EFFECT OF TEACHING USING PREFERRED LEARNING STYLES ON STUDENTS' PERFORMANCE IN BIOLOGY AND GEOGRAPHY IN SECONDARY SCHOOLS IN NAIROBI COUNTY, KENYA

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A Thesis Report Submitted to the Institute of Post Graduate Studies of Kabarak University in Partial Fulfilment for the Requirements of the Award of the Degree of Doctor of Philosophy in Education (Educational Psychology)

KABARAK UNIVERSITY

OCTOBER, 2018

DECLARATION

This thesis is my work and to the best of my knowledge, has not been presented for an award of a degree in any university or college.

……. ……..

Kaitho Simon Sila **Date**

REG.NO. GDE /M/0938/9/10

RECOMMENDATION

To the Institute of Postgraduate studies:

The research thesis entitled **"Effect of teaching using preferred learning styles on students' performance in biology and geography in secondary schools in Nairobi county, Kenya"** and written by **Kaitho Simon Sila** is presented to the Institute of Post Graduate Studies of Kabarak University. We have received the research thesis and recommend it to be accepted in partial fulfilment of the requirement for the award of the degree of Doctor of Philosophy, in Educational Psychology.

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ACKNOWLEDGEMENT

First, I express my deep gratitude to my supervisors: Prof. Gladys Kiptiony, and Dr. Owen Ngumi, for their expert guidance, encouragement, and advice that have helped me to perfect this report. I am grateful to the Institute of Post Graduate Studies, Kabarak University, and National Commission for Science, Technology, and Innovation for granting me permission to carry out the study. In addition, the fieldwork was successful because of the Principals of secondary schools in Nairobi County who gave me the opportunity to undertake the study in their sampled schools. I would like to thank my loving wife, Monica Mutave Sila, for her financial support and moral encouragement and my children: Jared, Japheth, and Jemima for their patience, love, support, and prayers to God during my study.

DEDICATION

I dedicate this work to all teachers who have committed their time and resources to effective teaching of their learners.

ABSTRACT

Learning styles influence students in all levels of education and a mismatch of teaching styles to preferred learning styles makes learning a stressful experience to many learners. In Nairobi County, students in both private and public schools have not been performing well in sciences. In the study, matched teaching styles with preferred learning styles were conceptualised as the independent variables that determine their performance in biology and geography. The purpose of this study therefore was to establish the effect of matching of teaching styles with preferred leaning styles of students' performance in biology and geography, in private and public secondary schools in Nairobi County. This County was chosen because of unsatisfactorily performance in sciences as, only 12.632% of the schools got a mean grade of B- and above, in the years 2004 to 2010. The study was based on Felder Learning Style Theory, and Grasha Teaching Style Theory. The study employed quasi-experimental research design, where a pre-test, treatment of experimental group and a post-test were used to estimate the impact of an intervention of mismatch of traditional teaching styles with preferred leaning styles in secondary schools in Nairobi County. A purposive sample of 1,322 Form Two Students in private and public schools were randomly selected for the study. Questionnaires and pre-test and post-test were used to collect quantitative data. A full disclosure of the nature of the study was given to subjects with an extended opportunity to ask questions and get their free consent to participate. The content and face validity of the two instruments were examined by experts and which were used to improve the tools before they were used to gather data. The reliability of treatment questionnaire and achievement test in pilot study were estimated using the Pearson's Correlation method and yielded a reliability coefficient of .723 and .955 respectively which were high enough to judge the instruments as reliable. The collected data was analysed with the aid of the Statistical Package for Social Sciences (SPSS) version 22. Data was described and summarized using percentages, and means. Multivariate analysis of variance and linear regression analysis showed statistically significant effect on performance of students taught using preferred learning styles in geography and biology. However, linear regression analysis of main effect of gender and type of schools (private and public), on performance in sciences of students taught using their preferred learning styles showed no statistically significant differences. The study is significance in informing teachers of the need to identify and teach their learners according to the learners' preferred learning styles to enhance their performance in sciences. The study recommends that the ministry of education science and technology ensure facilitation is done to enable teachers detect the learning style to use in different setting.

Key Words: Learning styles, teaching styles, performance, and biology and geography

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LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA: Analysis of Variance

ID: Identity

GLM: General Linear Model

KNEC: Kenya National Examination Council

MANOVA: Multivariate Analysis of Variance

MBTI: Meyers-Briggs Type Index

SMASSE INSET: Strengthening of Mathematics and Science in Secondary School Education In-Service Training

USA: United States of America`

OPERATIONAL DEFINITION OF TERMS

The following terms were operationalized to carry the following meaning:

Flanders Interaction

Analysis: This is evaluation of verbal interaction of teacher and learner in a learning situation. In this study, it refers to acceptance of learners in non-threatening manner, praise, or encouragement of actions and use of their suggested ideas.

Learning Styles: These include characteristic cognitive, affective, and physiological behaviours that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. They are ways students prefer to receive and process information during learning process. In this study, they refer to the way students prefer to receive and process scientific information in study biology and geography.

Mismatch: This is a pairing or combination of people or things that are incompatible with or apparently ill-suited to each other. In this study, it refers to pairing inappropriate teaching approaches with learning choices that are incompatible with learning styles.

Performance: This is how somebody does a job judged by its effectiveness, or the act of carrying out or accomplishing something such as a task or action. In this study, it refers to the test scores in pre-treatment and post-treatment of the students in biology and geography.

Post-test: This is an educational term which refers to a battery of tests given after a treatment process. In this study, it refers to biology and geography tests from area covered by regular teachers given to experimental group after treatment.

Preferred: This refers a choice which is most appropriate or favouring or fitting a situation of learning.In this study it refers to the choice of learning style most appropriate for each learner.

Pre-test: This is an educational term which refers to a battery of tests given before a treatment process **.** In this study it refers to biology and geography tests from area covered by regular teachers given to experimental group and control group before treatment.

Self-efficacy: The building of self-confidence in learning new information as it relates to significant valuation for student progress and advancement. In this study it

refers to a student's overall feelings toward capability to learn sciences readily and with ease.

Science: This is the study of the physical and natural world and phenomena, especially by using systematic observation and experiment. In Kenyan Education School System, it refers to biology, chemistry, physics, and geography subjects. In this study it refers to biology and geography subjects.

Teaching style: Refers to those enduring personal qualities and behaviours that appear in how teachers conduct their classes. In this study, it refers to traditional/common personal qualities and behaviours of teachers that appear in how teachers conduct their classes regardless of the preferred learning styles of their learners.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

In the Kenyan Education System (8-4-4), examinations and tests assess learning at each level of a student's life. This is a valid and undoubtedly, a fine way of determining students' learning ability and capacity. Learning is the process of acquiring, understanding, applying, and extending skills, attitudes, knowledge and concepts (Knoef**,** Mckenney & Coenders, 2017). On the other hand, learning style is the way students prefer to receive and process information (Rahadian & Budiningsih, 2017). Performance is determined by testing what the student can remember or apply, analyse, synthesize, or evaluate in a new situation. Testing evaluates teaching effectiveness. Felder and Soloman (2011) found that students preferentially take in and process information in different ways: by seeing and hearing, reflecting and acting, reasoning logically and intuitively, analysing and visualizing.

