schools, 2.9% had University postgraduate degree training in teaching Chemistry Subject at secondary schools, while 14.7% had diploma training in teaching Chemistry Subject at secondary schools. This shows that most of the teachers of Chemistry who participated in the study were well trained in teaching Chemistry subject at the secondary schools.

### Demographic characteristics of Learners

The learners were asked to describe their personal profile including gender, age, years of study, and mode of delivery in teaching.

#### Gender of the Learners

Gender	Count	Percentage
Male	167	59.2%
Female	115	40.8%
<b>Total</b>	<b>282</b>	<b>100.0%</b>

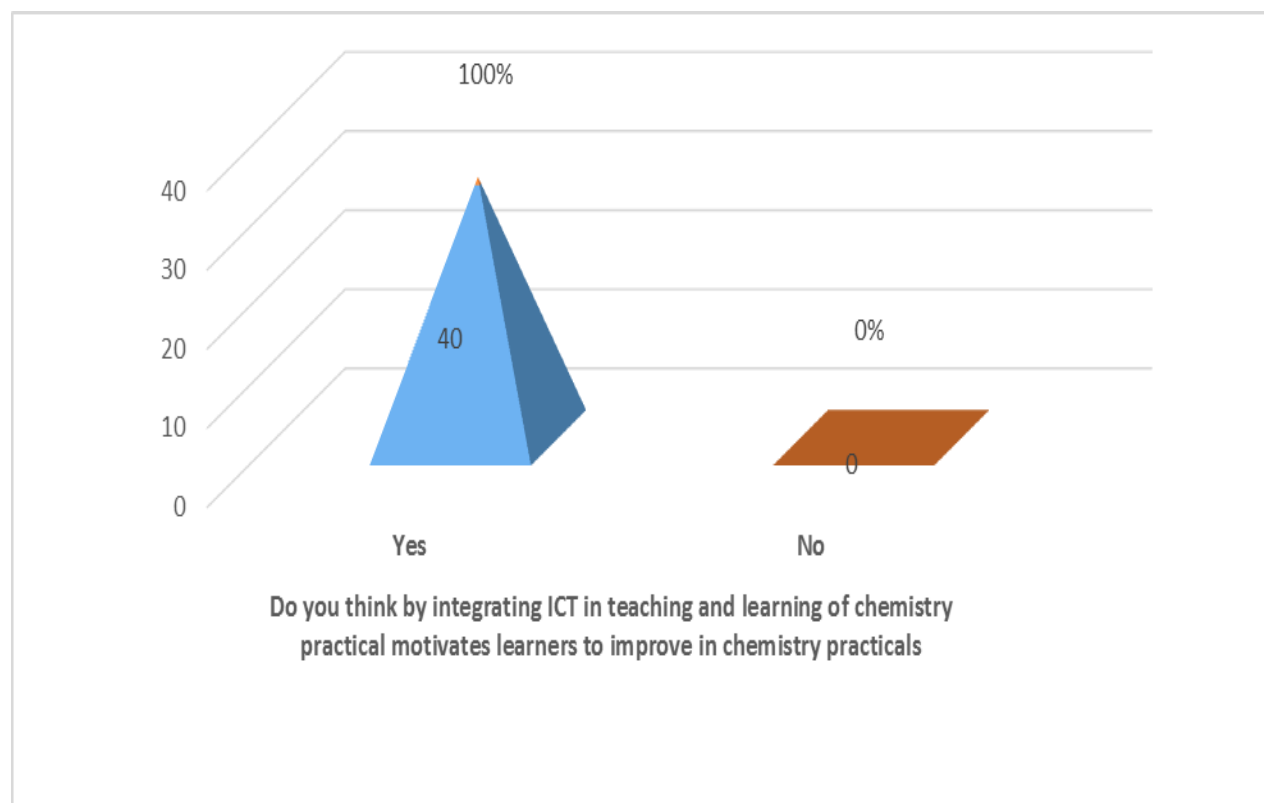
*Source: Field Data*

The table shows that majority of the respondents, 59.2% were male while 40.8% were female. The findings show that the rate of enrollment of the male students in the selected secondary school was higher than that of the female students. These findings are in agreement with Zimmerman (2004), that among the primary and secondary school going children, girls use computers 5 hours a week for play games whereas boys spend 13 hours a week for the same purpose. This then means that

the students like computer very much and can continue playing with it without ever getting bored. The study findings also indicated that the researcher ensured gender inclusivity when selecting students to participate in the study. The previous findings by scholars show that boys spend more time with computers enjoying playing online games this can be harnessed in education to create a very conducive environment for learning chemistry practical(Wasike,2013).

