A COMPARATIVE STUDY OF THE INFLUENCE OF GUIDED DISCOVERY AND EXPOSITION-WITH-INTERACTION TEACHING METHODS ON LEARNERS' PERFORMANCE IN BIOLOGY IN SECONDARY SCHOOLS OF NYAKACH SUB-COUNTY, KENYA

BY

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DECLARATION

DECLARATION BY CANDIDATE

This thesis is my original work and has not been submitted to any other University for a degree

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DEDICATION

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ABSTRACT

The Kenyan Secondary School biology syllabus strongly recommends the guided discovery (GD) approach to teaching biology. However, in 2012 a survey of science and mathematics teachers in secondary schools revealed that most teachers still use exposition-with-interaction (EI) method, though research is silent on this claim in Nyakach Sub-county. In GD learners interact through adoption of process skills such as observation, hypothesis testing and experimentation while in EI, interaction is through questioning, thus the two methods are therefore expected to have similar results on learners' performance, but the Kenya Certificate of Secondary Education (KCSE) results vary countrywide. In Nyakach Sub-county, students have continued to attain poor results in biology in K.C.S.E examination with mean scores within the years 2011 and 2013 ranging from 3.73 to 4.85 out of the possible 12.00. The Kenya National Examination Council (KNEC) and Sessional paper No.1 2005 attribute poor performance to methods used in teaching biology. However, no empirical study has been done to document differences in GD and EI and their influence on learners' performance in biology. There was therefore a need to compare the influence of the two methods on learners' performance. The purpose of this study was to compare the influence of GD and EI teaching methods on secondary school learners' performance in biology in Nyakach sub-county. Objectives of the study were to: establish the frequency of use of GD and EI in teaching biology in Nyakach sub-county, establish the influence of GD on learners' performance, establish the influence of EI on learners' performance and compare GD and EI on the basis of learners' performance in biology. This study was guided by a conceptual framework showing use of GD and EI teaching methods on learners' performance in biology. The study adopted causal-comparative and descriptive survey research designs. Target population consisted of 120 biology teachers and 3225 Form 4 students of the year 2014 distributed in 47 schools. Using a stratified sampling technique, fifteen secondary schools, five from each of the three administrative units in the sub-county were randomly selected for the study. A sample of 343 students was determined by use of Fischer formula. Added to the above, 44 Form 4 biology teachers within the study schools were sampled purposively for the study. The sampled teachers were categorized as GD and EI based on the method of teaching they were using. Data was collected as follows: Questionnaire was issued to teachers to establish the frequency of use of GD and EI. Secondly, teachers were observed as they taught to verify results from the questionnaire. Data was also generated through document analysis guide on analysis of documents that were relevant, that is KCSE (2014) examination results in order to provide scores differentiating GD and EI teachers. Experts in the department of Education Communication, Technology and Curriculum Studies helped to determine face validity of the instruments. Piloting was done through test-retest technique and a Pearson product moment correlation coefficient (r) score of .75 was realized for the Questionnaire and .83 for Observation Schedule. Quantitative data was analyzed using frequency counts, means and percentages; and t-test at ($p<0.05$). Qualitative data was analyzed using themes, categories and patterns. Results indicated that percentage mean score of students taught using GD method (54.09%) was higher than that of EI method (37.34%) and the difference was significant,($t(341) = 19.704$; $p=.05$). Findings of this research reveal that GD enhances learners' performance than EI and should be used to teach biology. The study therefore may benefit teachers and policy makers to adopt better teaching method for improved performance of learners in biology.

TABLE OF CONTENTS

Content **Page**

LIST OF ABBREVIATIONS AND ACRONYMNS

APHRC	African Population and Health Research Center
CEMASTEA	Center for Mathematics and Science Technology Education in Africa
KICD	Kenya Institute of Curriculum Development
KNEC	Kenya National Examinations Council
SMASSE	Strengthening of Mathematics and Science in Secondary Education
TV	Television
DQUASO	District Quality Assurance and Standards Officer
EI	Exposition-with-interaction
GD	Guided discovery
IBT	Interview for Biology Teachers
MOEST	Ministry of Education Science, and Technology

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

APPENDICES

Appendix **Page**

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Science is an essential tool for any nation's progress and development (Chukwuneke, 2006; Akinbola, 2009; Agboghoroma, 2009). There is, however, poor performance in science globally (Valverde & Schmidt, 1997; Landry, 1998; Conboy, 2006). Research studies since 2000 made it clear that there is alarming crisis in relation to students' interest in science, either as possible future career, or as intrinsic interest that will continue after school (Fensham, 2008 p.20). The list of countries experiencing declining interest of students in science is on the increase particularly among the developed countries (Fensham, 2008). In the U.K in the late 1960s, publication of the Dainton report (Department of Education Science (DES), 1968) which examined the flow of candidates in science and technology into higher Education documented a swing from science in the school age population. In the U.S, according to the National Centre for Statistics (NCES), US eighth-graders continue to perform below the international average in science when compared to the 23 nations participating in the 1999 Third International Science and Mathematics study (TIMSS). This problem is even worse in developing countries. In Nigeria for instance, science is still seen as a difficult one and has generated phobia among learners (Akanmu, M, & Fajemidagha, M, 2013). In Kenya, form 4 students perform poorly in sciences than other subjects in the Kenya National Exanimation Council (KNEC report, 2015). A wealth of research reported that students blamed their poor performance on three broad areas: poor or ineffective teaching methods, negative attitudes of students towards the subject, and examination difficulty. According to research findings by Akanmu et al., (2013), the degree of blame on these areas as reported is given as teaching methods 67%, negative attitude 42% and examination difficulties 21%. This implies

that teaching methods largely contribute to low performance. This unhealthy development in the disposition of students towards science has sparked the search for and development of alternative methods of science teaching and learning which stimulates students interest and guaranteed educational system that offers equal opportunities for all. Arising from the view of science as a process for generating knowledge, major reform efforts were carried out in science education in the 1990s and culminated in the development of the National Science Education Standards (NSES, 1996) in the US. The content standards presented in the National Standards elaborate what students should understand and able to do in natural science, and the personal and social context that should be considered in the design of science curriculum. Trowbridge & Bybee (1996, p.113) stated that "these standards emphasize guided discovery oriented activities, connections between science and technology, the history and nature of science as students develop an understanding of fundamental ideas and abilities in science, and a vision of good science teaching model.'' The NSES, although recommended for the US educational system, are internationally practiced in science education. The NSES emphasize that the learning of science is an active process. Learning of science is something that students do, not something which is done for them. They further stated that doing science requires students to be involved in both physical and mental processes, collectively known as guided discovery. The guided discovery requires both hands-on and minds-on activities. Biology (a branch of science) syllabus recommends use of guided discovery method in most parts of the world (SMASSE, 2015). This was as a result of realization that the leading causes of students' poor performance in Biology are instructional methods used by the teachers (KNEC report 2015; Akanmu et al., 2013; Republic Of Kenya Sessional paper No.1 of 2005; Muturi, 2005). In Kenya for instance, secondary school biology syllabus recommends guided discovery (GD) method, however, research study at national level indicate that many teachers use exposition-

with-interaction method (Chirwa & Njuge, 2004; Muturi, 2005; CEMESTEA, 2012), though the frequency of use of GD and EI in Nyakach sub-county remains unknown.

Schunk (2008) defines guided discovery learning as a method whereby a student obtains knowledge by himself. It involves constructing and testing hypothesis rather than passively reading or listening to teacher presentations. Kirschner, Sweller and Clark (2012) state that guided discovery involves inductive reasoning because students move from specific topic to formulating rules and principles. Contrary to Discovery learning, students are not permitted to do anything they want, but rather are guided by teachers (Nwagbo, 2008). Akinyemi & Folashade (2010) explains that in GD the teacher provides illustrative materials for students to study on their own. Leading questions are then asked by the teacher to enable students think and provide conclusion through adoption of science processes. GD therefore is defined as an instructional method in which learners interact with instructional materials through adoption of science process skills such as observation, hypothesis testing and experimentation to discover answers (practically oriented).

Moore (2008) states that exposition-with-interaction is an instructional method in which teachers' present information in some form and follow it up with questions and answers session at periodic intervals. In effect, questions are used to summarize the content of the lesson and to help the students consolidate and organize the information presented. According to Ibe (2013), EI is teacher-centered, student peripheral teaching approach in which the teacher delivers a pre-planned lesson to the student, with or without the use of instructional materials. Iheonu (2005) indicates that in this approach, the teacher talk about science while students read about science. Wabuke et al., (2013) posit that exposition-with-interaction method is characterized by deficiencies in

practical skills. EI therefore is an instructional method whereby teachers interact with students through questioning to confirm whether the presented information is understood (theoretically oriented). EI is thus characterized by making statements on facts and principles, questioning on facts and principles and note taking.

GD and EI involve interaction. In GD learners interact through manipulation of instructional materials to discover answers while in EI interaction is through questioning to confirm whether the presented information is understood. In GD interaction comes first; in EI it comes second. Guided discovery teaching method therefore involve working with concrete materials whereby the students are given materials or data, and the teacher guides learners to manipulate these materials so as to seek patterns or draw conclusions. Because this comes first in the sequence, it is an inductive activity. Secondly, concept introduction, whereby clarifying and exploratory concepts are introduced and links to the students work from the first phase. Finally, generalizations in which further tasks are posed which ask the learner to extend, generate and test the newly gained knowledge. In the Exposition-with-interaction method, first phase begin by concept introduction, whereby a general framework of clarifying, and exploratory concepts is introduced to guide the learners in absorption of presented material. Second phase involve working with concrete materials, whereby questions are posed to test whether learners have absorbed the presented material. Because this follows the concept of introduction phase, it takes on the characteristics of a deductive or application activity. Thirdly, generalizations, whereby further tasks are posed which ask the learner to extend, generate and test the newly gained knowledge. A question therefore arises as to whether the two methods produce similar results or not on learners' performance.

Many Scholars however, hold different opinion as to whether GD and EI are similar or not. According to Kolb (1984), knowledge is constantly extracted and tested from a learning individual's experience**.** Several scholars (Liang & Gabel, 2005; Akinyemi & Folashade, 2010, Braund et. al., 2013) hold the notion that pupil learning is more meaningful, more thorough, and therefore usable when pupils seek out and discover knowledge. Chickening and Graham (1983) state that: "learning is not a spectator sport. Students do not learn much just by sitting in class listening to teachers memorizing prepackaged assignments and spitting out answers". Surface rather than deep learning is the resulting impact of exposition-with-interaction teaching method (Race & Walker, 2003; Fry et al., 2003, Mayor, 2004). However, according to Kirschner et al., (2012), decades of research clearly demonstrate that for novices (comprising virtually all students) direct explicit instruction is more effective and more efficient than merely attempting to discover knowledge. Cognitive activity can happen with or without behavioral activity, therefore withholding information from students does not facilitate the construction of knowledge (Kirschner et. al., 2012). Maheshwari (2015) hold that students can learn new concepts and ideas better if all of the information they need to know is laid bare before them. A met analysis conducted by Kirschner, Sweller and Clark (2012) examined guided instructional approaches and found, based upon knowledge of human cognitive structure, guided discovery is ineffective. They believed that guided discovery appears to proceed without reference to the characteristics of working memory, long term memory, or the intricate relations between them (p.75). These disagreements therefore cast doubt as to whether the two methods produce similar results.

Effective methodology of teaching science through "hands-on-activities" creativity and improvisation are emphasized by SMASSE/ CEMESTEA, but still it was viewed that better performance in these subject could be achieved using exposition-with-interaction method other

than learner centered methods since performance seemed to be declining (Chepkwony, 2014). This implies that even though guided discovery is recommended for teaching biology, it is not yet clear whether the method is more effective in teaching biology hence the need to establish its influence on performance.

While innovative methods such as GD have gained increasing popularity worldwide, the reaction of educational researchers has been contentious. Klar and Nigram (2004), not only tested whether science learners learned more via discovery versus direct instruction but also, once learning has occurred whether the quality of learning differed. The study adopted randomized experimental design. Teachers were trained for one week on the use of either discovery or direct instruction. The findings were unambiguous. Direct instruction resulted in vast more learning than discovery. Braund and Bennet (2013) compared student attainment on context based, concept approaches and mixed approaches to teaching A-level Biology using ex post facto design. Efforts were made to categorize the 355 centers on the basis of teaching approach for the 2008-2010 cohorts of students. Centers were contacted by Email and asked which of these three approaches was predominantly used. No statistically significant difference was found between students performance in terms of mean marks sat at GCE A-level. These findings were disputed by Akiyemi and Folashade (2010) and Ibe (2013), who adopted experimental design. These researchers inducted teachers on the use of discovery or exposition method. They concluded from their research that discovery approach was more superior to expository approach. In reviewing the GD/ EI debate, and the inability of researchers to reach similar conclusions after reviewing the same studies, some problematic areas emerge. First, most studies adopted experimental-control design where teachers were inducted on the instructional methods under study (Folshade 2010, Ibe 2013, Ajaja 2013, Maheshwari, 2015).

Secondly, few studies contacted participants through questionnaire (Braund & Bennet, 2010) to find out the teaching method they commonly use. However, no empirical study has been done to document differences in GD and EI and their influence on learners' performance in biology. There was therefore a need to compare the influence of the two methods on learners' performance in Nyakach sub-county.