On the other hand, traditional teaching styles are those enduring personal qualities and behaviours that appear in how teachers conduct classes, which includes the expert, formal authority and personal model styles, facilitator and delegator teaching styles (Mohanty, 2015). These styles are founded on traditional teaching methods lectures, discussions, demonstrations, laboratories, projects, inquiry problem solving and activities (Akhtar & Saeed, 2017). These styles may not necessarily match the preferred learning styles in a classroom situation (Lee *et al*., 2014). The traditional teaching styles are either teacher centred or student centred who believe students have definite and fixed perceptions and ideas of their own roles and those of their teachers. The students are there to learn through instructions, and the focus is mainly passing tests and assessment where those who fail are because of their low ability or laziness (Audu, 2018). On the other hand, matched teaching style is an interactive process of sharing knowledge and skills with students, with a view to improving students' understanding and ability to manipulate the social, economic, political, and physical environment to enhance their survival (Odundo, 2013).

In Australia, a study by Brett, Ted, and Christian (2013) was done to investigate the learning style preferences of undergraduate paramedic students using a cross-sectional paper-based version of the Kolb Learning Style Inventory (K-LSI) to a cohort of students enrolled in an undergraduate paramedic degree programme. The results indicated that undergraduate

paramedic students prefer two learning styles: the Diverger style of learning (31%) and the Accommodator style of learning (26.5%). This study implied that different learners even in secondary level could have specific preferences of styles of learning. The researcher recommended that educators take into consideration the learning style preferences of undergraduate paramedic students when developing curriculum and evaluating teaching approaches, to enhance their academic performance, which could also be suggested to secondary school teachers. In a study in South Africa by Pather, Norodien-Fataar, Cupido and Mkonto, (2017) to determine whether students awareness of their learning styles improve their academic performance, it was found that college students' knowledge of their learning styles increased academic success and reduced dropout rate.

In Kenya, a study by Mutua (2015) in Machakos - Kathiani Sub-County was done on the relationship between learning styles and academic achievement among secondary school students in Kenya. Mutua found that there was positive and statistically significant relationship between learning styles and academic achievement for the trimodal learners, and among male and female students. However, analysis of specific learning styles and the effect of mismatch of teaching styles to preferred learners' styles have not been done in Kenya. The traditional way of teaching sciences in Kenyan secondary schools is the use of ASEI-PDSI (Activity-focused Student–centred learning Experiment Improvisation - Plan, Do, See, Improve) approach which continue to yield unsatisfactory performance (Makewa *et al*., 2011).

An analysis of repeated difficulty areas in performance of sciences, which refers to biology, chemistry, physics, and geography in Kenyan Education System in the last few years, indicates possible teacher-learner style mismatches in their learning process. In Biology Examination Reports of years 2006 to 2011 by Kenya National Examination Council (KNEC) on candidates' responses across the three Biology papers out of 84 difficulty items, 21 (25%) indicated common use of wrong spelling of biological terms, 14 (16.66%) incorrect use of biological terms, and 14 (16.66%) inadequate application of practical skills. A higher percentage, 35 (41.67%) indicated inadequate knowledge of the subject content (KNEC, 2007, 2008, 2010, 2011, 2012). In Chemistry, the situation was not different. An analysis of Chemistry Examination Reports of years 2006 to 2011 by KNEC on candidates' responses across the three Chemistry papers, out of 52 difficulty items 18 (34.62%), indicated inadequate exposure to practical procedures, 7 (13.46%) inability to write correct equations

and symbols of reactants, and 6 (11.54%) weakness in stating accurately observation made. A higher percentage 21 (40.38 %) were on inadequate knowledge of content (KNEC, 2007, 2008, 2010, 2011, 2012). The analysis of national performance in the sciences in 2006 -2011 was not satisfactory (Table 1).

Table 1: KCSE Percentage Mean Scores in Sciences 2006 to 2011

Year	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**
Biology	32.44 %	29.73 %	27.20 %	30.32 %	32.01 %	27.42 %
Chemistry	23.66 %	24.91%	19.13 %	22.74 %	24.27 %	24.54 %
Physics	36.64 %	35.13 %	31.33 %	36.71 %	36.95 %	34.42 %
Geography	48.97 %	46.13 %	39.80 %	37.01 %	49.66 %	40.88 %
Average	**35.42** %	**39.19** %	**29.36** %	**31.69** %	**35.72** %	**31.81** %

Sources: (Kenya National Examination Council Reports, 2010, 2011, & 2012)

The percentage mean scores ranged from 19.13% to 49.66%. In Nairobi County, analysis of general mean performance in sciences indicted persisted satisfactory performance during the period 2006 to 2015 (Table 2).

Table 2: Nairobi County Schools' KCSE Mean Grades in Sciences 2012 to 2015

Year	**2015**	**2014**	**2012**	**2011**	**2010**	**2009**	**2006**
Biology	5.93 C	4.74 C-	5.20 C-	5.20 C+	5.16 C-	4.39 D+	5.21 C-
Chemistry	5.03 C-	4.22 D+	4.60 C-	4.23 D+	4.30 D+	3.62 D+	4.62 C-
Physics	6.35 C	4.91 C-	6.84 C+	5.79 C	6.00 C	4.23 D+	6.49 C+
Geography	6.80 C+	6.62 C+	6.39 C	6.62 C+	5.44 C-	5.07 C-	6.1 C
Average	**6.03 C**	**5.12 C-**	**5.75 C**	**5.46** C-	**5.22 C-**	**4.33 C-**	**5.61 C**

Sources: (Kenya National Examination Council Reports 2011, 2012, & 2015)

Table 2 shows that the mean performance in sciences ranged from 3.62 D+ in chemistry to 6.8 C+ in geography. This low performance was across all types of schools, both private and public. There was a gap in analysis of the impact of traditional teaching styles on the

performance in sciences, in private and public secondary schools in Nairobi County. It was against this background that the researcher proposed to use test re-test method to evaluate the effect of matching teaching styles with preferred learning styles on students' performance in biology and geography in secondary schools in Nairobi County.

1.2 Statement of the Problem

In the recent past, the Kenyan government has been concerned on how to improve secondary school students' performance in sciences. However, literature review, indicate regardless of the effort of the government in the Strengthening of Mathematics and Science in Secondary School Education In-Service Training (SMASSE INSET), the Sciences that include biology and geography had no significant improvement year after year. The prescribed traditional ASEI-PDSI (Activity-focused Student–centred learning Experiment Improvisation - Plan, Do, See, Improve) approach in teaching has not yielded the expected high performance. The students in private and public secondary schools in Nairobi County have been performing unsatisfactorily in sciences in the last seven years. There is a gap of analysing the contribution of mismatching teaching styles with preferred learning styles to the unsatisfactorily performance in sciences. In the County, only 12.632% of the schools got mean of B- and above 24.471% got mean of C- to C+ although majority of the schools 62.896% got mean of grade D+ and below in biology, physics, chemistry and geography in the years 2004 to 2010. Since effective teaching requires every educator to know how their students' learn and the traditional teaching styles continually yielded unsatisfactory results there was need therefore, for a study to be carried out focusing on effect of teaching using preferred learning styles on students' performance in biology and geography in secondary schools in Nairobi County.