### **Perceptions of Teachers and Learners towards use of ICT Instructional Resources in Secondary Schools in Bungoma County.**

The second objective of the study was to establish the perceptions of teachers and learners towards integration of ICT instructional resources in secondary schools in Kenya. Teachers were asked to state their perception about how ICT integration motivates learners to improve in chemistry practical and the findings were as shown in the figure below.



**Source: field data**

The findings of figure 4.3 shows that 100% of the sampled teachers agreed that integration of ICT instructional resources in teaching and learning chemistry has improved the learners' motivation towards chemistry practical. Similarly, the teachers of chemistry agree (76%) and strongly agree (21%) that when ICT is frequently utilized, learning is simplified and it improves the mean in chemistry practical as shown in the table below.

### **Use of ICT in Chemistry Practical**

Statement	Count	Percentage (%)
When ICT is utilized frequently, learning is simplified and it improves the mean in chemistry practical	Strongly Agree	7 21%
	Agree	26 76%
	Disagree	0 0%
	Not Sure	1 3%
	<b>Total</b>	<b>34</b> <b>100%</b>

*Source: Field Data for Teachers*

The students were asked to state how they find interpretation of questions in chemistry practical examination while using ICT equipment and the findings were shown in the table below.

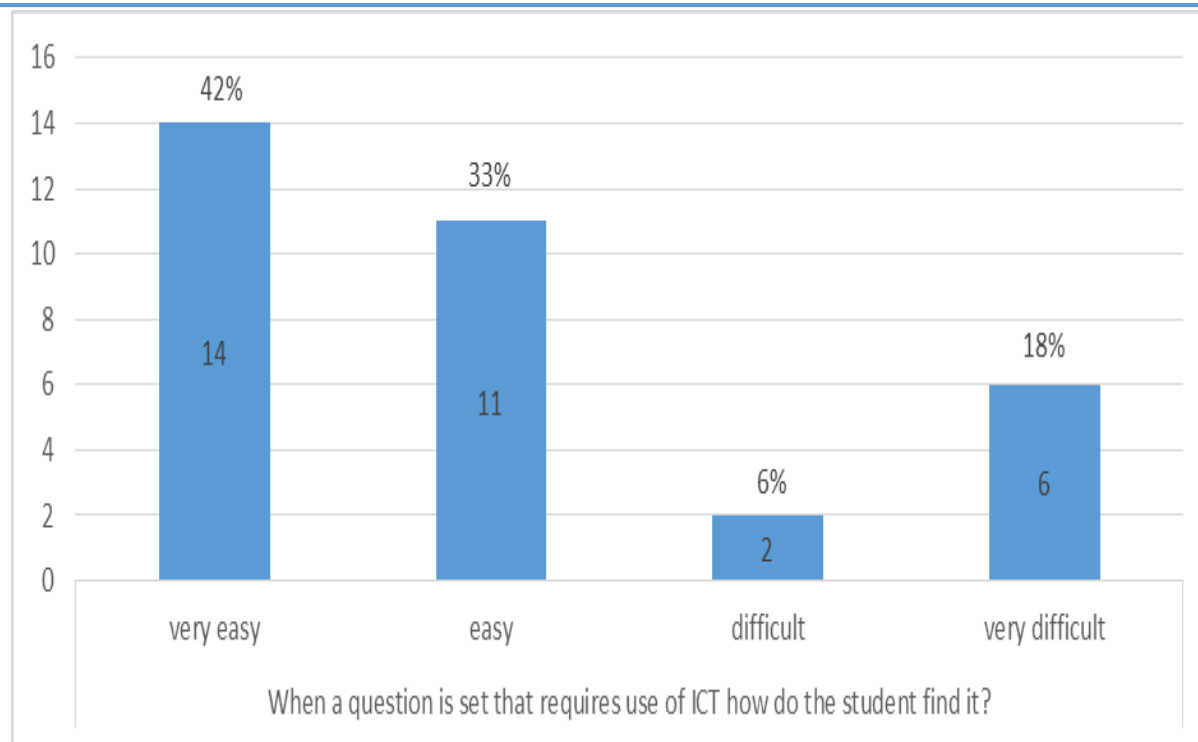
**Table 4.14: Interpretation of questions in Chemistry practical examination while using ICT equipment**

Statement	Count	Percentage (%)
How do you find the interpretation of questions in chemistry practical examination while using the ICT equipment	Very Easy	34 37%
	Easy	43 47%
	Difficult	10 11%
	Very Difficult	5 5%
	<b>Total</b>	<b>92</b> <b>100%</b>

*Source: Field Data for Students*

The results in table 4.14 above show that 47% and 37% of learners find it easy and very easy respectively interpreting questions in chemistry practical examination while using the ICT equipment. However, 11% and 5% find it difficult and very difficult interpreting questions in chemistry practical examination using ICT equipment. Besides, there seem to be inadequate equipment for learners with knowledge and skills in ICT despite embracing as indicted in the findings in figure 4.4 below.