Nevertheless, the performance in biology at Secondary School level in Kenya has been generally low, albeit inconsistent improvements. This, of course, occurs against a background of perennially dismal performance in mathematics and Science subjects in general. Table 1 shows the KCSE biology mean scores for the years 2006 to 2013.

Table 1: Kenya National Biology percentage mean scores in KCSE examinations

Year	National percentage mean score

2005	29.63
2006	27.45
2007	41.95
2008	30.32
2009	27.43
2011	32.44
2012	26.21
2013	32.32

Source: Kenya National Examination Council (KNEC) Examination Reports (2014).

With a mean score of 32.32 percent in 2013, biology was among the five (5) lowest performed of the 32 subjects offered in the secondary school curriculum. This low performance has been attributed to a number of factors, including inadequate resources and, more importantly, ineffective teaching methods used in teaching biology (Muturi, 2005; Republic Of Kenya Sessional paper No.1 of 2005; Akanmu et al., 2013; Kenya National Examination council (KNEC) report 2015).

Nyakach is among the sub-counties that perform poorly in biology, for instance in Kisumu county, Nyakach sub-county has the least mean scores for the last three consecutive years as revealed in Table 2.

Table 2. KCSE mean grade score in biology in Kisumu County

	K.C.S.E mean grade score in biology
Sub-county	**Year**

	2013	2012	2011
Muhoroni	5.6860	5.3895	6.1859
Nyando	4.7900	4.4276	5.3743
Kisumu west	4.3530	4.1510	4.9220
Kisumu east	4.4724	4.2650	5.1342
Kisumu central	5.8680	5.5789	6.4216
Nyakach	4.2850	3.7330	4.8500

Source: Kisumu County Educational Statistics, 2014

From Table 2, the performance in Biology at KCSE examination within Nyakach sub-county is poor compared to other sub-counties within Kisumu County. For instance in 2011-2013, Nyakach had a mean score of 4.8500, 3.7330 and 4.2850 respectively while that of Kisumu central (the best performing sub-county in Kisumu county) was 5.8680, 5.5789 and 6.4216 out of the possible 12 points. The poor performance is suspected to be as a result of the method used in teaching biology

(Muturi, 2005; Republic Of Kenya Sessional paper No.1 of 2005; Akanmu et al., 2013; Kenya National Examination council (KNEC) report 2015). Various scholars (Alexander & Hogan, 2002, Klar & Nigram, 2004; Braund & Bennet, 2013) state that GD does not yield better education outcomes. However, Akiyemi and Folashade (2010), and Ibe (2013) concluded from their research that discovery approach was more superior to expository approach. Though there is no accessible research study that has documented empirical differences in GD and EI as observed in the classroom and their influence on learners' performance in biology in Nyakach sub-county. It is on this premise that the purpose of this study was to compare the influence of GD and EI methods on learners' performance in biology in Nyakach sub-county.

1.2 Statement of the Problem

The government of Kenya through the ministry of education curriculum developers at the KICD recommends GD method of teaching biology at the expense of EI in secondary schools yet both involve pupil-teacher interaction. Reports at national level also indicate that most teachers in the field generally use EI. For example, situation analysis carried out by CEMASTEA staff in the year 2012, found out that most teaching was teacher-centered. In Kenya, performance in biology is poor; Nyakach sub-county for instance, has posted poor performance in biology for three consecutive years ranging from 3.73 to 4.85 out of the possible 12. Poor performance in Nyakach sub-county is suspected by KNEC report (2015) to be as a result of the method used in teaching biology. There is therefore a need to establish the influence of GD and EI on learners' performance so as to improve the quality of teaching. This study therefore intended to compare influence of GD and EI on learners' performance so as to sensitize teachers to adopt a better method of teaching biology between the two.

1.3 Purpose of the Study

The purpose of the study was to compare the influence of GD and EI teaching methods on secondary school learners' performance in biology in Nyakach sub-county.

1.3.1 Objectives of the Study

Objectives of this study were to:

1. Establish the frequency of use of GD and EI in teaching biology in Nyakach sub-county
2. Establish the influence of GD on learners' performance in biology
3. Establish the influence of EI on learners' performance in biology
4. Compare GD and EI on the basis of learners' performance in biology

1.3.2 Research Questions

1. What is the frequency of use of GD and EI in teaching biology in Nyakach Sub-county?
2. What is the influence of GD on learners' performance in biology?
3. What is the influence of EI on learners' performance in biology?
4. How do GD and EI compare on the basis of learners' performance in biology?

1.4 Assumptions of the Study

The study was based on the assumption that:

i. GD teaching method was being used by some teachers in teaching biology in public Secondary schools

ii. EI teaching method was being used by some teachers in teaching biology in public Secondary schools

iii. Use of GD and EI teaching methods influenced students' performance.

1.5 Scope of the study

This research compared the influence of GD and EI teaching methods on learners' performance in biology at KCSE examination in Nyakach sub-county. Form 4 students and their respective teachers of biology participated in the study for they had covered most of the secondary school biology syllabus and were in a better position to be assessed based on the use of GD and EI on learners' performance in biology. The findings focused on the K.C.S.E biology examination only. KCSE examination results are considered to be reliable because it is standardized.

1.6 Limitation of the study

The study confined itself to comparing the influence of GD and EI on learners' performance in KCSE biology examination in selected secondary schools in Nyakach sub-county, Kisumu County. The results were, therefore, interpreted only in this context of the study. The study was limited to a small sample of schools that were selected and Form four Biology students and Biology teachers participated. However, the sample cannot adequately represent the entire community in Kenya since variations are expected between various parts of the country in terms of resources, exposure and culture. Although considerable attempts were made to minimize variations such as facilities provided by the schools and teachers, it was difficult to perfectly match students with respect to past experiences such as primary education, income and socio cultural backgrounds.

1.7 Significance of the study

The study is significant because the findings may assist teachers and policy makers to adopt the better method of teaching biology between GD and EI so as to improve performance in the subject. The study results may also open an avenue for further research in this field so as to fill in the gaps which may be exposed in this study.

1.8 Conceptual framework

The study was based on a conceptual framework showing influence of GD and EI methods of teaching on learners' performance in biology at KCSE examination. Independent variables were GD and EI. The dependent variable was learners' performance in biology at KCSE examination.

GD is defined as an instructional method in which learners interact with instructional materials through adoption of science process skills such as observation, hypothesis testing and experimentation to discover answers (practically oriented). In Kenya, Sessional Paper No.1 of 2005 and KICD syllabus encourage science teachers to use GD. EI is an instructional method whereby teachers interact with students through questioning to confirm whether the presented information is understood (theoretically oriented). EI is thus characterized by making statements on facts and principles, questioning on facts and principles and note taking.

This study is grounded on Piaget's theory of cognitive functioning development and realist development of Education. The realists are of the view that the world we perceive is not the world that we have recreated mentally but the world as it is (Kneller 1972). This epistemology stance suggests that the selection of the learning task for the student should be the responsibility of the school. The initiative in education therefore lies with the teacher, not the student who must decide what subject matter can be made to satisfy the student personal needs and interest (Kneller, 1972). The major principle in Piaget's cognitive theory is that learning is attained through 'construction'

(Piaget, 1970). This theory suggests that human knowledge is innate and that human knowledge is directly shaped by experience. This theory sees learning as occurring based on the interaction between what the learner already knows and the physical environment. The basic principle of this theory which is the basic knowledge through interaction between the learner and the environment perfectly agrees with the fundamental structures of guided discovery teaching method. The study of biology aims at equipping the learner with knowledge, attitude and skills necessary for controlling and preserving environment (Republic Of Kenya, 2005). This subject is important in fields such as health, Agriculture, environment and education. Biology is the precursor of biotechnology which is a tool for industrial and technological development.

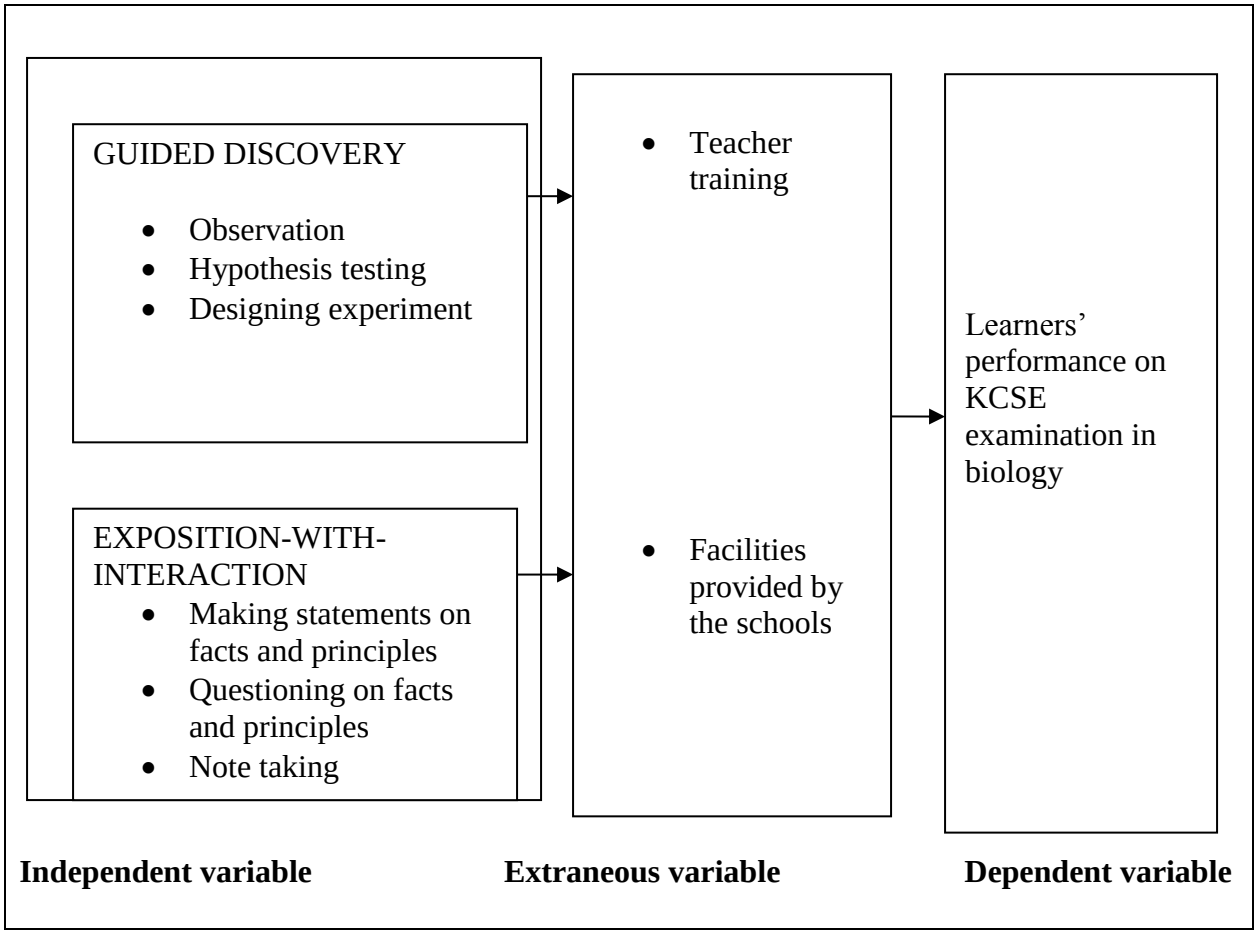

Figure 1*:* Conceptual Framework showing influence of GD and EI on learners' performance in biology.

Source: Researcher

Listed below were suggested control for extraneous variables; Resources such as school laboratory and availability of learning materials were likely to influence learners' performance. Simple random sampling technique was used to select schools to ensure that each comparison group has the same group category proportions. Teacher instructor ability was likely to affect learners' performance. Therefore only diploma or degree holder trained teachers who had attended SMASSE were purposively selected from the sample.

1.9: Definition of Terms

Category- Teaching method behavior between GD and EI that is observed in the classroom based on adopted version of Eggleston et al (1976).

Exposition-with-interaction -an instructional method characterized by making statements on facts and principles, questioning on facts and principles and note taking.

Guided discovery –an instructional method characterized by adoption of process skills such as hypothesis testing, designing experiment and problem solving.

Influence – refers to the relationship between method of teaching and students academic performance

Knowledge- being able to define a concept

KCSE examination- Questions set to asses Form 4 students at the end of their four years in secondary education nationwide as a qualification to various opportunities such as tertiary education.

Performance- A score attained by a pupil in a KCSE examination

Student- refer to a learner in an educational institution who is either male or female

Skills –being able to perform practical learning tasks such as drawing, hypothesis testing, problem solving and designing experiment.

Understanding – Attained scores above average on questions testing skills and knowledge of biological concepts.

CHAPTER TWO

LITERATURE REVIEW

2.1 lntroduction

In this chapter, related literatures were reviewed on the influence of GD and EI methods on learners' performance in biology. They were reviewed under the following sub-headings: frequency of use of GD and EI in teaching biology, influence of GD on learners performance in biology, influence of EI on learners performance in biology and comparing influence of GD and EI teaching methods based on learners' performance in biology

2.2 Frequency of use of GD and EI in Teaching Biology

The Kenya Institute of Curriculum Development (KICD) presents the biology syllabus with its philosophy as a practical subject where scientific concepts, principles and skills are developed through experimental investigation. Various studies have been conducted to find out the frequency of use of recommended instructional methods.