1.3 Purpose of the Study

The purpose of this study was to establish the effect of teaching using preferred leaning styles on students' performance in biology and geography in private and public secondary schools in Nairobi County.

1.4 Objectives of the Study

The researcher endeavoured to achieve the following objectives:

i) To determine the effect of teaching using to preferred learning styles on students' performance, in biology and geography in secondary schools in Nairobi County.

ii) To determine effect of gender on performance of students in biology and geography taught using preferred learnings styles in secondary schools in Nairobi County.

iii) To establish the differences in performance in biology and geography between private and public secondary students taught using their preferred learning styles in secondary schools in Nairobi County.

1.5 Hypotheses

Ho_1 There are no statistically significant effects in performance in biology and geography between students taught in their preferred learning styles and those taught using traditional teaching styles in secondary schools in Nairobi County.

Ho_2 There are no statistically significant effects of gender differences on performance in biology and geography of students taught according to preferred learning styles, in secondary schools in Nairobi County.

Ho_3 There are no statistically significant differences in performance in biology and geography between private and public secondary students taught using their preferred learning styles in secondary schools in Nairobi County.

1.6 Significance of the Study

The teaching of science subjects in Kenya since the inception of the 8-4-4 system of education has become a matter of debate by the parents, teachers, students, and among other stakeholders, due to poor performance in the national examinations by many candidates. This study will inform teachers of need to identify and teach their learners according to the learners' preferred learning styles to enhance to their performance in biology and geography. This may aid the teachers get information about how their students learn, which will provide them with a deeper understanding, and determination of mismatch of teaching styles to preferred students' learning styles may suggest to educators at all levels of learning to change their teaching to better meet learning styles preferences of their students. This study can aid students in identifying and utilizing their preferred learning styles and take advantage of those preferences under their teachers' guidance. Providing students with learning material and activities that fit their preferred ways of learning can make their learning easier and may improve performance.

The improvement in the performance of science subjects in Kenya will aid the Country to realise its goal of industrialization by 2030 and for it to become globally competitive. The

result of this study can aid textbook writers and e-learning programmers to develop technology based teaching and learning materials diversified to meet the learning preferences of all the learners from infancy stages in most education settings. This can also guide the ministry of education quality assurances to articulate well their assessments and recommendations on effective teaching and evaluation in educational institutions. It can also enhance teacher training in colleges and universities to put emphasis on learning styles.

1.7 Scope of the Study

This study covered the effect of teaching using preferred learning styles on students' performance in biology and geography in secondary schools in Nairobi County, Kenya. It was delimited to secondary schools in Nairobi County of Kenya, which had both private and public secondary schools with varied performance index in sciences, there by getting a reflection of the effect of mismatch in teaching and learning representative to all secondary schools in the Country. The study was delimited to Form Two Students in the private and public sampled schools because they had stayed in secondary school system for a reasonable period, and matured compared to form ones. In addition, they were taking all the sciences compared to Form Three Students and Examination Classes who had selected the electives. The study was further delimited to performance in biology and geography in secondary schools in Nairobi County. Other sciences, which performed equally, could have been chosen however, biology and geography was representative of physical and biological sciences. The study only investigated preferred learning styles of students in biology and geography despite of unsatisfactory performance existed in other sciences in the County. This was deu to constrain of limited resources and time.

1.8 Limitations of the Study

The following posed as limitation to this study:

The study lacked randomization of the subjects when forming groupings. This was mitigated with pre-tests. The study was confined only to private and public secondary schools in Nairobi County and therefore its findings would be applied to all levels of learning with similar urban and rural set up.

1.9 Assumption of the Study

The following assumptions were made in relation to the study:

i) All the students selected would cooperate and freely self-express their preferred learning styles.

ii) All the learners would be of sound health during the taking of pre-test and post-test.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter is a summary of scholarly works of existing literature on preference of learning styles and their effects on academic performance. It explores effects of concept of mismatch and match of teaching styles and learning styles to performance of students in biology and geography in private and public schools. It also focuses on critical analysis of gender, students, and type of school differences in performance in biology and geography among those students taught in their preferred learning styles from those taught without considering their learning styles.

2.2 The Concept of Preferred Learning Styles and Creation of Mismatch

The concept of preferred learning styles is the combination of characteristics of cognitive, affective, and psychological elements (Abidin *et al.,* 2011). According to Bayrak (2012) learning styles are collections of personal characteristics, strengths, and preferences, describing how individuals acquire, store, and process information. The different factors that influence personal qualities include information processing modes, environmental and instructional preferences, cognitive capabilities, gender and personality features. The cognitive capabilities involves meta-learning which is the awareness of learning styles one possesses, which creates the need for high levels of meaningful learning to enhance creativity and new knowledge creation. It consists of a product (knowledge), thought process, (the routes to new learning), and a behavioural process, (the regulation of behaviours that enhance learning) (Alharbi *et al.,* 2011). These elements determine the way of perceiving, interacting with, and responding to the learning environment. They determine how one particular individual will react to a specific situation and how he or she will behave in a unique or common learning situation (Abidin *et al*., 2011).

Most high school students are not aware of how they learn and why certain ways of learning resonate with them. Seifert (2016) noted that students do not tend to reflect on the learning processes that are most productive for them. They simply learn and produce outcomes with little thought of the process itself. However, students who are aware of their own learning styles easily adapt to varied teachers' instructions, which enhance performance in sciences. This also creates self-regulated learning, which does not completely rely on the teachers' participation. Furthermore, Hendry et al. (2005) have found that awareness of learning styles

and choice of study strategy options are positively correlated to students' achievement. Hendry investigated how offering students different instructional options based on their learning styles affected learning outcomes in a positive way. It was observed that such offering had a significant effect on students' overall achievement. Conversely, Gilakjani, (2012) examined how students cope with the experience of having to learn when their learning style does not match that of the teachers' style of teaching. Gilakjani (2012) found that students had lower achievement when teaching approaches did not match their learning styles and he advocated for adaptive instruction within their learning perception. Students who endure incongruent learning experiences suffer from diminished self-efficacy for tackling novel learning experiences in the future (Luedtke, 2016).

In a study in South Africa by Pather et al. (2017) to determine whether students awareness of their learning styles enhanced academic performance it was observed that students coming from the previously disadvantaged educational backgrounds were not aware of their own learning styles which could otherwise empower them to understand how to adequately be prepared for tertiary learning. In Kenya according to Musamali (2014), the best performing schools have the practice of training their candidates on study skills, which articulate their learning styles, nevertheless, a gap remains in the literature of effect of matching of teaching styles with preferred learning styles and performance of students in biology and geography. In-depth research revealed three models that display what teachers should consider in their style of presentation of content to enhance performance of students. The three models include personality patterns model, perceptual model, and information-processing model.