**Figure 4.4: Learners' Perception towards ICT Integration in Chemistry Practical**

**Source: field data**

The findings in figure 4.4 above show that 42% of sampled teachers have learners who find it very easy to answer questions relating to ICT use and 33% find it easy too. This indicates that learners have embraced use of ICT in chemistry practical learning sessions. However, 18% find it very difficult to answer questions requiring use of ICT. This is supported by key informant's explanation which states that learners have embraced integration of ICT into the learning, however, they lack relevant knowledge and skills as indicated in the quote from the interview schedule below.

*... in my region, students have impressed the integration of ICT in learning especially in practical sessions. In fact they're happy about it. The most challenge they find is lack of adequate knowledge and skills in ICT. If the teachers can fill this gap, then I can assure you that ICT integration in teaching especially for Chemistry practical is a game changer in the education sector.*

Various scholars have supported this views, according to Zimmerman(2004), students like computers so much that they spend many hours on computers without getting bored. This makes use of computers in teaching and learning chemistry practical enjoyable and they willingly can perform tasks assigned by the teachers. Research has it that the manner in which the learning environment is organized is critically important because learners perceive a positive learning environment by what makes it easier for them to achieve. According to Wasike (2013), learners might not learn all that is taught in a single exposure to teaching using conventional methods of instruction. It therefore calls for the teachers of chemistry to vary their methods particularly using

ICT. Performance in chemistry practical is a very important concept because it opens the way for better grades in the chemistry examination at National level. A student who performs better in practical stands a good chance to pass well in the overall assessment. Perception of the learning environment by students is a precursor, which will inform the teachers about the readiness of students to learn. The teachers should therefore organize the environment in such a way that learning will be easier for learners who utilize ICT. Perception of ICT equipment by the teacher of chemistry should be that the chosen equipment will not complicate learning but make teaching and learning easier. According to Wekesa (2003), the orderly presentation of simulation and animation using ICT equipment during ICT lessons allowed the learners to interact with the contents of the lesson with minimal teacher participation that contributed to the learners' liking of the classroom activities

**Table 4.13 Responses of Teachers on How They Perceive Use of ICT in Teaching Chemistry Practical.**

STATEMENT	S.A	A	U	D	S.D	TOTAL
1. There are adequate computers for use by teachers and learners in my school	12 (35.2%)	8 (23.5%)	11 (32.4%)	2 (5.9%)	1 (2.9%)	34 100%
2. They are available every time the teacher requires them for use in every lesson of chemistry	7 (20.6%)	9 (26.5%)	13 (38.2%)	5 (14.7%)	0 (0%)	34 100%
3. Teachers and students are motivated to use ICT every time	9 (26.5%)	6 (17.6%)	17 (50%)	0 (0%)	1 (2.9%)	34 100%
4. ICT equipment for teaching chemistry is availed to learners during instruction	7 (20.5%)	11 (32.4%)	9 (26.5%)	4 (11.8%)	3 (8.9%)	34 100%
5. Learners interact mostly with ICT during chemistry practical	5 (14.7%)	7 (20.5%)	7 (20.5%)	10 (29.4%)	5 (14.7%)	34 100%
6. Virtual laboratory if available would provide better opportunities for teaching and learning of chemistry.	18 (52.9%)	6 (17.6%)	7 (20.5%)	1 (2.9%)	2 (5.9%)	34 100%

<b>7. Computers are adequate in school and students find them useful in learning of chemistry.</b>	10 (29.4%)	9 (26.5%)	11 (32.4%)	3 (8.8%)	1 (2.9%)	34 100%
<b>8. The use of virtual laboratory in teaching and learning of chemistry enhances learners' mastery of concepts</b>	16 (47.1%)	13 (38.2%)	3 (8.8%)	2 (5.9%)	0 (0%)	34 100%
<b>9. The use of virtual laboratory whether during teaching or examination would influence learners' engagement in classroom activities.</b>	17 (50%)	13 (38.2%)	4 (11.7%)	0 (0%)	0 (0%)	34 100%
<b>10. Students who frequently use ICT perform better in chemistry practical questions than those who do not</b>	19 (55.9%)	10 (29.4%)	1 (2.9%)	4 (11.7%)	0 (0%)	34 100%

The results from table 4.13 showed that 12(35.2%) respondents strongly agreed that there are adequate computers for use by the teachers of chemistry in schools, only 1(2.9%) strongly disagree that they were in use. Subsequently, the findings also indicated that 2(5.3%) were undecided that these computers were available every time the teachers and students required them for use in the lesson of chemistry in comparison to 9(26.5%) who agreed that they were available every time teachers and learners needed the for use in chemistry lesson. It could also be inferred from the findings that 6(17.6%) of the respondents agreed that teachers and students are motivated to integrate ICT in teaching and learning chemistry every time. From these findings, if 7(20.5%) strongly agreed that ICT equipment is availed to learners every time during instruction in chemistry, while 5(14.7%) strongly agreed learners mostly interact with ICT during chemistry experiments.