Yandila (2001) carried out a study to find out the extent to which senior secondary school teachers were employing the recommended teaching methods and approaches in teaching Pure, Double and Single Sciences. The study involved classroom observation using checklist, whose content was based on the prescribed teaching methods. The Class Observation checklist consisted of a fixed

number of competencies listed in the new Science Syllabi. It was developed by drawing information from various sources, including the instrument used for assessing student teachers at the University of Botswana, in colleges of Education in Botswana and literature. Twenty seven competencies were identified and placed in the major categories of Administrative, general professional competencies related to the teacher appearance, attitudes towards students, school authorities and response to students complaints about his or her treatment of them. It consisted of three-sub categories. Teaching competencies consisted of 17 sub-categories covering a wide range of classroom activities that the teacher and students might undertake.

The results of this study suggested that most Science teachers were not following the recommended teaching methods and teaching approaches and the majority of the lessons did not encourage a learner centered approaches as emphasized in the Curriculum Blue print (1997). Teachers dominated in class activities with the student participation, except in question and answer discourse and during demonstration. A variety of teaching methods including, but not limited to inquiry, demonstrations, or practical work, were not being used on a regular basis and students were not exposed to practical applications of Science in everyday life.

This study was indicant of the fact that most Science teachers did not encourage a learner-centered approach. In light of all the results presented above, it was necessary to investigate how Biology is being taught in the classroom. This required recording of classroom observation using classroom Observation Schedule, an adopted version of Eggleston et al. (1976) that could be analyzed thoroughly. Also the study simply observed teaching approaches being effected in the classroom when teaching, the current study established the more frequently used method between GD and EI in teaching biology.

A research carried out by African population and Health Research center (APHRC) in the standard press (Sept 1, 2010), during a study to assess the quality of teaching and learning in primary schools, found out that the dominant teaching methods in top schools were individual and recitation teaching methods. Individual work involves a teacher checking each pupils work as they do assignments, while in recitation, the teacher engages learners in discussions, appropriately correcting them where they go wrong (practically oriented). Conversely, in bottom schools, the dominant teaching methods were whole class and individual work. Whole class involves the teacher doing a sum on the board as students follow and during individual work a teacher gives an assignment leaving the learners to do it on their own (theoretical). The research is relevant to the current study since it has established the common teaching methods in primary schools. It is however evident that the research was done at primary level. It was therefore necessary to establish the more frequently used teaching method between GD (practically oriented) and EI (theoretically oriented) in Secondary Schools in Nyakach sub-county.

After the introduction of modularization at universities and an outcomes-based education at schools in South Africa based on science teacher educators to change their teaching styles from a teacher-centered approach to learner-centered approach, Sathiaseelan (2008) conducted a research to establish the extent to which science-teacher educators responded to this policy change. Eleven science teacher educators (lecturers) at 3 universities in a province in S. Africa participated in the study. An interview schedule and an observation schedule were used as a research instrument for the cross-case study with each science teacher being used as a case in the study. Science teacher educators were observed teaching science education topics in preparation of student science

teachers for teaching the natural sciences learning Area from Grades Four to Nine. The Observation-schedule was structured to determine the extent to which science teachers integrated aspects of the curriculum change process related to learner-centeredness into their lecture programs. Another purpose of the observations of their teaching was to seek consistency in terms of claims made by science educators during interviews. An analysis of the observations showed that some science teacher educators had made appropriate changes for learner-centeredness through role modeling process while others continued in a traditional teacher-centered approach.

The findings of Sathiaseelan (2008) is a confirmation that despite policy changes on curriculum in favor of learner-centered approach, some teachers still use teacher-centered approach. However the study was conducted among university lecturers and the sample was small to represent the whole country. The current study targeted secondary school biology teachers with a representative sample of all secondary schools in the sub-county.

The studies identified common methods used in teaching biology. A variety of teaching methods including but not limited to inquiry, demonstrations or practical were not being used on a regular basis (Yaandila, 2008). The common teaching methods in primary top schools was individual and recitation methods while in bottom schools was whole class and individual work (APHRC, 2010), some science teachers educators still use teacher-centered approach despite policy change of curriculum in favor of learner-centered approach (Saathiaseelan, 2008). These studies therefore confirm that despite learner-centered approach being encouraged worldwide, most teachers still use teacher-centered approach. In Kenya, even though GD is recommended (Republic of Kenya, 2005), EI is commonly used in teaching Biology (CEMESTEA, 2012 ;), though research is silent

on this claim at sub-county level, especially in Nyakach, thus occasioning the need to establish the frequency of use of GD and EI in the sub-county.

2.3 Influence of GD on learners performance in biology

Guided discovery learning is when a student obtains knowledge by himself. It involves constructing and testing hypothesis rather than passively reading or listening to teacher presentations (Schunk, 2008). GD involves inductive reasoning because students move from specific topic to formulating rules and principles (Kirschner, Sweller, & Clark, 2012). Contrary to Discovery learning, students are not permitted to do anything they want, but rather are guided by teachers. Instructors will typically arrange activities, and then allow students to work with the materials provided to figure out concepts. They will also present questions or problems to encourage learners to make intuitive guesses (Schunk, 2008). Nwagbo (2008, as cited in Akinyemi & Folashade, 2010) explains that in GD the teacher provides illustrative materials for students to study on their own. Leading questions are then asked by the teacher to enable students think and provide conclusion through adoption of science processes. In summary, the guided discovery teaching method involve working with concrete materials whereby the students are given materials or data, and the teacher guides learners to manipulate these materials so as to seek patterns or draw conclusions. Because this comes first in the sequence, it is an inductive activity. Secondly, concept introduction, whereby clarifying and exploratory concepts are introduced and links to the students work from the first phase. Finally, generalizations in which further tasks are posed which ask the learner to extend, generate and test the newly gained knowledge. In this study, GD is defined as an instructional method predominated by adoption of process skills such as observation, hypothesis testing and experimentation (practically oriented).

Guided discovery is rooted in the cognitive and socio-cultural constructivism which involves individuals actively constructs their own reality in an effort to make sense of their experience (Prince, & Fielder, 2006). There are two main assumptions which underlie this type of instructional program. The first is that it challenges students to solve authentic problems in information rich settings. This assumption is based on the idea that encouraging a learner to construct his own solution leads to the most effective learning experience. The second assumption is that knowledge can best be acquired through experience (Kirschner, Sweller, & Clark, 2006). GD is therefore thought to increase the ability of students to transfer information they construct to other areas, as it allows students to independently explore broader issues (Klar & Nigram, 2004). Various findings across 138 analyzed studies indicate a clear, positive trend favoring discovery based instructional practices, particularly instructions that emphasizes student active thinking and drawing conclusions from data (Minner, Levy & Century, 2010, p.474). These authors conclude that "teaching strategies that actively engage students in the learning process through scientific investigations are more likely to increase intellectual understanding than are strategies that rely on more passive techniques." However, no study has documented GD instructional teaching method as observed in the classroom and their influence on learners' performance in Nyakach sub-county.

Many scholars (Liang & Gabel, 2005; Akinyemi & Folashade, 2010) hold the notion that pupil learning is more meaningful, more thorough, and therefore usable when pupils seek out and discover knowledge. Chickening and Graham (1983) state that: "learning is not a spectator sport. Students do not learn much just by sitting in class listening to teachers memorizing prepackaged assignments and spitting out answers". Ibe (2013) concur that use of GD method results in comprehension of concepts in learners. According to Kolb (1984), knowledge is constantly

extracted and tested from a learning individual's experience. If the learner is allowed to discover relationships and methods of solutions, make generalizations and draw conclusions from them, the learner may then be prepared to make wide applications of the material learned (Akinyemi & Folashade, 2010; Braund et. al., 2013;). De jong and Joolingen (1998) have however, stated that learners may encounter difficulties in four categories; when using guided discovery methodology; difficulty in generating and adopting hypotheses, poorly designed experiments, difficulty in data interpretations, and problems regarding the regulation of guided discovery learning (as cited in Reid, Zhang, & Chen, 2003). Bennet (2003) reported that questions were asked about the appropriateness of asking pupils to "discover" things for themselves when both learners and pupils knew that the answers were already there in the form of currently accepted theories. There was also a question over the nature of the understanding pupils develop when left to their own devices and to what extent pupils "discover" the scientifically accepted explanations of the phenomenon they experience. The current study therefore sought to establish the influence of GD on learners' performance in biology in Nyakach sub-county.

One of the goals of instruction is to give learners specific guidance about how to manipulate information in ways that are consistent with a goal, and enable the students to store knowledge in long term memory. Guided discovery learning does not serve that purpose. Results of studies conducted on a novice and expert chess players in 1972 by Chase and Simon (as cited in Kirschner, Sweller & Clark, 2012) demonstrate that expert problem solvers derive their skills by drawing on the experiences they have stored in their long term memory and select and apply the best procedures when it comes to solving problems. It is our long term memory that allows us to assess the characteristics of a situation and generates a procedure to handle it effectively. Because of this,

instruction must alter long term memory. Methods of effective instruction must also be sensitive to the limits imposed on the working memory, and how those limits disappear when working with familiar information. A great deal of guided discovery learning ignore the units of working memory, as problem based searching makes heavy demands on it. This form of instruction also does not enable information to get stored in long term memory, because while working memory is being used to search for solutions, it is not available to be used to learn and store. These findings were concluded from expert chess players but not from biology lessons as intended by this study.

Guided discovery learning, may even hinder students learning. Brown and Campione (as cited in Kirschner, Sweller, & Clark, 2012), demonstrated that when students learn in guided discovery science classrooms they often become lost and frustrated. Another problem inherent in guided discovery based method of teaching is the failure to distinguish between learning as a discipline and practicing a discipline. The idea is that the methods and behaviors of expert in a profession are entirely different from those of students new to a field. Students first need to learn and understand the basic skills and facts before taking on more complex roles. Kirschner, Sweller, and Clark (2012) strengthen the idea that when learners are presented with novel information, they should be explicitly instructed on what to do and how to do it. A research was conducted by Chepkonga (2014) on the extent to which the SMASSE project had achieved its purpose based on the purpose-output relationship. The purpose had been improving quality of Mathematics and science education in secondary school. But still it was viewed that, better performance in these subjects could be achieved by using exposition-with-interaction other than teaching for understanding since it seemed to be declining. This implies that even though guided discovery is

recommended for teaching biology, it is not yet clear whether the method is more effective in teaching biology hence the need for this study.

2.4 Influence of EI on learners performance in biology

Exposition-with-interaction (EI) is a model for teaching that "----- emphasizes well-developed and carefully planned lessons designed around small learning increments and clearly defined and prescribed teaching tasks" (National Institute, 2007). EI is rooted in positivist view of objective reality, which emphasize that the role of the teacher is to transmit knowledge to the students. According to Rosenshine (2013), there are six functions of each exposition-with-interaction lesson, which are: review, presentation, guided practice, corrections and feedback, independent practice and weekly and monthly reviews. The teacher models the behavior, provides practice and feedback, and assess whether or not the skill needs to be retaught (Ryder, Burton, & Silberg, 2006). It is not a lecture approach, but rather an instructional model that focuses on the interaction between teachers and students. The fundamental principle that connects the components of EI is that ……. learners are actively engaged in the relevant curriculum in order to build knowledge, skills, and dispositions related to goals and objectives of the lesson (Magliaro, Lockee & Burton, 2005, p.44). In EI teachers' present information in some form and follows it up with questions and answers session at periodic intervals (Moore, 2008). In effect, questions are used to summarize the content of the lesson and to help the students consolidate and organize the information presented. In summary, In the Exposition-with-interaction method, first phase begin by concept introduction, whereby a general framework of clarifying, and exploratory concepts is introduced to guide the learners in absorption of presented material. Second phase involve working with concrete materials, whereby questions are asked to test whether learners have absorbed the presented

material. Because this follows the concept of introduction phase, it takes on the characteristics of a deductive or application activity. Thirdly, generalizations, whereby further tasks are posed which ask the learner to extend, generate and test the newly gained knowledge. Thus, EI is an instructional method whereby teachers question students to confirm whether the information presented is understood (theoretically oriented), and as such, it is predominated by making statements, questioning on facts and principles; and note taking. Therefore, EI is characterized by deficiencies in practical skills (Wabuke et al., 2013).

A major benefit of exposition-with-interaction teaching method is that it provides a means of efficiently communicating large amount of information in a short period of time, however, there is relatively little student activity and involvement (Ajaja, 2009, Bennet, 2003, Berich, 2004). The idea behind this methodology is that EI eliminate misconceptions which occur during the learning process, and allows for accelerated and more efficient learning. According to Kirschner et al., (2012), decades of research clearly demonstrate that for novices (comprising virtually all students), direct explicit instruction is more effective and more efficient than merely attempting to discover knowledge by themselves. Cognitive activity can happen with or without behavioral activity, therefore withholding information from students does not facilitate the construction of knowledge (Kirschner et al., 2012). Maheshwari (2013) posit that often times when students are discovering information on their own, they can get distracted and confused by unnecessary information and have difficulty determining what is important. Some of the educators believe that students can learn new concepts and ideas better if all of the information they need to know is laid bare before them ((Magliaro, Lockee, and Burton, 2005). According to Mayer (2004), EI involves questioning, and when students answer questions and receive feedback, they process materials

more deeply and store material in a more retrievable form. This implies that when answering questions, students are able to gauge their level of understanding so that they can allocate their cognitive processing to aspects of the lesson they do not understand. Ausubel believes that the reason for lack of research in expository-with-interaction teaching is that EI teaching has been identified with rote learning. EI, however present a rich body of highly related facts and principles which the student can learn and transfer (Maheshwari, 2013). Ausubel further provides a clear picture of the expository-with-interaction teaching merits "The arts and Science of presenting ideas and information meaningfully and effectively- so that clear, stable and unambiguous meanings emerge and are retained over a long period of time as an organized body of knowledge- is really the principle function of pedagogy. This is demanding and creative rather than the rote listing of facts (Maheshwari, 2013). This therefore implies that students taught using EI method are likely to improve learners' performance hence the need to establish influence of EI on learners' performance in biology.