2.2.1 Information Processing Model

Information processing model or cognitive styles, describes learning style as the manner of acquiring and processing information by the brain (Lusweti *et al.,* 2018). The brain must actively generate meaning to make sense of new experience, to create the neural networks in which knowledge resides, and to organize them in ways that facilitate easy retrieval (Gee, 2011). This implies that learning can be impaired if the learner perceives incongruence of the preconditions (Daemi *et al.,* 2017). Mohsen (2017) argues that successful teaching for comprehension, application, analysis, synthesis, and evaluation involves guiding the learner to generate relations among concepts and between new information and prior learning.

However, performance during learning process is a poor predictor of future performance because it reflects the momentary accessibility of knowledge (i.e., retrieval strength) rather than how well it has been stored in memory (i.e., storage strength) (Langley *et al.,* 2017). Mismatch of teaching style to learning occurs in the event where teachers rely on immediate performance during the learning process which make them fail to comprehend the poor performance of their learners at the end of course of study. To understand processing model and the distinction between retrieval strength and storage strength is to try answering the following question: What did you eat for dinner last night? You probably retrieve the answer very quickly and easily because retrieval strength is high for that particular memory, (since it is very recent, and you have not eaten any other dinners in the interim). However, a month from now is unlikely to remember what you ate last night because retrieval strength dissipates overtime. Instead, remembering your dinner a month from now would depend upon the storage strength of the memory of that particular dinner. Storage strength increases when a memory is retrieved or the event is re-experienced (Gee, 2011). However, mismatch occurs where frequency of testing and revision is low. On the other hand, the goal of learning must be to increase storage strength, not momentary accessibility.

The storage strength is increased in learning by introducing desirable difficulties during learning which result in superior long-term retention because the greatest gains in storage strength occur when retrieval strength is low (Marsh & Butler, 2013). According to Roediger (2008), the general laws of learning and memory, none withstands manipulation across the four sets of factors identified as critical to memory experiments by that Jenkins (1979) as cited by Bianchi, (2011). The fact that simple laws, that is, types of subjects, kinds of events remembered, manipulation of encoding conditions, and variations in test conditions (Pandeirada *et al,* 2017) do not hold reveals the complex, interactive nature of memory phenomena and diversity of learning styles preferred by different learners.

Research has shown that learning is better when the processing induced by the materials is complementary to the processing of the learning task (Beaudoin, 2015). However, characteristics of the learner will affect whether the processing induced by a particular task enhances memory. Karl-Heinz et al. (2014) observed that repetition provided the occasion for organization to occur and organization support good recall. Repetition effects refer to any situation in which a repeated event is better retained than an event presented once. However,

repetition does not always improve performance and therefore it is limited to particular learners.

On the other hand, although spaced repetitions do lead to greater retention than massed repetitions under many circumstances, numerous experiments have failed to find such an effect. Spacing or lag effects refer to cases in which a systematic increase in retention occurs with the amount of lag or spacing between two events. This implies it can be used as style of teaching but with limited application because learners have different preferred learning styles. Karl-Heinz et al. (2014) observed that, presentations of material that were distributed in time were retained better than presentations presented close together in time. Distribution effects refer to the case when events distributed in time are better recalled than ones presented back-to-back, or massed. Distribution of repetitions do not qualify as law of memory and learning due great diversity of preferred learning styles although spaced repetitions do lead to greater retention than massed repetitions under many circumstances.

The processing of information includes hemispheric lateralisation where right brain is associated with global learners and left-brain with analytic learners (Varghese & Pandya, 2016). The left-brain thinkers learn in a systematic logical format and like to split the subject matter into smaller parts so are the sequential and analytical learners. Analytic learners' value established knowledge and detail, because they prefer sequential, systematic learning and right- and left- brain lateralization for specific or localized areas rather than a purely right or purely left global lateralization (Leahy *et al*., 2017). In other words, instead of having a left- or right-brain global preference, individuals use specific areas of the brain for specific tasks: these areas may be in different hemispheres of the brain.

Lateral biases may be a more appropriate term. Rogers (2014) notes lateral biases as activity either to the left or to right depending on the brain region and task. Right- or left-handedness in primates and humans affects brain function; however, it is not a whole right- or left-sided difference. These generalizations are not a function of solely one side of the brain; research has pinpointed specific areas of the brain that are active during tasks unique to the individual and therefore learners cannot be categorised as left or right brain thinkers (Leahy *et al*., 2017). As Nielsen et al. (2013) indicates areas in the brain participate in strongly lateralized connections in both hemispheres; however, areas in both the left- and right-hemispheres communicate and function together. While complexity of the brain continues exploration,

with much more to be learned, lateralization and specialization is evident in both humans and animals from the extant literature. This implies the teacher can plan the environment, lessons and activities, and materials to cater for many categories of learners in classroom setting.

Willingham et al. (2015), demonstrated that, contrary to the wide belief Piaget's four distinct stages of development and other cognitive stage theories, research over the past 20 years suggests cognitive development is a continuous process that varies based on the individual and the cognitive task. A more accurate description of cognitive development from birth to adolescence is a developmental sequence that is not entirely concrete for all areas. Moreover, research shows a child's behaviour indicates movement back and forth between cognitive levels (Fischer & Bidell, 2006). For example, a first grade student may be able to solve a math problem one day; however, the following day he cannot. If cognitive stages were concrete steps, once the stage is reached those abilities accompanying the cognitive development would remain. Synchronous, concrete stages would not allow this child to be in both stages. Cognitive development is a seamless multi-dimensional movement, not a concrete transition from step to step. By looking at individual differences, using effective instruction, and providing appropriate tasks, educators should recognize that no content is fundamentally developmentally inappropriate (Willingham *et al*., 2015). Looking beyond synchronous, concrete cognitive developmental stages, professional educators can focus on providing appropriate foundational experiences, background information, and appropriate methods of instruction for all students.

Fiechter (2017) postulates that testing benefit learning to varying degree when its mode is use as a teaching style to enhance memory strength. Making things hard on yourself, but in a good way while creating desirable difficulties to enhance learning. When testing is assumed as part of teaching strategy, which further informs effectiveness of teaching, it plays a critical role in performance of students or otherwise create mismatch in learning. A study conducted by Honigsfield and Dunn (2009) throughout the United States of America found that standard tests in schools tend to be analytical and sequential cognitive, and common approach to teaching in secondary schools is carried out using the traditional method of using chalk and talk, lectures, writing notes, reading and topical test after a given area. This style of teaching and testing is not different from the Kenyan schools, which tend to favour a section of learners with lateral biases in analytical, verbal, linear, and logical learners.

However, the examination results showed the great numbers of students failed to pass satisfactorily after exposure to such traditional teaching methods especially the global, visual, rational, and intuitive learners (Subramaniam *et al.,* 2014). Bos (2002) postulates that global and intuitive learners needs time to process input and build the physical connections that are necessary for storage and processing of new information in the neural network. However, mismatch and unclear understanding is more likely to occur if rushed over the content and try to do too many things in too short a time and there is inadequate time of writing tests, they seem to finish last and even leave gaps. Testing effects refer to the advantage often conferred on retention if subjects actively retrieve information (Karl-Heinz *et al*., 2014).