The findings of this study agree with (Amadalo et al., 2012) who found that achievement in chemistry practical subject depend on individual learner' involvement with the subject matter. The findings of this research show that performance is still below bar, yet the teachers hold the opinion that ICT instructional resources provides a better platform for carrying out experiments in chemistry practical to clarify the content and concepts(Lord & Orkwiszewski,2006; Marx et al 2004). The virtual titration sent to the teachers of chemistry to administer to learners. The findings of this study show that network dependent form of ICT motivates the teachers of chemistry to administer any chemistry practical because it probably takes a short period to prepare, administer and process the marks; unlike planning for practical lesson that involve purchasing the apparatus,

chemicals and laboratory fittings that take time and money. The teachers could easily administer the virtual titration as opposed to the real titration and students could easily press a button to reveal the steps involved and carry out the experiment without actual handling of chemicals and apparatus. However, teacher techniques play a significant role on students' learning and these influences on performance in chemistry practical examination. Group work allows learners to interact while utilizing ICT due shortage of ICT equipment and the teachers and learners could make comparison and grow conceptually (Chirac & Frykedal, 2011). The findings by Vim bah (2012) indicated that learners swallow whole concepts without cognitive digestion if lecture method is adopted by the teacher instead of hands on, minds on approach to learning improves performance in chemistry because they engender learning (Zan et al, 2011; Martin 2009; Mastropieri & Scruggs, 1999). Interactive learning means that students interact with the ICT resources and other learners to process the information needed to solve the problems.

## **SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

### **Summary of the Study**

Chapter one highlighted the background information of the study from the global perspective to the local perspective. This led to anchoring the statement of the problem and the purpose of the study. The objectives and research questions were articulated to bring about the significance of the study, limitations, scope, assumption, conceptual framework, theoretical framework. The objectives of the study was; To determine the types of ICT instructional resources integrated in teaching and learning of chemistry practical in secondary schools in Bungoma County.

Chapter two contains a review of the literature related to the study. The review was done in line with the research objectives.

Chapter three elaborates on the study methodology comprising of: the research design, study population, sampling techniques and sample size, data collection instruments which includes questionnaires for form three students, teachers of chemistry and ICT technicians and work sheet, data analysis procedure and ethical consideration of the research.

Chapter four detailed the findings from the analysis of data and how it is interpreted and discussed based on the objectives of the study. Both descriptive and inferential statistics were employed to summarize the information from the sampled schools.

### **Summary of the Findings**

The following is the summary of the significant findings of the study in tandem with the stated objectives.

### **The Perceptions of Teachers and Learners towards Integration of ICT Instructional Resources in Secondary Schools.**

The second objective was to establish the perceptions of teachers and learners towards use of ICT instructional resources in secondary schools in Bungoma County. It was found out that teachers and learners prefer to use computers because they provide very suitable platform to handle any



software in chemistry and access the same for use in classroom teaching and learning of chemistry practical. A large percentage of respondents were of the view that when computers were frequently integrated in teaching and learning of chemistry, students achieved better results on questions that required them to use Information Communication Technology instructional resources. It was noted that computers had the appropriate software with pertinent information that was useful for teaching and learning of chemistry practical. This perception is based on the availability of ICT equipment that can be harnessed by the teachers and educators to impart knowledge, skills and attitudes to students; it cannot substitute the teacher, but should be the tool in the hands of the teacher while discharging the duties. As such focus on a specific content area or a particular pedagogical strategy will enable teachers to take this new knowledge from the professional development and integrate it with their classroom practices. Teacher professional development in computer technology should not just focus on Information Communication Technology applications. Rather, must connect with a specific curriculum and subject area and with specific attention to the pedagogical practices associated with the subject area.

In the opinion of those who integrate them in the classroom instruction, the ICT instructional resources were ideal as they shorten the time taken to achieve the formulated instructional objectives, but the teachers and learners could not access them because of their high cost and other logistical issues.

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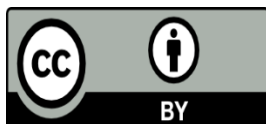
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