There are however, some cynical views of EI method. The exposition-with-interaction method fails to provide Psychological safety, sensitivity to problems and flexibility in reasoning. Moreover, it focuses more on transmitting knowledge to the learner at the expense of developing process skills, and encourages conformity to conventional knowledge thereby curtailing intellectual freedom of students (SMASSE project, 1998, Ochangi, 1999). Race (2000) also states that surface rather than deep learning is the resulting impact of exposition-with-interaction teaching method (Race &Walker, 2003; Fry et al., 2003). As Williams (2002) notes, a significant criticism of exposition-with-interaction method is the "passive role often adopted by students, with them sitting and taking copious notes, sometimes verbatim" (p.4). This reinforces the idea that

students can be taught all they need to know (Race, 2000, Ramsdem, 2003, Williams, 2002), and equates with the concept of "pouring new ideas into an empty brain" (Moodhefer & Roe, 2010, p.65). In this particular context it is questionable 'how effective a learning strategy, the exposition-with-interaction is, when it is well-established that students respond best to teaching that relates to their own pace of learning, and within their own context and experience (Williams, 2002, p.4). William suggests that:

'The learning taking place, however using this (exposition-with-interaction) teaching method is questionable; at its best, it can motivate learners and help them to make sense of a variety of competing views, but at its worst it can support the ethos of learners as a passive empty vessel' (p.4).

These controversies therefore cast doubt as to whether EI has high influence or not on learners' performance, hence the need for more research on the influence of EI on learners' performance as intended in this study.

A study by Stella (2010) found that the traditional or teacher-centered methods of teaching resulted in learner not enjoying lessons and missing the benefits of discovering on their own. In the long run pupils were left with no choice but remained passive during the teaching and learning process. Other than using interview schedule and questionnaire to gather information on teaching styles as done by the above mentioned researcher, the current study incorporated a lesson observation schedule which gave a detailed analysis of the teaching strategies used in Biology classrooms.

2.5 Comparing influence of GD and EI teaching methods on learners' performance in biology

GD and EI involve interaction. In GD learners interact through manipulation of instructional materials to discover answers while in EI interaction is through questioning to confirm whether the presented information is understood. The two approaches therefore seem to be in underlying agreement that fruitful interaction enhances learning, but differ as to the order in which organization is injected in the learning sequence. In GD format interaction comes first; in EI format, it comes second. This comparison can be seen most clearly by viewing the two formats as variations in a three-stage process. Cast in neutral terms appropriate to either approach, these are: The Guided discovery teaching method involves working with concrete materials whereby the students are given materials or data, and the teacher guides learners to manipulate these materials so as to seek patterns or draw conclusions. Because this comes first in the sequence, it is an inductive activity. Secondly, concept introduction, whereby clarifying and exploratory concepts are introduced and links to the students work from the first phase. Finally, generalizations in which further tasks are posed which ask the learner to extend, generate and test the newly gained knowledge. In the Exposition-with-interaction method, first phase begin by concept introduction, whereby a general framework of clarifying, and exploratory concepts is introduced to guide the learners in absorption of presented material. Second phase involve working with concrete materials, whereby questions are posed to test whether learners have absorbed the presented material. Because this follows the concept introduction phase, it takes on the characteristics of a deductive or application activity. Thirdly, generalizations, whereby further tasks are posed which ask the learner to extend, generate and test the newly gained knowledge. Of course the specific characteristic of Phase one and two are not completely identical because their places in the larger content affect the way students approaches the task. Yet the similarly labeled phases are essentially

the same in function. Thus the two approaches can be operationally compared based on their influence on learners' performance in biology.

Braund and Bennet (2013) compared student attainment in context-based, concept approaches and mixed approaches to teaching A-level biology using ex post facto design. Efforts were made to categorize the 355 centers on the basis of teaching approach for the 2008-2010 cohorts of students. Centers were contacted by Email and asked which of these three approaches was predominantly used. Examination data for centers (marks for the whole examination out of total of 600) were subjected to bivariate tests (t-test and x^2) to compare performance of students following a context-SNAB and concept approach. To include the third category of the independent variable, a mixed delivery approach, an analysis of variance, ANOVA, was used. No statically significant difference was found between student performance in terms of mean marks (out of 600) at GCE A-level for those following the context-SNAB and concept approaches. When mixed delivery was included in the analysis using ANOVA, statistically significant difference was found between the three delivery methods with students experiencing a mixed delivery approach gaining higher marks than those experiencing either context-SNAB or concept approaches alone ($F=22.8$, $p<0.001$).

The study compared two methods of teaching biology among secondary schools using ex post facto design while the current study used comparative design. In addition, the previous study had no controls for extraneous variables. The current research endeavored to control confounding factors such as: teachers, location and learning resources through randomization of schools and purposive sampling of teachers based on qualifications.

Ibe (2013) investigated the effect of guided inquiry (GI) and expository (E) teaching methods on students' performance in biology. The performance of students in the Researcher Made Test

(RMBT) using the expository method and guided-inquiry were compared. A purposive sample of 84 senior secondary school two (SSS II) students was drawn from two intact classes in a co-educational secondary school in Imo state. Two instruments were used for the study namely Biology Achievement Test (BAT) and Biology Interest Scale (BIS). The reliability of BAT was established at .78 through the use of Kuder-Richardson (K-R 20) statistic and the coefficient of .91obtained. The research question was answered using means and standard deviation while the hypothesis was tested using analysis of co-variance (ANCOVA). The major finding was that students taught with guided-inquiry teaching method outperformed students taught with expository teaching method in biology.

From this research it was established that guided-inquiry approach was superior to expository teaching. The study was therefore a motivation to compare influence of GD and EI teaching methods on learners' performance. The point of departure is that the study of Ibe (2013) did not have a representative sample of Imo State since it was drawn from only two intact classes. The current study had a representative sample drawn from all public Secondary Schools in Nyakach Sub-county. The previous study had limited itself to classroom assessment of performance in biology by adopting Biology Achievement Test (BAT); in contrast, the current study is broader, dealing with performance of candidates completing their high school, a point in time when application of the skills learnt in school is an important entry point of behavior. Also the approaches incorporated were GI and E while the current study incorporated GD and EI teaching methods.

Akiyemi and Folshade (2010), investigated constructivist practices through guided discovery approach and the effects on students' cognitive achievement in Nigeria senior secondary school

physics. A criterion sampling technique was used to select six schools out of nine schools that met the criteria. A total of 278 students took part in the study; this was made up of 141 male students and 137 female using kuder Richardson formula 21 was the instrument used for collecting the data. The data was analyzed using analysis of covariance (ANCOVA) and t-test. The result showed that guided discovery approach was more effective than demonstration. The study of Akiyemi and Folshade (2010) however, used intact classes and did not specify the class size for each of the classes whether equivalent or non-equivalent. A criterion sampling technique was used to select schools with well equipped laboratory equipments unlike the present study where all categories of schools were represented.

Klar and Nigram (2004), not only tested whether science learners learned more via discovery versus direct instruction but also, once learning had occurred whether the quality of learning differed. Specifically they tested whether those who had learned through discovery were able to transfer their learning to new contexts. The findings were unambiguous. Direct instruction involving considerable guidance, including examples, resulted in vastly more learning than discovery (Kirschner, 2012). Those relatively few students who learned via discovery showed no signs of superior quality of learning. This is against wide documentation that discovery learning is more effective than direct instruction (Sweller, 2012).

The inconsistent findings in this research were a strong motivation to the present study which sought to compare influence of GD and EI teaching methods on learners' performance in biology at KCSE examination. The point of departure is that Klar and Nigram tested content knowledge (recalling facts and principles) while the present study tested understanding (having content knowledge and skills pertaining to that concept).

The studies showed that there is no statistically significant difference in terms of mean mark at GCE-A- level for those following the context-SNAB and concept approaches (Braund & Bennet, 2013). Ibe (2013) found that students taught using guided inquiry outperformed students taught with exposition. Similarly, Akiyemi and Folshade (2010) showed that guided discovery was more effective than demonstration. Contrary to the general expectation, Klar and Nigram (2004) showed that direct instruction involving considerable guidance resulted in vastly more learning than discovery. These contentious findings imply that the better teaching method between GD and EI is not yet clear. In reviewing the GD/ EI debate, and the inability of researchers to reach similar conclusions after reviewing the same studies, some problematic areas emerge. First, most studies adopted experimental-control design where teachers were inducted on the instructional methods under study (Klar & Nigram 2004, Folshade 2010, Ibe 2013, Ajaja 2013, Maheshwari, 2015). Secondly, few studies contacted participants through questionnaire (Braund & Bennet, 2010) to find out the teaching method they commonly use. However, no accessible research has documented empirical differences on teachers subscribing to GD and EI as observed in the classroom and their influence on learners' performance in biology in Nyakach sub-county as was intended by this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes research design, area of study, study population, the sample size and sampling techniques, instruments and data collection procedures and methods of data analysis

3.2 Research Design

This study was conducted through causal-comparative and descriptive survey designs. Causal-comparative is a research design in which investigators attempt to determine the cause or consequences of differences that already exist between or among groups of individuals (Cooper & Schindler 2001). Causal-comparative design was suitable for this study because it determines the consequences of an existing state of affairs.

Descriptive survey is a method of collecting information by interviewing or collecting a questionnaire to a sample of individuals (Kombo & Tromp, 2006). This design was relevant to the current study because questions raised in the study required collecting information through questionnaire. The design was also used because it gave the researcher opportunity to explore situations as they were happening on the ground (MacNabb, 2009)

3.3 Study Area

Nyakach Sub-county is one of the newly created sub-counties in Kisumu County. The sub-county was curved out of the wider Nyando District, which is located along the shores of Lake Victoria.

The sub-county lies between latitude 0^0 00 (the equator) and $0^0$25 south, and between longitude $34^0$45' East and $35^0$21 East. It boarders Nyando Sub-county to the north, Rachuonyo North Sub-county to the south, Kisumu East Sub-county to the West and Kericho County to the East. Nyakach Sub-county covers an area of 358.6 km^2, including 71 $km^2$of the lake water surface, with a population of 133, 041 (2009- Kenya population and housing census). The sub-county is divided into three divisions namely; South, North and West Nyakach.

The main economic activities of the area are peasant farming, sand harvesting and fishing in North Nyakach, coffee growing in South Nyakach and cotton growing in West Nyakach. The Sondu Miriu hydro-electric power plant is located in West Nyakach, while the Sondu Miriu dam is located in South Nyakach. The district has 47 fully fledged secondary schools offering K.C.S.E Examinations.

The study was conducted in secondary schools within Nyakach Sub-county, a rural set up of similar environment. The area was selected purposely because its performance is poorer than other sub-counties in Kisumu county. For instance in 2011-2013, Nyakach had a mean score of 4.8500, 3.7330 and 4.2850 respectively while Kisumu Central (the best performing sub-county in Kisumu county) had a mean score of 5.8680, 5.5789 and 6.4216 out of the possible 112 points. Also, no research of this nature had been carried out in the sub-county.

3.4. Target Population

There were two categories of the target population; the teachers of biology in secondary schools and the Form four secondary school biology students of the year 2014. The form four biology students were selected for this study because they would have covered most of the secondary

school biology syllabus and would be in a better position to be assessed based on how GD and EI influence learners' performance in biology at KCSE examination in Nyakach Sub-county. The teachers were one hundred and twenty (120) in number while students were three thousand; two hundred and twenty five (3,225). Thus the total population was three thousand two hundred and eighty five (3285) distributed in 47 Secondary schools within the sub-county. The unit of analysis was the mean score between learners taught using GD and those taught using EI.

3.5 Sample Size and Sampling Techniques

The study targeted the teachers of biology in secondary schools within Nyakach sub-county. Secondly it targeted Form four students in the secondary schools in the sub-county. In this study a number of sampling methods were used so that a more representative sample could be connived at. Krathwol (2003) supports the view that where a study population is large and showing divergent characteristics, a combination of sampling methods is most preferred so as to enable the researcher to get a more representative sample. For the teachers of biology, forty four (44) out of the total one hundred and twenty (120) were purposively sampled for use in the study. Purposive sampling was used on the basis of demographic characteristics of teachers which included academic qualifications and experience to provide focused information needed for the study. Mugenda and Mugenda (2003) and Nkpa (1997) reinforces this position by adding that, purposive is necessary where a sample shows good evidence of providing a researcher with the needed information. The sample was also dictated by the data collection method which was observation (Israel, 2009).

The criteria for purposive sampling were as follows: (1) teachers who were teaching Form 4 biology students at the time of study and (2) professional graduate or diploma trained teachers who attended SMASSE workshops. These teachers were purposively categorized into GD and EI based

on the approach they were using in their respective schools. In this study, GD involved adoption of process skills such as; observation, hypothesis testing and experimentation. EI on the other hand involved factual transmission, questioning learners to confirm whether the presented information is understood and note taking.