Research by Marsh, and Butler (2013) indicated that the testing effect could be powerful when retrieving only some of the information and not receiving feedback, which usually produces better retention than does restudying the whole set of material, although obtaining this effect depends on the delays used in the first test. However, Karl-Heinz et al. (2014) noted that if the first test delayed so long, performance on it was quite poor, and then the testing effect was low. Marsh and Butler (2013) displayed that after two days or a week, the study-plus-test condition outperformed the repeated-study condition, showing that taking a test (even without feedback) is better for long-term retention than an equivalent time spent in repeated study.

Testing as strategy of teaching probably does not help much when retrieval occurs from working memory but only when it occurs with some difficulty from secondary memory. Testing can have a large influence on performance, as with the other variables considered in this section, but no general law cuts across because leaners have different preferred styles of processing information (Karpicke & Roediger, 2007). This called for the need to establish the effect of traditional methods of teaching secondary students biology and geography in Nairobi County with the intension of establishing whether they adhere to the principles of gain in storage strength of memory that determines long-term retrieval of knowledge and to identify different preferred learning styles of students.

2.2.2 Personality Patterns Model

As stated by Keirsey (2013) and Longchamp (2017), personality patterns model views learning styles as personal qualities that influence a student's ability to acquire information, to interact with peers and the teachers, and otherwise participate in learning experiences. This

implies that there are personalities a teacher must demonstrate and practice during learning process in order to activate the innate qualities for learning to take place. In this sense, personality model seems to articulate aspects of learning that are motivational and critically influence learning. However, mismatch occurs in the event where teachers cannot accurately identify the preferred personality learning styles of the learners. Personality learning styles refers to distinctive behaviours, which serve as indicators of how a person learns from and adapts to his environment, and provide clues as to how a person's mind operates (Al-Sarem *et al.*, 2014).This implies that to match and sustain personality learning styles of different learners in a class teachers must develop emotional intelligence.

Goleman (1998) upholds that Emotional Intelligence is the capacity for recognizing our own feelings and those of others, for motivating ourselves, and for managing emotions well in ourselves and in our relationships. Teachers must develop emotional and social intelligence to teach learners with diverse personality learning styles (Walter, & Marcel, 2013). This involves development in the aspects of Self-awareness, Self-regulation, Motivation, Empathy, and Social skill. Self-awareness is the ability to recognize and understand your moods, emotions, and drives as well as their effects on the learners. This includes paying attention on how learners influence your emotional state and having realistic self-assessment and self-deprecation sense of humour. Self-regulation is the ability to control or redirect disruptive impulses and moods. It involves the propensity to suspend judgement and think before acting to accommodate deserving learners and development of comfort with ubiquity and openness to change and organisational commitment.

Motivation is a passion to work for reason that goes beyond money, status, and recognition. It involves a propensity to pursue goals with energy and persistence even in the face of failure where you do not give up about them. Empathy is the ability to understand the emotional makeup of the learners. It involves the skill in treating learners according to their emotional reactions and expertise in building and retaining cross-cultural sensitivity. Social skill is proficiency in managing relationships and building networks among the learners. It involves development of ability to find common ground where they have different views and build a rapport. In addition, caring what learners are going through as well as hearing their opinions. Similarly, Nehdi, (2016) also stipulates that, the use of whole brain thinking of Daniel Goleman to manage personality differences among learners have everything to do with

teachers' performance to think about how students' brains learn when designing learning and performance programs.

Moreover, research by Nolting (2014), indicate that, variables contributing to student academic achievement include cognitive entry skills, affective characteristics, and quality of instruction. Example in maths and sciences, cognitive entry skills (how much math or science concepts you know before entering a new course), and intelligence quotient (how fast you can learn old and new concepts) contribute 50% of the course grade. However, mismatch occurs in the event where instructors cannot accurately identify the entry skills in a learner and develop them. The quality of instruction (effectiveness of math and science instruction: textbook, teaching style, extra teaching aids, etc.) contribute 25% of the course grade. On the other hand, affective characteristics (personality, self-concept, locus of control, motivation, attitudes, anxiety, and study habits) contribute 25% of the course grade.

However, most students do not have this 25 percent of the grade in their favour because of mismatch of personality learning styles by teaching personalities in mode of motivation and attitude management of their instructors. Attitude is an inward feeling expressed in our outward behaviour. It comes from our personality, our environment, the impact of others, our self-image, and our exposure to growth opportunities, our association with others, our beliefs, and our choices. However, mismatch occurs in the event where teachers fail to accept learners' in non-threatening manner, praise or encourage students' actions, accept and use ideas suggested by students and ask questions with intents that students answer without victimization (Kang'ahi *et al.*, 2012).

Effective management of learners' attitude by teachers contribute to development of positive academic, attitudinal, and social outcomes for students such as regular attendance, on-time promotion to the next grade, on-time graduation, self-efficacy, and cooperative behaviour (Longchamp, 2017). Self-efficacy is what allows a person to tackle a challenge with motivation of mastery, instead of avoidance and viewing a challenge as a threat. According to Keirsey, (2013) there are four personality learning styles displayed by learners which a teacher must identify and match his/her teaching style for effective performance. The personality learning styles include idealist, rational, guardian, and artisan learning styles.

a) The Idealist Learners

Keirsey (2013) postulates that**,** idealist learners are intuitive feeling conceptual-global learners who seek to discover how their learning relates to themselves and to their relationships with others. However, mismatch occurs in the event that teachers fail to help their learners discover how their learning relates to themselves and to their relationships with others. In line with Jordan, Carlile and Stack (2008), Idealist learners with science mind-set are favoured by personal model teachers with friendly scholars' personality who emphasize academic knowledge and teacher personality characteristics (want the students to like what they learn from them). Such teachers, stress immediate relevance of science subject matter, how subject areas help students solve personal problems and understand current issues and events. The students take a broad, holistic view of things, and tend to dislike details (Arzy-Mitchell, 2013). Brief summaries of lesson covered in class help such learners to remember concepts during examination time (Noguera, 2013). Idealist learners enjoy learning about ideas and values, and tend to look at them more subjectively than objectively. They are highly impressionable, easily affected by the opinions of others and may need assistance in becoming a participating member of the classroom (Dunlosky *et al.,* 2013).