In the student category, five secondary schools were selected from each division within Nyakach sub-county (five in lower Nyakach, five in upper Nyakach and five in Lakers). The sub-county has a total of forty seven (47) schools. Krathwol suggests that thirty percent sample of the institutions will be more representative. On the basis of the forgoing, a total of fifteen secondary schools were selected for the study using stratified sampling method. Stratified sampling technique was used here because it was advisable to subdivide the population into smaller homogenous groups to get more accurate representation. The schools had Form four students' population of three thousand, two hundred and twenty five. Of these, by using the Fischer et al., (1995) and Israel (2009) method for population less than 10,000, a total of 343 respondents were calculated. Once the above was done, simple random sampling technique was employed to select the three hundred and forty three students for the study. These were drawn from the fifteen schools earmarked for the research. Table 3 below shows a sample frame for this study.

Table 3: Sample frame

Category of Respondents	Population	Sample	Percentage%
Schools	47	15	30
Teachers	120	44	30
Learners	3,225	343	10.6

3.6 Instruments of Data Collection

3.6.1 Teacher Questionnaire (TQ)

Teacher-Questionnaire was issued to the teachers who were teaching the candidate class in the year 2014 in Nyakach Sub-county. The Questionnaire probed teachers on the method they frequently used between GD and EI in teaching biology.

The choice of this instrument of data collection was suitable because Questionnaires have the ability to reach a large population, save time and are not expensive (Kerlinger, 1978). The questionnaire is free from bias hence reliable. Such items are also easy to answer for the respondent and thus give a more accurate response. Closed-ended questions are also easier to analyze since they are in immediate usable form (Mugenda & Mugenda, 1999), they are also economical to use in terms of money and time. The format of closed ended questions has some disadvantages such as the respondent will be called upon to answer questions according to the researcher's choices. It was therefore necessary for the researcher to validate this format with The Science Teaching Observation Schedule (STOS). The Teacher-Questionnaire is attached as Appendix I.

3.6.2 The Science Teaching Observation Schedule (STOS)

The selected 44 teachers were randomly sampled by applying the 33% rule (Gay, 1981) to get 15 teachers for the Science Teaching Observation schedule. The Science Teaching Observation Schedule was done using adopted version of Eggleston et al., (1976) that was modified to answer research questions in the current study. The schedule was divided into two main parts, teacher talk and pupils initiated and maintained talks and activities. Teacher talk consisted of four categories of questions (a_1, a_2, a_3 and a_4) and four each of statements (b_1, b_2, b_3 and b_4) and directives (c_1, c_2, c_3

and c_4). Pupils' activities are subdivided into eight categories, where pupils either sought information (d_1, d_2 d_3 and d_4) or refer back to the teacher (e_1, e_2, e_3 and e_4), where GD intellectual transactions included a_2 a_3 a_4 b_2 b_3 b_4 c_2 c_3 c_4 d_2 d_3 d_4 e_2 e_3 e_4 while EI intellectual transactions included a_1 b_1 c_1 d_1 e_1. The schedule was wholly concerned with the cognitive aspects of science teaching: recalling facts and principles, formulating hypothesis, designing experimental procedures, interpretation of data, and making inferences. It took no account of managerial or affective transactions. The main features of the system of classification used in STOS are shown in appendix II.

Recording of behavior: A record of a lesson is produced by noting when any one or more of the 20 intellectual transactions occurred in each four-minute "time sampling unit". Thus, in a lesson lasting 80 minutes there would be 20 sampling units (20×4=80). In each of these one or more transactions may occur and would be noted. However, if one kind of transaction occurs a number of times in any one time unit, all occasions after the first are ignored. Each category of behavior is recorded only once, on the first occasions on which it occurs, during any given four-minute time unit. Thus, the overall count for any category represents the minimum frequency of occurrence of that behavior. In order to estimate the frequency of use of any category, the fraction was calculated (Eggleston, Galton and Jones, 1976):

$$\frac{\text{No of time units in which behavior occurred} \times 100}{\text{Total number of time units observed}}$$

Observation procedure: All classroom observations were conducted by the researcher. Each classroom was observed once per week for a lesson lasting 80 minutes by the STOS adapted (Eggleston, Galton & Jones, 1976, Galton & Eggleston, 1979) for a total of three observation lessons. The total number of lessons observed was 45 lessons.

3.6.3 Document Analysis Guide

Document analysis guide focused on analysis of documents that were relevant, that is KCSE (2014) examination results in order to obtain information about the students mean score in biology academic performance. The results of biology KCSE examination for Form 4 students of the year-2014 among the sampled schools were analyzed to provide scores which differentiated GD and EI group. The average scores per group were calculated. If the average score was the same, then there was no difference between GD and EI methods of teaching biology. If the mean score significantly differed then either GD or EI better enhanced learning than the other. KCSE examination results are considered to be reliable as it is standardized. The researcher developed the document analysis guide. It is attached as Appendix III, while KCSE (2014) biology results for sampled schools are attached as Appendix IV.

3.6.4 Ethical Consideration

In this study**,** the researcher did not fabricate, falsify, or misrepresent authorship, evidence, data, findings or conclusions. Each participant received an explanation of the test and experimental procedures to be used. The participant were also informed at the outset of the study who would have access to the data so that no one, including the researcher, could link to the data of specific individuals. The participants were also assured of availing the results of the research findings to them.

3.6.5 Reliability of the Instruments

Reliability is the ability of a test to consistently yield the same results when repeated measurements are taken, of the same individuals under the same conditions.

In this study, the reliability of the questionnaire was established through the test-retest statistical technique and application of the Pearson Product Moment Correlation. To do this a pilot study was conducted among 4 teachers who were not part of the study sample (Cohen et al., 2007) representing 10% of the total number of sampled teachers. The same test was administered twice to the same respondents within an interval of two weeks. The score from both tests were correlated using Pearson's (r) that gave the researcher .75 reliability coefficient index for Questionnaire and .83 for Observation schedule which was acceptable (Borg et al., 2007).

3.6.6 Validity of the Instruments

Validity is the degree to which the results obtained from the analysis of the data actually represent the phenomenon under study. Validity is therefore concerned with how accurately the study is a true reflection of the variables, and then inferences based on such data will be accurate and meaningful.

To ensure that the data collection instruments were valid, a number of measures were put in place. The questionnaire was constructed with close consultation of the supervisors. After which they were given to experts in the faculty of education of Maseno University to ascertain their face validity. The advice in the form of suggestions, clarification and other inputs were incorporated in

making necessary amendment to the research instruments. A test is valid if the content selected and included in the questionnaire or observation schedule are relevant to the variable being investigated (Mugenda & Mugenda, 1999).

3.7 Data Collection Procedure

Before any investigation into the research problem was undertaken, the researcher obtained consent and cooperation of the people who provided the information, giving them a clear picture of what the research entailed, stating clearly the purpose of the visit, objectives and nature of the study. The researcher obtained a letter of ethical clearance from Maseno University to do a research in selected secondary schools in Nyakach Sub-county. The researcher used the letter to obtain an introductory letter and permission from the District Education Officer (DEO) to conduct research in the sub-county. After obtaining this consent letter, the researcher wrote a letter of introduction addressed to head teachers and concerned biology teachers of the sampled schools. This was an information letter concerning the intended visit and issuing of data collection instruments. Arrangements were then made by biology teachers for a suitable date to collect the data. The researcher administered a questionnaire in person and made clarifications when need arose. Guided by adopted version of Eggleston et al (1976) Observation Schedule, the researcher also attended normal biology lessons and observed predominant teaching methods subscribed by teachers in the classrooms. Some teachers seemed hesitant to be observed as they thought the researcher wanted to inspect them. In such cases the researcher explained to them that the need for observation was for purpose of research. Having understood this, the biology teachers' classes were observed. The researcher sat at the back centre of the classroom so as to have a wider view of what was happening

without obstructing the teacher or the students. Various intellectual transactions that occurred during the lesson were coded on the Science Teaching Observation Schedule (STOS) at an interval of four minutes in an 80 minute lessons. Each school was visited once per week for three consecutive weeks. The researcher did not interfere in any way, or exercised any control over the teacher, the learner or the lesson content. In schools where the classes failed to take off during visitations, the researcher rescheduled the visit on a different day.

Relevant documents such as K.C.S.E (2014) examination results were obtained from the heads of the institutions two months after the observation of biology teachers in classrooms. Required information from the documents was recorded down. This gave a clear picture of the students' academic performance in biology in relation to teaching method subscribed by GD and EI teachers.

3.8 Method of Data Analysis

Data was coded and organized for analysis using the Statistical Package for Social sciences (SPSS) data editor. Quantitative data was analyzed using descriptive statistics; frequency counts, percentages and means. Inferential statistics (t-test) was also used. In qualitative data, the close-ended responses were coded (Blanche et al., 2008). Once complete, the responses were transferred into a summary table by tabulating. These were tallied to establish frequencies which were then converted into mean scores.

The researcher used t-test to analyze the significant difference in mean score for learners taught using guided discovery and those taught using exposition-with-interaction

$$\bar{X}_A - \bar{X}_B$$

Where $\bar{X}_A$ was the KCSE mean score for students taught using guided discovery, while $\bar{X}_B$ was the KCSE mean score for students taught using exposition-with-interaction method. The variance between mean of students taught using guided discovery and those taught using exposition-with-interaction:

$$\text{Variance } (\bar{X}_A - \bar{X}_B) = \frac{S_1^{\,2}}{n_1} + \frac{S_2^{\,2}}{n_2}$$

Where $\frac{S_1^{\,2}}{n_1}$ was the variance of mean of students taught using guided discovery method.

$\frac{S_2^{\,2}}{n_2}$ was the variance of mean of students taught using exposition-with-interaction method.

$$\text{S.E } (\bar{X}_A - \bar{X}_B) = \sqrt{\frac{S_1^{\,2}}{n_1} + \frac{S_2^{\,2}}{n_2}}$$

Where S.E was the standard error of the difference between mean of guided discovery ($\bar{X}_A$) and exposition-with-interaction ($\bar{X}_B$)

$$t = \frac{\bar{X}_A - \bar{X}_B}{\sqrt{\frac{S_1^{\,2}}{n_1} + \frac{S_2^{\,2}}{n_2}}}$$

where‘t’ was the t-test for the significance mean difference between learners taught using guided discovery and those taught using exposition-with-interaction. All data was analyzed at a level of significance of 95% degree of freedom on the particular case as was determined. This value had been chosen because the sample size was adopted from figures calculated on the basis of 0.95 level of confidence.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion in line with objectives of the study. The first section constitutes the findings on frequency of use of GD and EI in teaching biology. The second section established the influence of GD on learners’ performance in Biology. The third section established the influence of EI on learners’ performance in biology. The last section compared GD and EI on the basis of learners’ performance in Biology.

4.2 Frequency of use of GD and EI in teaching biology

The first part of the research was to establish the frequency of use of GD and EI in teaching biology. To achieve this objective, teachers were asked to state the strategy or approach they frequently use between GD and EI in teaching biology. Out of a total number of 44 teachers, 16 frequently used GD and 28 used EI as indicated in Table 4

Table 4: The number of teachers who frequently use GD and EI in teaching biology

	(n=44)
Category	**Number of Teachers (%)**
GD	16 (36.36%)
EI	28 (63.64%)

The researcher further presented teachers with a set of items in Likert scales to establish the frequency of use of GD and EI based on their teaching approaches. The teachers were to report as either never, less frequently, not sure, frequently or more frequently. Never was given a score of 1, less frequently was given a score of 2, not sure was given a score of 3, frequently was given a score of 4 and more frequently was given a score of 5. For each question, the scores of the responses of teachers were summed up and divided by the total number of teachers to present a mean. A mean less than 1.5 meant that in general teachers never used the approach, a mean score ranging between 1.5 and 2.5 meant that teachers less frequently used the approach, a mean score ranging between 2.5 and 3.5 meant that the teachers were not sure while a mean score ranging between 3.5 and 4.5 meant that teachers frequently used the approach and lastly a mean score greater than 4.5 meant that teachers more frequently used the approach. Table 5 shows the response

of teachers on the frequency of use of GD and EI in teaching biology as captured from Likert scales.

Table 5: The frequency of use of GD and EI based on learning approaches conducted by teachers

Question		N	LF	NS	F	MF	Mean %
How frequent do you							
(EI) identify a new concept at the beginning of instruction	**Freq**	2	5	9	20	8	3.614
	%	4.55	11.36	20.45	45.45	18.19	100
(GD) guide learners to observe or manipulate biological materials at the beginning of instruction to discover new concepts	**Freq**	3	22	3	11	5	2.840
	%	6.82	50.00	6.82	25.00	11.36	100
(EI) conduct a lesson sequentially moving from concrete to abstract concepts in defined steps	**Freq**	1	7	8	18	10	3.659
	%	2.27	15.90	18.19	40.90	22.73	100
(EI) outline a clear and effective solution, to the problem rather than having learners spend much time and effort on exploratory activities	**Freq**	0	10	6	23	5	3.523
	%	0	22.73	13.64	52.27	11.36	100
(GD) emphasize the problem solving process rather than the solution	**Freq**	7	14	7	10	6	2.705
	%	15.90	31.82	15.90	22.73	13.64	99.99

Key

N----- Never **LF**-----Less frequent **NS**-----Not sure **F**------Frequently **MF**---- More frequently

In responding to how frequent a teacher identify a new concept at the beginning of instruction, 2(4.55%) Biology teachers said that they had never used the approach, 5 (11.36%) Biology teachers said that they used it less frequently while 9 (20.45%) Biology teacher said that they were not sure. In contrast 20 (45.45%) of the Biology teachers said they frequently used the approach while 8 (18.19%) used it more frequently. The mean response was 3.614 meaning that most of the Biology teachers in Nyakach Sub-county frequently identify a concept at the beginning of instruction; a practice synonymous with EI.

The results on how frequent a teacher expose and guide learners to observe or manipulate biological materials at the beginning of the lesson so as to discover a new concept, shows that 3 (6.82%) Biology teachers said that they had never used the approach, 22 (50%) Biology teachers said that they used it less frequently while 3 (6.82%) Biology teacher said that they were not sure. In contrast 11 (25%) of the Biology teachers said they frequently used the approach while 5 (11.36%) used it more frequently. The mean response was 2.840 meaning that few Biology teachers in Nyakach Sub-county frequently expose and guide learners to observe and, or manipulate biological materials at the beginning of instruction, so as to discover a new concept, a practice synonymous with GD method.

Teachers response to how frequent a teacher conduct a lesson sequentially moving from concrete to abstract concepts in defined steps, were as follows: 1 (2.27%) Biology teachers said that they had never used it, 7 (15.90%) Biology teachers said that they used it less frequently while 8(18.19%) Biology teachers said that they were not sure. In contrast 18 (40.90%) of the Biology teachers said they frequently used the approach while 10 (22.73%) used it more frequently. The

mean response was 3.659 meaning that most of the Biology teachers in Nyakach Sub-county conduct a lesson sequentially moving from concrete to abstract concepts in defined steps, a practice synonymous with EI method.

In responding to how frequent a teacher outline a clear and effective solution, to the problem rather than having learners spend much time and effort on exploratory activities, none of the Biology teachers said that they had never used the approach, 10 (22.73%) Biology teachers said that they used it less frequently while 6 (13.64%) Biology teacher said that they were not sure. In contrast 23 (52.27%) of the Biology teachers said they frequently used the approach while 5 (11.36%) used it more frequently. The mean response was 3.523 meaning that most of the Biology teachers in Nyakach Sub-county outline a clear and effective solution, to the problem rather than having learners spend much time and effort on exploratory activities, a practice synonymous with EI method.

The response on how frequent a teacher emphasize the problem solving process rather than the solution as revealed on table 5 were: 7(15.90%) of the Biology teachers said that they had never used the approach, 14 (31.82%) Biology teachers said that they used it less frequently while 7 (15.90%) Biology teacher said that they were not sure. In contrast 10 (22.73%) of the Biology teachers said they frequently used the approach while 6 (13.64%) used it more frequently. The mean response was 2.705 meaning that few of the Biology teachers in Nyakach Sub-county emphasize the problem solving process rather than the solution, a practice synonymous with GD method. In summary the mean response to use of GD is below 2.9 while that of EI is above 3.5 in

Nyakach sub-county. This implies that few biology teachers use GD while majority use EI in Nyakach Sub-county.

The results of the STOS analysis of individual participants' classroom intellectual transactions in form of talk and initiated activity to validate results from questionnaire are shown in Table 6.

Table 6: Frequencies of use of STOS categories by the respondents (incidence per 100 time sampling units)

T1	cat	a_1	a_2	a_3	b_1	b_2	c_1	d_1	d_2	d_3	e_1	e_3
	f	26	30	30	18	8	8	28	36	8	4	20
T2	cat	a_1	a_2	a_3	b_1	b_2	c_1	d_1	d_2	d_3	e_1	e_2
	f	20	10	18	16	8	8	24	32	8	8	16
T3	cat	a_1	a_3	b_1	b_2	c_1	c_2	d_1	d_3	e_1	e_2	
	f	24	14	12	10	14	30	8	14	4	30	
T4	cat	a_1	a_2	a_3	b_1	b_2	c_1	c_2	d_1	d_3	e_1	e_2
	f	20	16	12	12	8	12	24	10	12	8	32
T5	cat	a_1	a_2	a_3	b_1	c_1	d_2	d_3	e_3			
	f	20	30	28	14	14	32	15	24			
T6	cat	a_1	a_3	b_1	b_2	c_1	d_1	d_2	d_3			
	f	20	28	20	30	8	12	28	24			
T7	cat	a_1	b_1	c_1	c_2	d_1	d_2					
	f	64	40	40	12	12	12					
T8	cat	a_1	b_1	c_1	c_2	d_1	d_2					
	f	60	72	36	16	12	16					

T9	cat	a_1	b_1	c_1	c_2	d_1	d_2
	f	56	72	32	20	12	12
T10	cat	a_1	b_1	c_1	c_2	d_1	d_2
	f	64	60	44	24	16	16
T11	cat	a_1	b_1	c_1	c_2	d_1	
	f	60	72	36	8	4	
T12	cat	a_1	b_1	c_1	c_2	d_1	
	f	52	60	40	8	8	
T13	cat	a_1	b_1	c_2	d_1		
	f	48	28	12	12		
T14	cat	a_1	b_1	c_1	c_2	d_1	
	f	56	68	44	8	16	
T15	cat	a_1	b_1	c_1	c_2	d_1	
	F	52	64	48	06	14	

KEY

Cat- category

f- incidence/100 sampling units

T1- Teacher one T2- Teacher two T3- Teacher three T4-Teacher four
T5- Teacher five T6- Teacher six T7- Teacher seven T8- Teacher eight
T9- Teacher nine T7- Teacher ten T11- Teacher eleven T12- Teacher twelve
T13-Teacher thirteen T14-Teacher fourteen T15- Teacher fifteen

1a Teacher asks a question (or invites comments) which are answered by:

a_1 recalling facts and principles
a_2 applying facts and principles to problem solving
a_3 making hypothesis and speculation
a_4 designing experimental procedure

1b Teacher makes statements:

b_1 on facts and principle
b_2 of problems
b_3 of hypothesis or speculation
b_4 of experimental procedure

1c Teacher directs pupils to sources of information for the purpose of:
c_1 acquiring or confirming facts and principles
c_2 identifying or solving problems
c_3 making inferences, formulation or testing hypothesis
c_4 seeking guidance on experimental procedure

2d Pupils seek information or consult for the purpose of:
d_1 acquiring or confirming facts or principles
d_2 identifying or solving problems
d_3 making inferences, formulating or testing hypothesis
d_4 clarifying experimental procedures

2e Pupils refer to teachers for the purpose of:
e_1 acquiring or confirming facts or principles
e_2 seeking guidance when identifying or solving problems
e_3 seeking guidance when making inferences, formulating or testing hypothesis
e_4 seeking guidance on experimental procedures.

An examination of table 6 reveals that the transactions of T1 are characterized by the unique features of a_2 (30) and a_3 (30), that is, teacher questions answered by students applying facts and principles to problem solving and constructing hypothesis. Students seek information or consult for the purpose of identifying problems (d_2=36) and e_3 (20), pupils refer to teachers for the purpose of seeking guidance when making inferences, formulating or testing hypothesis.

The transactions of T2 are characterized by the unique features of a_3 (18), that is, the teacher questions answered by students constructing hypothesis and d_2 (32), Students seek information or consult for the purpose of identifying or solving problems, while T3 are characterized by the unique features of c_2 (30), that is, the teacher directs pupils to sources of information for the purpose of identifying or solving problems, and e_2 (30), pupil refer to the teacher for the purpose of seeking guidance when identifying or solving problems.

The transactions of T4 are characterized by the unique features of c_2 (24), that is, the teacher directs pupils to sources of information for the purpose of identifying or solving problems, and e_2 (32), pupil refer to the teacher for the purpose of seeking guidance when identifying or solving the problem. T4 seemed to adopt process skills more than information aspects of science.

The intellectual interactions of T5 are characterized by the unique features of a_2 (30), that is, teacher questions answered by students recalling facts and principles to problem solving, a_3 (28) students constructing hypothesis, d_2 (32), students seek information or consult for the purpose of identifying or solving problems, and e_3 (24), pupil refer to teacher for the purpose of seeking guidance when making inferences, formulating or testing hypothesis. Similarly, T6 is characterized by the unique features of a_3 (28), that is, the teacher questions are answered by students constructing hypothesis, d_2 (28), students seek information or consult for the purpose of identifying or solving problems, and d_3 (24), students making inferences, formulating or testing hypothesis. T6 seemed to emphasize practical skills at the expense of theory, a practice synonymous to GD.

The findings from table 6 reveals that T7 intellectual interactions are characterized by the unique features of a_1 (64), that is, teacher questions answered by students recalling facts and principles, b_1 (40), teacher makes statements on principle and facts and c_1 (40), teacher directs pupils to sources of information for the purpose of acquiring or confirming facts and principles. T7 transactions seemed singular in their infrequent use of teacher questions and in having the highest category of a_1.

T8 intellectual interactions are characterized by the unique features of a_1 (60), that is, teacher questions answered by students recalling facts and principles, b_1 (72), teacher makes statements on principle and facts and c_1 (36), teacher directs pupils to sources of information for the purpose of acquiring or confirming facts and principles. The relatively infrequent use of pupil initiated and maintained talk or activity suggests passive, attentive class.

The findings from table 6 also reveal that T9 intellectual interactions are characterized by the unique features of a_1 (56), that is, teacher questions answered by students recalling facts and principles, b_1 (72), teacher makes statements on facts and principles and c_1 (32), teacher directs pupils to sources of information for the purpose of acquiring or confirming facts and principles. T9 transactions seemed to emphasize theory at the expense of practical skills.

T10 intellectual interactions are characterized by the unique features of a_1 (64), that is, teacher questions answered by students recalling facts and principles, b_1 (60), teacher makes statements on facts and principles and c_1 (44), teacher directs pupils to sources of information for the purpose of acquiring or confirming facts and principles. The relatively infrequent use of pupil initiated and maintained talk or activity suggests passive attentive class.

The intellectual interactions of T11 are characterized by the unique features of a_1 (60), that is, teacher questions answered by students recalling facts and principles, b_1 (72), teacher makes statement on facts and principles and c_1 (36), teacher directs pupils to sources of information for the purpose of acquiring or confirming facts and principles.

The findings from table 6 also show that T12 intellectual interactions are characterized by the unique features of a_1 (52), that is, teacher questions answered by students recalling facts and principles, b_1 (60), teacher makes statements on facts and principles and c_1 (40), teacher directs pupils to sources of information for the purpose of acquiring or confirming facts and principles, while that of T13 is characterized by the unique features of a_1 (48), that is, teacher questions answered by students recalling facts and principles, b_1 (28), teacher makes statements on facts and principles.

T14 intellectual interactions are characterized by the unique features of a_1 (56), that is, teacher questions answered by students recalling facts and principles, b_1 (68), teacher makes statements on facts and principles and c_1 (44), teacher directs pupils to sources of information for the purpose of acquiring or confirming facts and principles. The relatively infrequent use of pupil initiated and maintained talk or activity suggests passive attentive class.

The findings from table 6 also reveals that T15 intellectual interactions are characterized by the unique features of a_1 (52), that is, teacher questions answered by students recalling facts and principles, b_1 (64), teacher makes statement on facts and principles and c_1 (48), teacher directs pupils to sources of information for the purpose of acquiring or confirming facts and principles.

The ratio of GD and EI transactions as a fraction of all recorded transactions per teacher is shown in table 7

$$\text{Ratio of GD} = \frac{a_2 + a_3 + a_4 + b_2 + b_3 + b_4 + c_2 + c_3 + c_4 + d_2 + d_3 + d_4 + e_2 + e_3 + e_4}{\text{Total recorded transactions}} \times 100$$

Ratio of EI = $\frac{a_1 + b_1 + c_1 + d_1 + e_1}{\text{Total recorded transactions}} \times 100$

Table 7: Ratio of GD and EI as a fraction of all recorded transactions per teacher

Participant	Percentage of use of GD	Percentage of use of EI
T1	61.1 %	38.9%
T2	62.7%	37.3%
T3	61.2%	38.8%
T4	62.7%	37.3%
T5	60.3%	39.7%
T6	68.7%	31.3%
T7	13.3%	86.7%
T8	15.1%	84.9%
T9	21.6%	78.4%-
T10	17.9%	82.1%
T11	4.5 %	95.5%
T12	4.7 %	95.3%
T13	12 %	88 %
T14	4.2 %	95.8%
T15	3.3 %	96.7%

The findings from table 7 show that the percentage of use of GD and EI by Teacher 1 (TI) per lesson is 61.1% for GD and 38.9% for EI, while that of T2 is 62.7% for GD and 37.3% for EI. Similarly the percentage frequency of use of GD and EI by T3 are 61.2% for GD and 38.8% for EI while that of T4 is 62.7% for GD and 37.3% for EI. The results on table 6 also show that the percentage frequency of use of GD and EI by Teacher 5 (T5) per lesson is 60.3% for GD and 39.7% for EI while that of T6 is 68.7% for GD and 31.3% for EI. This implies that these teachers are GD oriented.