They are expert judges of character and sensitive to others. However, mismatch is perceived from teachers who revert to using expert teaching style challenging the students to enhance their competence in abstract scientific concepts. They are vulnerable to criticism and conflict. Noguera (2013) identifies idealist learner as hypersensitive to the slightest gesture or word of rejection, especially from a teacher he/she idolizes. This implies teacher-rewarding pattern critically affect their learning. Fostering positive attitude to sciences is cultivated by rewarding even slight effort by the leaners. In this study, there was need to find effect of mismatch created by insensitivity of teachers to the needs and lack of relevance of content to daily life of students in learning biology and geography in Nairobi secondary schools.

b) Rational Learner

Harlow et al. (2017) postulate that, rational learners are intuitive thinking conceptual-specific learners who learn by creative thinking. The scientist type wants to be able to understand, explain, predict, and control realities. They are usually not interested in isolated facts, but want to use theories and principles to explain facts (Keirsey, 2013). They tend to be intellectually competitive. Students in this group will vary greatly in the quality of their thinking, so teachers should be careful to match expectations with these students' ability

(Keirsey, 2013). Learning concrete information or following a routine task will hold little interest for these students. They frequently have difficulty relating to others and are often perceived as cold, unfeeling and arrogant (Fussell, 2017). Such students feel isolated, and experience a deep sense of loneliness. They need nurturing of interpersonal skills. They prefer teachers who use concrete examples to illustrate critical information and allow them time to formulate and ask questions (Felder & Brent, 2017).There is need to find out if traditional teaching practices match personality preferred leaning styles or students feel left out when learning biology and geography in secondary schools in Nairobi County.

c) Guardian Learners

The guardian learners are sensing judging learners who learns best in orderly and well-structured classrooms (Keirsey, 2013).This is especially in practical areas in sciences with clear instructions. Sensing learners focus on responsibility, developing good study habits, developing proper social attitudes, and on completing well-structured assignments, which have met with teachers' approval (Janet, 2008). They gain knowledge through identifying and memorizing facts and procedures, through repetition and drill, and through sequenced, systematic presentation of material (Janet, 2008). They need clear expectations and specific procedures for accomplishing a task. They are most interested in the mechanics and the practical aspects of the subject when studying a subject (Keirsey, 2013). They have problems with teachers who dwell on fundamentals, abstractions and theoretical principles of subject matter (Willis, 2017). There is need to find out if traditional teaching styles affords practical approach and orderliness in learning sciences which could create matching in teaching learning process.

d) Artisan Learners

The artisan learners are sensing spontaneous learner who prefers to learn by experience (Keirsey, 2013) especially from science teachers who demonstrate practical skills. These students are interested in dealing with physical realities. They try to do written work as expediently as possible, paying little attention to neatness. They enjoy frequent changes from individual to small group to large-group activities (Fussell, 2017). They appreciate the random use of variety of equipment by a teacher in demonstration of science concepts. Yan et al. (2013) noted that, artisan learners thrive on competition, a contest, or a challenge. Knowledge has only significance when it has immediate relevance. They feel restricted and restrained by the structure and routine of traditional educational systems (Dunlosky *et al*.,

2013). As demands for concentration increases and activity decreases, they become bored, restless, and begin to turn to activities of their own choosing (Yan et *al*., 2013). There is need to find out if balancing pressure of learning detailed science concepts make some students improve performance in learning.

2.2.3 Perceptual Model of Learning Styles

Felder and Brent (2017) postulates that perceptual model describes learning style as the way a student prefers to receive, progress and process information, which is a more comprehensive and easily linked to classroom experiences. It incorporates the aspects of information processing and personal qualities that influence a student's ability to acquire information (Odendaal, 2013). This implies there are choices the learners make in order to learn which can be referred to as their instructional preferred learning styles. Felder and Brent (2017) classified preferred learning styles into four dimensions based on the way learners prefer to process information and covert it to knowledge, the way people preferentially perceive information, the sensory channel by which people most effectively perceive information, and the manner in which people progress to understand and master the material.

On the other hand, Wang and Mendori (2015) classifies learners into four paired types of learning styles and strategies as active and reflective learners, sensing and intuitive learners, visual and verbal learners and sequential and global learners. However, Janet (2008) adds aspect of kinaesthetic leaning style a subgroup of sensing learning style. All the four-paired type of learners uses strategies, which involve memory that can be impaired by, stress experiences, which accrues due to mismatch of teaching styles to learners' preferred learning styles (Souza-Talarico *et al.,* 2014).

a) Active and Reflective Learners

Active and reflective dimension deals with the way learners prefer to process information and convert it into knowledge (Zywno & Waalen, 2012). Active learners learn by trying things out, working in a group, and discussing which is ideal for practical oriented sciences. Reflective learners learn by thinking things through and working alone (Felder & Brent, 2017).

i) Active Learners

Mismatch and low performance among active learners arises due to failure of teachers to understand that conversion of perceived information into knowledge involves active experimentation of doing something in the external world with the information discussing it, explaining it, or testing it in some way (Kehatsin & Solok, 2013). Active learners learn best from activities in which there are new experiences and challenges from which to learn (Odendaal, 2013). They tend to process information actively by doing something physical with presented material, then reflecting on it. They like short 'here and now' tasks involving competitive teamwork and problem solving. They think aloud, "let us try it out and see how it goes" they tend to jump in prematurely to conclusion (Janet, 2008). Mismatch comes where there is no immediate rewarding of their effort. They like group work, retain, and understand information best by discussing in-group, applying it, or explaining it to others (Felder & Brent, 2017). This implies that forums must be set for students to have group discussion. Schools with best teaching styles give questions and provide time for discussions and answering of questions in the groups where each student develops answers from the group discussion. This creates the need to investigate the gap of peer involvement in the process of learning of biology and geography in Nairobi secondary schools.

Janet, (2008) observed that, a mismatch of teaching style to preferred learning style makes active learners to learn least from, and may react against, activities where: They have a passive role (lectures, instructions, reading) and are observers. They are required to assimilate, analyse, and interpret many 'messy' data. They must work in a solitary way (reading and writing alone). Zywno and Waalen (2012) argues mismatch also occurs when statements are theoretical explanation and there is considerable repetition (practising the same skill). There are precise instructions with little room for manoeuvre. Further, where teachers must be thorough, and do not allow alternative ways of expression (Zywno & Waalen, 2012).

ii) Reflective Learners

On the other hand, reflective learners prefer to think about and work out something alone (Zywno & Waalen, 2012). Mismatch develops where teachers do not accord learners time to have reflective observation, which involves examining, and manipulating the information introspectively (Kehatsin & Solok, 2013). Reflective learners learn best from activities where are allowed, encouraged watching and thinking on activities. Janet (2008) articulates

reflective learners as those who need time to think before acting and to assimilate before commenting. They carry out careful and detailed research and have time to review their learning and produce carefully considered analysis and reports. Siddique et al. (2014) display reflective learners as those who perform well where helped to exchange views with other people without threats, or within a structured learning experience. They require opportunity to reach a decision without pressure and tight deadlines especially in analysis and development of scientific theories (Kehatsin & Solok, 2013). This creates the need to investigate if the students feel hurried and not given adequate time in the process of learning of biology and geography in Nairobi secondary schools.

In line with Kresta (2013) and Janet (2008) a mismatch of teaching style to preferred learning style make reflective learners learn least from, and may react against activities where they feel 'forced' into the limelight and must act without time for planning. This is more so where they are asked for an instant reaction and are given insufficient data on which to base a conclusion. In the interests of expediency, they have to make short cuts or do a superficial job. This creates the need to investigate whether schools provide opportunity for students to have private study, purposely give revision question where each student answers individually, and give a written report match reflective minds to their learning preference, which enhance performance.

b) Sensing and Intuitive Learners

Sensing/intuitive dimension deals with the way the learners tend to perceive the world either through the senses or through thinking (Zywno & Waalen, 2012). Sensing learners are practical, oriented towards facts and procedures, and favour information arriving through their senses. They prefer getting facts and procedures using senses in knowledge acquisition to feelings. Intuitive learners are conceptual, innovative, oriented towards theories and meanings, and favour information that arise internally through memory, reflection and imagination (Awla, 2014). They prefer to know something using feelings to considering the facts.

i) Sensing Learners

Sensing is procedural and concrete thinking that involves observing and gathering data through the senses (Awla, 2014). Teachers insisting on use of principles, theories, and symbols in explaining lesson content cause mismatch (Kehatsin & Solok, 2013). Sensing

learners notice their surroundings, tend to know where they put things, and remember people they only met once. Sensing learners like to learn facts and solve problems by well-established methods (Janet, 2008). Middleton *et al.,* (2013) observed that sensing learners are good at memorizing facts as concrete thinkers and doing hands-on (laboratory) works or experimentation. In laboratory work, they are meticulous and have instinct of setting up experiments, produce identical results in repeat of one experiment (Janet, 2008).

As reviewed by to Ricks et al. (2013) sensing learners learn best in sciences from activities where there is an obvious link between the subject matter and a 'real life' problem. This includes situations where shown techniques for doing things with obvious practical advantages involved. They assimilate more where they have the chance to try out and practise techniques with coaching or feedback from a credible expert. Consisted with Jarmon (2013) they understand better, where they see a model they can emulate .Teachers who employ personal model-teaching style (Abu-Asba *et al*., 2014) favour them. They do well when given techniques are currently applicable to their own work and have immediate opportunities to implement what they have learned. They can concentrate on practical issues, such as drawing up action plans or giving tips to others (Janet, 2008). Sensors like solving problems by standard methods.

Yan et al. (2013) articulate that a mismatch of teaching style to preferred learning style occurs to sensing learners when teaching learning activities are not related to an immediate need they recognise. Grasha (2002) postulate that sensing learners do poorly in non-laboratory work where teachers do not use visual demonstration, transparencies, pictures and diagrams and actual equipment. Where teachers fail to provide solution, procedures and give practical application of all theories and formulae, the students fail to get the required learning because there are no clear guidelines (Grasha, 2002). The learners feel people are going round in circles rather than getting to the point and there is no apparent reward from the learning activity, for example higher grades. They dislike complications as well as surprises.

In tests, sensing learners read the first problem, read it again, and tend to repeat each numerical calculation (Janet, 2008). This denies them whole picture of demand of the questions, run out of time and get class average or lower. Sensing learners resent testing on material not explicitly covered in class. They dislike courses that have no apparent connection with the real world (Felder & Brent 2017).This implies that sensing learners

require teachers who effectively cover the syllabus and all details of the verbs used in the objectives during the learning process. According to Li and Zhou (2018), sensing learners like global learners require teachers provide them with a comprehensive course outline, which guides them in the course of study and revision. They also accord opportunity for note taking where each learner captures in writing the main facts of each concept learnt.

Such environment where they are exposed to regular practical/laboratory work where they manipulate experiments and record observation for inference purpose (Grasha, 2002). These require teachers when constructing tests to include questions, which demand stating/giving outline or summering essential point. Such knowledge enhances their performance because examiners demand that students respond appropriately to the verbs state /outline, name, list, define, and discuss (McKinsey & Company, 2016). This creates the need to investigate if the students feel left out if meaning and scope of verbs used to phrase questions are not clearly articulated in the process of learning of biology and geography in Nairobi secondary schools.

ii) Kinaesthetic Learners

Kinaesthetic learning involves both information perception (touching, tasting, smelling) and information processing (moving, relating, doing something active while learning) (Felder & Brent 2017). Remember and process information through interacting with the space around them (Mutua, 2015). The kinaesthetic learning style refers to the ability to absorb information best by experiencing, touching, doing, moving and being active in some manner (Awla, 2014; Felder & Brent, 2017). Methods for tactile/kinaesthetic learners include hands-on activities (experiments, etc.), projects, and take frequent study breaks to allow movement, visual aids, role-play, and field trips (Sprenger, 2017). Move around to learn new things (e.g. read while using an exercise bike; model in clay to learn a new concept (Janet, 2008).

According to Kehatsin and Solok (2013), teachers that insist on order in classroom, which restricts movement cause mismatch. Felder and Soloman (2001) observed that kinaesthetic learners stand up to work, use bright colours to highlight reading material and turn it into posters or models, and enjoy action, experiences, and discovery. Kinaesthetic learners remember best by manipulating things, using tools and enjoy concept demonstrations. They master skills through practice and imitation and they skim before reading in details (Felder & Soloman, 2001). They use hands to communicate and benefit from role-playing situations. Kinaesthetic learners are not distracted by minimal noise in class while working or studying

because they enjoy having music playing in the background. This creates the need to find out whether mismatch to their preferred learning style occurs in environment where teachers demand total order and silence in study rooms.

Janet (2008) observed that kinaesthetic or tactile learners are often able to maximize their study sessions through practicing a technique. They enjoy demonstrating of concepts, creating a model and or engaging in a hands-on activity. They prefer to study in a position that is comfortable, even if it is not a traditional desk/table or chair setup, take a field trip, and work on drills or memory exercises while walking or exercising. Zywno and Waalen (2012) explain that miming or acting out key points is common form of memory reinforcement and movement is a tool for learning which create need to find whether science teachers in secondary schools in Nairobi plan learning activities, which allow movement within groups to facilitate effective learning.

iii) Intuitive Learners

On the other hand, intuition involves indirect perception by way of the unconscious speculation, imagination, insight, and abstraction (Awla, 2014; Felder & Brent 2017). Intuitive learners like innovation, and are quick and good at grasping new concepts. They prefer principles, theories, welcome complications and they favour internally generated information (memory, conjecture, interpretation) (Awla, 2014). Graf (2008) argues that intuitive learners prefer to learn abstract material, like challenges, and are more innovative than sensing learners are. Intuitive learners are more comfortable with symbols. They read science fiction and mystery novels voraciously. Since words are symbols, translating them into what they represent comes naturally to intuitive learners (Felder & Brent 2017). In tests, they work quickly, finish early, and get high grades. However, answering questions before they have read them thoroughly enough make them miss important data or answer different questions that they are not asked. Kresta (2013) argues that intuitive learners make careless mistakes and lack patience to check their calculation and normally get low grades in courses that emphasize facts, experimentation, and repetitive calculation. On the other hand, teachers who insist on lengthy and concrete science facts cause mismatch (Kehatsin & Solok, 2013).