Contrary to the information above, the percentage frequency of use of GD and EI by T7 per lesson is 13.3% for GD and 86.7% for EI while that of T8 is 15.1% for GD and 84.9% for EI. Furthermore, the percentage frequency of use of GD and EI by Teacher 9 (T9) per lesson is 21.6% for GD and 78.4% for EI while that of T10 is 17.9% for GD and 82.1% for EI. Similarly, the percentage frequency of use of GD and EI by T11 per lesson is 4.5% for GD and 95.5% for EI while that of T12 is 4.7% for GD and 95.3% for EI. Table 6 also shows that the percentage frequency of use of GD and EI by Teacher 13 is 12% for GD and 88% for EI while that of T14 is 4.2% for GD and 95.8% for EI. The percentage frequency of use of GD and EI by Teacher 15 per lesson is 3.3% for GD and 96.7% for EI. This implies that these teachers frequently use EI.

In summary, Table 6 and 7 reveal the following patterns: in most cases, there was a high frequency of teachers' questions in categories a_1 - a_4, high frequencies of teacher statements in categories b_1-b_2 and of teacher directives in categories c_1-c_2 supported by pupils initiated and maintained talk and activities in categories d_1-d_4 and e_1-e_2 . The transactions of T1, T2, T3, T4, T5 and T6 are characterized by the unique features of a_3, that is, teachers' questions answered by constructing hypothesis, and b_2, teachers' statements of problems. Compared to T7, T8, T9, T10, T11, T12, T13, T14 and 15, these teachers showed a de-emphasis of the informational aspects of science, in favor of problem-solving and speculative processes. The transactions of teacher T1 and T2 in particular, uniquely stand out in having frequencies distribution in the d and e major categories. A fitting characteristic orientation of this group of teachers would be the 'pupil-centered' one.

Teachers T7, T8, T9, T10, T11, T12, T13, T14 and T15 transactions seemed singular in their infrequent use of teacher questions (categories a_2-a_7) and in having the highest frequency (T7 and T10) of all categories of a_1, that is, teacher questions demanding recall of facts and principles. They are further characterized by having relatively high incidences of teacher statements of facts (category b_1) and teacher directions to sources for fact finding (category c_1). The relatively infrequent use of pupil initiated and maintained talk or activity suggests passive, attentive classes, offering little in response to teacher fact-oriented talk and activity. The teacher image arising in this transaction is that of a content-oriented transmitter of factual information (teacher-centered).

In summary, teachers T1, T2, T3, T4, T5, and T6 (6 Teachers) are the GD group while T7, T8, T9, T10, T11, T12, T13, T14 and T15 (9 Teachers) are the EI group as indicated in figure 2.

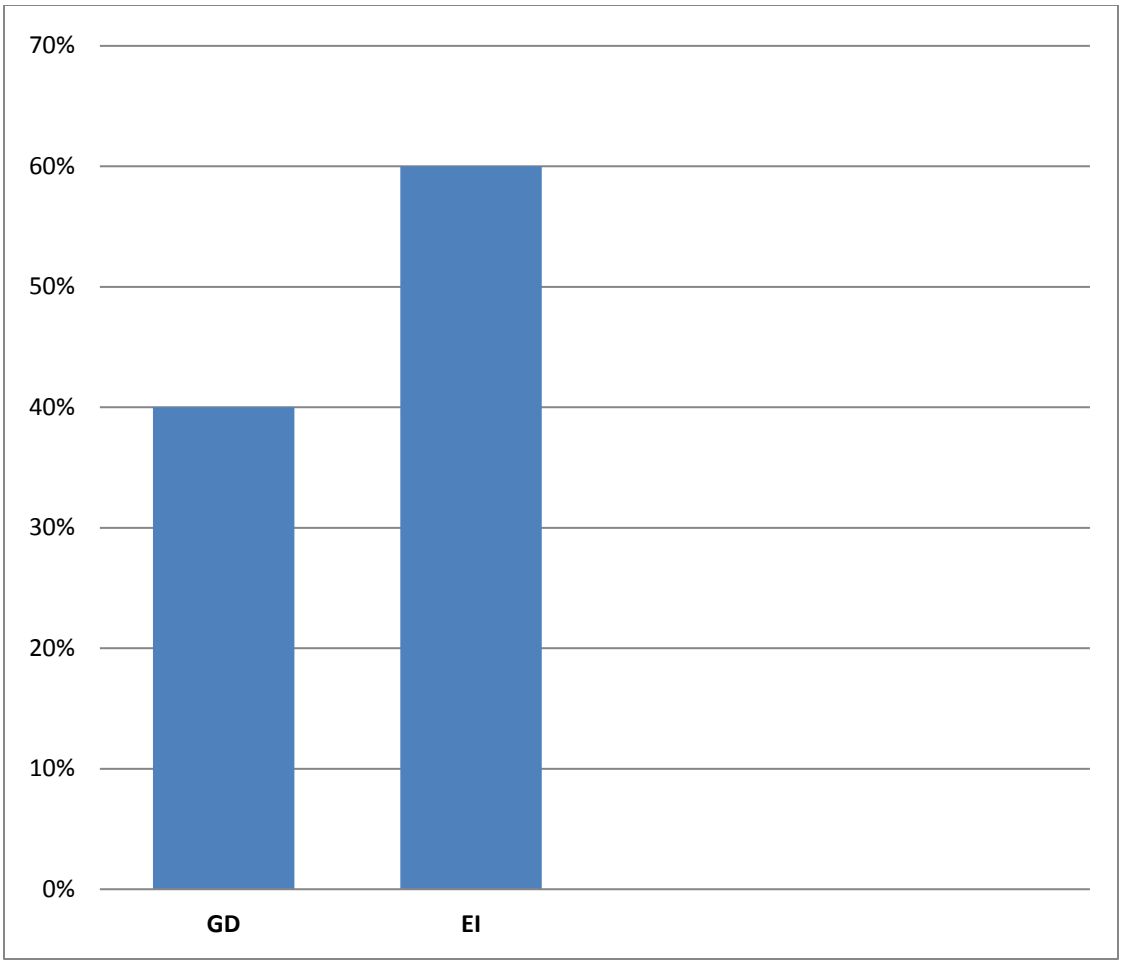

Figure 2: Summary of frequencies of use of STOS categories by the respondents

The results from figure 2 reveals that out of the total number of 15 teachers, 9 (60%) frequently used EI in teaching biology while 6(40%) frequently used GD in teaching biology.

The Gronlund expectancy table was used to depict relationship between questionnaire and STOS on frequency of use of GD and EI as shown in Table 8 below.

Table 8: Gronlund expectancy table showing the relationship between TQ and STOS on the frequency of use of GD and EI in teaching biology.

Category	Instrument for collecting data	
	Questionnaire (%score)	Observation Schedule (%score)
GD	36.36	40
EI	63.64	60

The Table 8 above shows that 36.36% of respondents issued with questionnaire and 40% of teachers observed in classroom teaching biology were using GD. On the other hand 63.64% and 60% of respondents issued with questionnaire and STOS respectively were using EI method. This shows that the two instruments have strong positive correlation.

The results of the study revealed that the number of teachers frequently using EI (63.64%) in teaching biology was more than those using GD (36.36%). These findings could be attributed to the fact that GD was a relatively new approach compared to EI. According to Shing-fong, Yin-kum Law and Mark Shin-kee Shum (2009), teachers' resistance is expected because the new practice bears little resemblance to the practices they had experienced as students themselves. As Petty (2008) noted, GD method is difficult for an inexperienced teacher to use. Muwanga-Zake (1998) argues that many graduate teachers are not well grounded on Pedagogy-teaching skills, and this affects the way they impart scientific knowledge to their students. Findings from previous

studies (APHRC, 2010 and CEMESTEA, 2009) had some similarities with the current findings that most teaching endeavors were seen to be teacher centered.

4.3 Influence of GD on learners' performance in biology

The results for percentage mean scores in KCSE examinations (2014) for students taught using GD is shown in Table 9

Table 9: Percentage mean scores in KCSE biology examinations (2014) for students taught using GD

	MAGUNGA	NYABONDO	AGAI	NYAKACH	THURDIBUORO	NYONG'ONG'A
S_1	60	62	65	60	62	60
S_2	64	68	64	58	64	62
S_3	70	66	62	59	62	64
S_4	62	63	64	58	64	60
S_5	58	67	65	54	61	66
S_6	56	64	60	57	60	60
S_7	62	65	58	62	49	59
S_8	50	65	52	60	46	58
S_9	48	63	57	56	44	55
S_{10}	46	64	52	64	47	53
S_{11}	44	62	48	59	49	52
S_{12}	42	68	49	54	40	50
S_{13}	40	62	48	57	55	52
S_{14}	48	64	41	58	52	50
S_{15}	47	61	45	52	53	58

S_{16}	44	64	50	60	55	54
S_{17}	51	63	53	58	52	52
S_{18}	46	66	56	56	60	58
S_{19}	42	64	52	46	59	56
S_{20}	51	64	40	47	62	54
S_{21}	47	56	58	42	56	50
S_{22}	40	60	44	40	60	48
S_{23}	42	58	48	41	40	44
S_{24}	55	54	52	43	62	41
S_{25}	50	48	46	42	64	42
S_{26}	58	43	42	40	63	46
S_{27}	45	47	40	55	52	44
S_{28}	43	49	48	63	58	40
S_{29}	50	44				58

Key: S-Student

Scale of interpretation: 0-29% Weak, 30-39% Below average, 40-49% Average, 50-59% Above average, 60-69% Good, 70-76% Very good, 80-100% Excellence

The Table 9 above shows that most students taught using GD had percentage mean score above 50%. For instance, out of 29 students in Nyabondo, 24 students had percentage mean score above 50% while in Thurdibuoro 22 students had percentage mean score above 50%.

The percentage means score per school using GD is shown in Table 10

Table 10: Percentage mean scores in KCSE (2014) biology examinations for schools with GD teachers

School	Percentage mean score
Magunga	50.38
Nyabondo	60.13
Nyong'ong'a	52.11
Thurdibuoro	55.39
Agai	52.11
Nyakach Girls	53.23

Scale of interpretation: 0-29% Weak, 30-39% Below average, 40-49% Average, 50-59% Above average, 60-69% Good, 70-76% Very good, 80-100% Excellence

The Table 10 above shows that schools with teachers using GD method in teaching biology had percentage mean score above 50%. For instance, Nyabondo had percentage mean score of 60.13% while Thurdibuoro had percentage mean score of 55.39%.

This study established influence of GD on learners' performance in biology on KCSE (2014) examinations in Nyakach sub-county. The results in Table 9 shows that the percentages mean scores in KCSE biology examinations (2014) for students taught using GD was above 50%. Table 10 also indicates that percentage mean score per school with GD teachers was above 50%. Therefore GD method has high influence on learners' performance in biology examinations. The

high influence of GD on learners' performance might be attributed to the fact that GD challenge students to solve authentic problems in information rich settings, thus knowledge can best be acquired through experience. Pupil learning is more meaningful, more thorough, and therefore usable when pupils seek out and discover knowledge. Therefore, teaching strategies that actively engage students in the learning process through scientific investigations such as GD are more likely to increase intellectual understanding. The findings tally with the results of Braund and Bennet (2013), Ajaja (2013), Akinyemi and Folshade (2010), Miner, Levy and Century (2010), Mayor (2004), Race and Walker (2003), Fry et al., (2003), that GD approach was effective in enhancing achievement and retention of students in science subjects. On the other hand, the findings disagree with that of Maheshwari (2015), Chepkwony, (2014), Kirschner, Sweller and Clark (2012), Reid, Zhang and Chen (2003) who found that students learn new concepts and ideas better if all of the information they need to know is laid bare before them. The disagreement could be because the researchers tested knowledge of concepts and ideas while the current study tested understanding (having concept knowledge and skills pertaining to that concept).

4.4. Influence of EI on learners' performance in biology at KCSE examination

The results for percentage mean scores in KCSE examinations (2014) for students taught using EI is shown in Table 11

Table 11: Percentage mean scores in KCSE biology examinations (2014) for students taught using EI

	MORO	URUDI	LISANA	SANGO'RO	LWANDA	OBANGE	ODAWA	THURGEM	ANDING'O
S_1	44	36	32	38	40	39	36	40	35
S_2	47	35	28	26	39	45	32	47	33
S_3	42	30	25	28	30	44	54	30	38
S_4	38	28	39	32	32	48	59	40	40
S_5	42	31	35	36	23	42	62	31	34
S_6	38	26	31	30	36	38	55	54	33
S_7	32	48	33	36	38	36	52	58	32
S_8	30	40	35	22	36	40	49	54	35
S_9	39	35	44	24	34	32	45	55	49
S_{10}	30	36	42	30	37	36	43	48	50
S_{11}	32	30	40	38	30	32	44	43	43
S_{12}	35	27	33	47	31	34	44	38	41
S_{13}	30	30	34	36	30	49	36	36	43
S_{14}	32	30	39	30	33	30	32	34	38
S_{15}	33	28	28	32	37	31	38	35	46
S_{16}	27	35	30	21	37	37	30	38	49
S_{17}	36	24	30	36	43	36	32	39	34
S_{18}	30	35	33	41	31	42	48	37	34
S_{19}	48	42	34	49	55	51	44	45	40
S_{20}	37								

The Table 11 above shows that most students taught using EI had percentage mean score below 50%. For instance, all sampled students in Holo had percentage mean score below 50% while in Odawa, 14 out of the 19 sampled students had percentage mean score below 50%.

Table 12: Percentage mean scores in KCSE (2014) biology examinations for schools with EI teachers

School	Percentage mean score
Moro	36.10
Lisana	33.95
Urudi	31.05
Thurgem	42.42
Sang'oro	33.26
Lwanda	35.36
Obange	39.05
Anding'o	39.32
Odowa	43.95

The Table 12 above shows that most schools with teachers using EI method in teaching biology had percentage mean score below 50%. For instance, Urudi had percentage mean score of 31.05% while Lwanda had 35.36.

This study established influence of EI on learners' performance in biology on KCSE (2014) examinations in Nyakach sub-county. The results in Table 9 shows that the percentage means scores in KCSE biology examinations (2014) for students taught using EI was below 50%. Table 12 also indicates that percentage mean score per school using EI method in teaching biology was below 50%. Therefore EI method has low influence on learners' performance in biology examinations. The low influence of EI on learners' performance might be attributed to the fact that exposition-with-interaction method fails to provide Psychological safety, sensitivity to problems and flexibility in reasoning. Moreover, it focuses more on transmitting knowledge to the learner at the expense of developing process skills, and encourages conformity to conventional knowledge thereby curtailing intellectual freedom of students. EI therefore, equates with the concept of "pouring new ideas into an empty brain." The findings tally with the results of Stella (2010), Moodhefer and Roe (2010), Ramsden (2003), Williams (2002), Race and Walker (2003), Race (2000), Ochangi (1998). However, the findings disagree with that of Maheshwari (2015), Chepkwony, (2014), Kirschner, Sweller and Clark (2012), Reid, and Zhang and Chen (2003) who found that students learn new concepts and ideas better if all of the information they need to know is laid bare before them. The disagreement could be because the researchers tested knowledge of concepts and ideas while the current study tested understanding (having concept knowledge and skills pertaining to that concept).

4.5 Comparison of GD and EI on learners' performance in biology examination

Analysis on Table 13 reveals that the percentages mean score of the GD group on biology KCSE examination (2014) was 54.09% while that of EI group was 37.34%. This indicates that there were variations between the mean score of students taught biology using GD method and those taught

Biology using EI method. The percentage mean score for biology KCSE examination (2014) of the GD group was more than that of the EI group. Therefore, the mean academic achievement of students taught biology using GD method was higher than that of the EI group.

Table 13: Means, Standard deviations and gain in achievement of GD and EI

Teaching method	N	Mean	Std. Deviation	Std. Error Mean
GD	171	54.0877	7.96303	.60895
EI	172	37.3430	7.77489	.59283

Analysis in Table 14 shows that students taught using GD method performed significantly higher than those taught using EI on the same biology KCSE examination (2014). The analysis revealed that an independent sample t-test conducted to compare the biology KCSE examination (2014) scores for GD and EI group was significant. The calculated t(341) value was 19.704. This value is greater than the t-critical significance of 0.000.

Table 14: Analysis of independent t-test for KCSE scores (2014) of GD and EI groups (p=0.005)

Group	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
GD	19.704	341	.000	16.74470	15.07306
EI	19.703	340.698	.000	16.74470	15.07306

This study compared difference in performance between learners taught using GD and EI methods on KCSE examination in biology of Nyakach sub-county. The results in Table 13 show that the

mean achievement of students taught biology using GD method was higher than that of EI method. Table 14 also indicates that those taught using GD method performed significantly higher than those taught using EI. Therefore GD method has higher influence on learners' performance than EI. The higher performance of students taught using GD method might be attributed to the fact that GD has the benefit of increasing intellectual potency by enhancing the learners' ability to organize and classify information. Information imbibed through GD becomes firmly embedded in the cognitive structure of the learner thereby facilitating retrieval. Also GD teaching is based on the fact that learning occurs as learners are actively involved in a process of meaningful and knowledge construction rather than passively receiving information.

Learners are the makers of their own learning; the teacher only facilitates and provides students with experiences that allow them to use the science process skills such as experimental design, observation and manipulation of variables. The findings tally with the results of Bundrick (1968); Kersh (1998); Omuirhiren (2002); Akinbobola (2006); Okerke (2006); Chukuneke (2006); Ifeakor (2007); Agbhogoroma (2009); Akiyemi et al., (2010) and Ibe, (2013) that GD approach was effective in enhancing achievement and retention of students in science subjects and foster students' interest in science subjects than the conventional expository method. On the other hand, the findings disagree with that of Klar and Nigram (2004, as cited in Kirschner et al., (2012) and Clark et al., (2012) who found that direct instruction involving considerable guidance, including examples, resulted in vastly more learning than guided discovery. This disagreement could be because Klar and Nigram tested content knowledge (recalling facts and principles) while the present study tested understanding (having content knowledge and skills pertaining to that knowledge).

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This is a summary, conclusions and recommendations of the findings of the study based on the objectives.

5.2 Summary

The summary of the findings of the study were as follows:

5.2.1 Frequency of use of GD and EI in teaching biology.

The study established the frequency of use of GD and EI in Nyakach sub-county.

The findings of the study using Teacher Questionnaire established that 16 (36.36%) used GD while 28 (63.64%) used EI. This meant that the frequency of use of EI was more than GD in teaching biology in Nyakach sub-county.

5.2.2 Influence of GD on learners' performance in biology

The study established the influence of GD on learners' performance in biology.

The findings of the study using a document analysis established that the percentage mean scores in KCSE biology examinations (2014) for students taught using GD was 54.09%. This meant that GD method had high influence on learners' performance in biology examinations in Nyakach sub-county.

5.2.3 Influence of EI on learners' performance in biology

The study established the influence of EI on learners' performance in biology.

The findings of the study using a document analysis established that the percentage mean scores in KCSE biology examinations (2014) for students taught using EI was 37.34%. This meant that EI method had low influence on learners' performance in biology examinations in Nyakach sub-county.

5.2.4 Comparison of GD and EI on learners' performance in biology examination

The study compared influence of GD and EI on learners' performance in biology.

The findings of the study using a document analysis revealed that the mean score of the GD group on biology KCSE examination (2014) was 54.09% while that of EI group was 37.34.%. The result also revealed that there was a significant difference between the mean score of students taught using GD method and those taught using EI (t(341)-value =19.704, t-critical value =0.000). This meant that GD had higher influence than EI on learners' performance in biology within Nyakach sub-county.

5.3 Conclusions

In reference to the findings discussed in chapter four, the study makes the following conclusions in order to find answers to research questions:

5.3.1 What is the frequency of use of GD and EI in teaching biology?

EI is frequently used than GD in teaching biology in Nyakach sub-county.

5.3.2 What is the influence of GD on learners' performance in biology?

GD method has high influence on learners' performance in biology.

5.3.3 What is the influence of EI on learners' performance in biology?

EI method has low influence on learners' performance in biology

5.3.4 How do GD and EI compare on learners' performance in biology?

GD is a better method than EI on learners' performance in biology.

5.4 Recommendations

In reference to the above mentioned conclusions, the study recommends the following based on research objectives:

5.4.1 Frequency of use of GD and EI in teaching biology

The teachers should be assisted to use GD frequently in teaching biology. This could be by means of workshops and seminars on use of GD as recommended in the biology curriculum.

5.4.2 Influence of GD on learners' performance in biology

Guided Discovery teaching method should be used to teach biology.

5.4.3 Influence of EI method on learners' performance in biology

Exposition-with-interaction teaching method should not be used to teach biology

5.4.4 Comparison of GD and EI on learners' performance in biology examination.

(i) Biology teachers as well as science teachers should use guided discovery teaching method as performance of science would be enhanced.

(ii) More attention should be given to GD for biology teacher trainees in public training institutions.

(iii) Teacher training program should update their courses so that biology teachers are able to impart the skill of study in the learner.

5.5 Suggestions for further research

In view of the fact that GD is better than EI in teaching Biology, this study recommends that further research should be conducted in the following areas:

(i) Teachers' perspective on the use of GD method in order to find out why most teachers are not using GD method despite its KICD syllabus recommendation.

(ii) Similar research should be conducted by adopting experimental design instead of ex post-facto to ascertain the current findings.

(iii) The effect of GD and EI at different age bracket levels should be established because there is scanty information from previous research to show whether GD is more influential than EI in ECDE, Primary schools, Secondary schools and Colleges.

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APPENDICES

Appendix I

Questionnaire for Biology Teachers

Introduction

The aim of this study is to compare the influence of Guided discovery (GD) and Exposition-with-interaction teaching methods on learners' performance in biology. In light of this, your participation by way of giving valuable information is crucial to the success of this study. It is hoped that the result of this study may enable teachers to adopt method of teaching biology between GD and EI that enhances understanding.

Below are definitions of GD and EI teaching methods for the respondent perusal if he deemed necessary.

Guided discovery (GD)

Guided discovery is an instructional method characterized by adoption of process skills such as hypothesis testing, designing experiment and problem solving.

Exposition-with-interaction

Exposition-with-interaction is an instructional method characterized by making statements on facts and principles, questioning on facts and principles; and note taking.

Section I

Background information

1. School----------

2. Name (optional) ----------

3. Do you teach biology in the following forms? (tick (√) where applicable)

Form 1 ( ) Form 2 ( ) Form 3 ( ) Form 4 ( )

4. For how long have you been teaching biology in your present school?

2yrs and below ( ) 3-5yrs ( ) 6-9yrs ( ) 10yrs and above ( )

4. For how long have you been teaching biology in your teaching experience?

Section II

Teaching Approach

1. In Biology, what strategy or approach do you frequently use? (Tick (√) one)

☐ Teacher-centered

☐ Pupil-centered

2. Which of the following descriptions best characterize your teaching method? (Tick (√) one)

☐ Knowledge-transmission

☐ Skills and attitude development

3. What do you believe is the best thing to emphasize in your teaching to achieve the best results? (Tick (√) one)

☐ Content

☐ Process

NB: (1. Teacher-centered-EI; Pupil-centered-GD; 2.Knowledge-transmission-EI; Skills and attitude development-GD; Content-EI; Process-GD)

4. For each of the following statements, indicate how frequent you use the approach above when teaching biology. Tick (√) in relevant spaces provided.

1= never (N) 2= less frequently (LF) 3= Not sure 4= frequently (F) 5= more frequently (MF)

(i) I identify a new concept at the beginning of the instruction

Never ( )

Less frequent ( )

Not sure ( )

Frequently ( )

More frequently ( )

(ii) I expose and guide learners to observe and, or manipulate biological materials at the beginning of instruction, so as to discover a new concept.

Never ( )

Less frequent ( )

Not sure ( )

Frequently ( )

More frequently ( )

(iii) I conduct a lesson sequentially moving from concrete to abstract concepts in defined steps.

Never ( )

Less frequent ( )

Not sure ( )

Frequently ( )

More frequently ( )

iv) I emphasize the problem solving process rather than the solution

Never ( )

Less frequent ( )

Not sure ( )

Frequently ( )

More frequently ( )

v) I outline a clear and effective solution, to the problem rather than having learners spend much time and effort on exploratory activities

Never ( )

Less frequent ( )

Not sure ( )

Frequently ( )

More frequently ( )

NB (EI- i, iii, v; **GD**-ii, iv,)

Appendix II

The Science Teaching Observation Schedule

0 3 6 9 12 15 18 21 24 27 30 33

a_1 a_2 a_3 a_4

1 ***Teacher Talk***
1a Teacher asks a question (or invites comments) which are answered by:
a_1.Recalling facts and principles
a_2 applying facts and principal to problem solving
a_3 making hypothesis and speculation
a_4 designing of experimental procedure

b_1 b_2 b_3 b_4

1b Teacher makes statements
b_1 or facts and principles
b_2 of problems
b_3 of hypothesis or speculation
$b_4$or experimental procedure

c_1 2 c_3 c_4

1c Teacher directs pupils to sources of information for the purpose of:
c_1 acquiring or confirming facts and principles
c_2 identifying or solving problems
c_3 making inferences, formulating or testing hypothesis
c_4 seeking guidance on experimental procedure

d_1 d_2 d_3 d_4

2 TALK AND ACTIVITY INTIATED AND/OR MAINTAINED BY PUPILS
2d Pupils seek information or consult for the purpose of:
d_1 acquiring or confirming facts or principles
d_2 identifying or solving problems
d_3 making inferences, formulating or testing hypothesis
d_4 clarifying experimental procedures

e_1 e_2 e_3 e_4

2e pupils refer to teachers for the purpose of:
e_1 acquiring or confirming facts and principles
e_2 seeking guidance when indentifying or solving problems
e_3 seeking guidance when making inferences, formulating or testing hypothesis
e_4 seeking guidance on experimental procedure

1c Teacher directs pupils to sources of information for purpose of:

Appendix III

Document Analysis Guide

1. What is the mean score of Form 4 students in the 2014 biology KCSE examination in Nyakach sub-county?

2. What is the distribution of students mean score in the KCSE (2014) examination in the sub-county?

3. What is the difference in performance between students taught using GD and EI in the KCSE (2014) examination in the sub-county?

Appendix IV

KCSE (2014) Biology Results in Nyakach sub-county

Name of School	No of students	Category (GD or	%mean score
Nyabondo	29	GD	60.13
Odowa	19	EI	43.95
Urudi	19	EI	31.05
Thurgem	18	EI	42.42
Thurdibuoro	28	GD	55.39
Moro	20	EI	36.10
Obange	19	EI	39.05
Magunga	29	GD	50.38
Lisana	19	EI	33.95
Nyakach	28	GD	53.23
Agai	28	GD	51.93
Sang'oro	19	EI	33.26
Nyong'ong'a	29	GD	52.11

Appendix V

Kenyan Secondary School Biology Syllabus

Appendix VI

MAP OF NYAKACH SUB-COUNTY

Appendix VII

LETTER OF CLEARANCE TO CONDUCT RESEARCH