c) Visual and Verbal Learners

Visual and Verbal dimension deals with the sensory channel the learners prefer to receive external information. Visual learners prefer pictures, diagrams, graphs, flow charts,

experiments and demonstrations, but verbal auditory learners prefer written or spoken explanations and formulae (Zywno & Waalen, 2012).

i) Visual Learners

Visual learners demonstrate outstanding photographic memory and relate best to written information such as graphs, maps, diagrams, charts, highlighted notes, and flashcards (Janet, 2008). Graf (2008) argues that visual learners remember best what they have seen, whereas verbal learners get more out of words, regardless of whether they are spoken or written. Mismatch in teaching occurs where teachers mainly use oral exposition. According to Janet (2008) visual learners love magazines, books and other types of reading materials and therefore mismatch in teaching occur where there are no adequate library and reference materials. They benefit from making their own notes even from information that is already printed, but feel frustrated when unable to take notes when teachers do not write legibly on chalkboards. They are typically tidy, organized, and good at spelling. Boras (2003) indicated that, visual learners appear to rely more on their visual memory for how to spell words correctly, because of the fact that they know they do not pronounce words like a native speaker and cannot rely on the phonology they hear. They concentrate better with a clear line of sight to visual aids and must have a quiet place to study.

Grasha (2002) argues that visual learners mismatch in teaching occur in noisy classes with many movements that cause obstruction. They must observe instructor's body language and facial expressions and therefore are disadvantaged when they fail to sit near the front of the classroom. They tend to be detail oriented but have difficulty following long lessons (Zywno & Waalen, 2012). They often asks for verbal directions to be repeated hence are left behind where teachers do not tolerate repetition of important information.

ii) Verbal Learners

On the other hand, Verbal learners get more out of words from written and spoken explanations (Zywno & Waalen, 2012). Cognitive scientists have established that our brains generally convert written words into their spoken equivalents and process them in the same way that they process spoken words (Felder & Brent 2017). Written words are therefore not equivalent to real visual information (Graf, 2008).

Auditory or verbal learners are frequently talkative in class; learn most effectively through audio books, lectures, oral presentations and verbal instructions (Zywno & Waalen, 2012). Information usually has little relevance unless heard, and therefore mismatch in teaching occur when the teacher is not audible. These learners prefer presenting oral reports rather than written reports and enjoy debates and discussions (Janet, 2008). They benefit from reading aloud and therefore mismatch in teaching occur when classes are required to remain silent or there are no opportunities of isolated places for private study. These types of learners follow verbal directions better than written directions (Felder & Brent 2017).They do not automatically understand maps, diagrams, or graphs and therefore mismatch in teaching occur when teachers do not explain the graphics verbally.

d) Global and Sequential Learners

Global and Sequential dimension deals with how the students' progress towards understanding (Narayani, 2014). Sequential learners are linear, orderly, learn in small incremental steps and can solve problems with incomplete understanding but may lack a grasp of the big picture (Felder & Brent 2017). Global learners are holistic, systems thinkers and learn in large leaps (Zywno & Waalen, 2012). They like to study with friends and enjoy the lengthy full sessions that the study sessions sometimes turn.

i) Sequential Learners

Sequential learners tend to gain understanding in a linear fashion, with each new piece of information building logically from previous pieces (Narayani, 2014). Mismatch occurs when teachers fail to review the previous lesson to link with current lesson. They tend to solve problems the way they learn in a linear, stepwise fashion and their solutions make sense to others (Janet, 2008). However, mismatch occurs where teachers do not present information in a logical order (Subramaniam *et al*., 2014). They generally have little trouble in school because of their sequential way of learning and solving problems (Felder & Brent 2017).They get well with teachers due to their style. This create the need to find out whether students feel confused when teachers write disorderly on the board and jump from one area to another before they comprehend science concepts.

ii) Global Learners

Global learners absorb information almost randomly, in no apparent logical sequence (Felder & Brent 2017). In consequence, when they are first learning a subject, nothing may make

sense to them, and they may be incapable of solving trivially simple problems. Mismatch occurs where science teachers rush over the content due to constrain of time to cover the syllabus (Subramaniam *et al*., 2014). At first, their problem solutions in chemistry or physics are jumbles of apparently unrelated numbers and equations with the answer magically appearing at the end (Narayani, 2014). Their grades in a class is usually a mixture of 'As' and 'Ds' (Felder & Brent, 2017). According to Grasha (2002), they usually start out in a class by doing poorly on the homework and failing the first quiz, and may spend the rest of the term trying to catch up. Then at some point, a key piece of data is taken in, critical connections made, and finally get it. In addition, they may be uncertain about details after that, but they see the big picture in a way that most other learners never achieve (Narayani, 2014). Thereafter, when presented with new material that they can fit into this picture they may appear to assimilate it instantly, and when solving problems they may leap directly to the solution without seeming to go through the required intermediate steps. They may also see surprising connections between newly learned material and material from other subjects and disciplines. Graf (2008) argues that global learners learn in large leaps and prefer more freedom in their learning process.

Mismatch occurs with expert teaching style when challenged to enhance their competence in limited time because of their slow nature (Khurshid & Aurangzeb, 2012). Strongly global that learners often have difficulty in learning sciences where mismatch occur when neglected as they are termed slow in learning (Narayani, 2014). This is because before they make their mental breakthrough in a given subject, their struggle to solve problems that their counterparts handle with ease makes them feel stupid. Even after they make breakthroughs, their inability to explain their problem-solving processes can get them into trouble, as are suspected to have copied from others (Graf, 2008).This creates the need to investigate whether there are students left behind due to their delay to get the big picture of the scientific concepts during learning process.

Graf (2008) argues that students with a strong preference for a particular learning style have more difficulties in learning if their learning styles are not supported in the learning environment. Adaptability is more difficult for learners who extremely prefer one style of learning than others who can use different learning styles. On the other hand, Bagarukayo (2012) and Chinedu et al. (2015) observed that Learners, who have no strong preference for any of the learning styles, demonstrate a balance among the dimensions of learning styles.

Students taught only in their less preferred modes, tend to be too uncomfortable to learn effectively, and will not gain skills in either mode. On the other hand, if taught only in their preferred modes, they will gain skills in those modes but will not develop equally important skills in their less preferred modes of learning styles (Felder & Brent 2017).

According to Dung and Florea (2012) the academic performance in sciences and future professionals need to function sometimes as sensors (careful, methodical, practical, and observant) and sometimes as intuits (analytical, critical, and creative). Brown and Lewandowsky (2009) also postulates that effective learning occurs when taught partly in a less preferred manner, which provides practice and feedback in ways of thinking and solving scientific problems which they may not initially be comfortable with but which they will have to use to be fully effective professionals. Zahra et al. (2010) asserts that students must experience non-preferred learning styles in order to develop in other spheres where they are not naturally inclined. However, if teachers teach exclusively in a student's less preferred style, discomfort may interfere with learning. The researcher proposes to determine whether the strength of learning styles has an effect on the students' performance in biology and geography in secondary schools in Nairobi County.

2.3 The Concept of Traditional Teaching styles

In order to determine the differences in effect of traditional teaching and teaching according to preferred learning styles on students' performance, in biology and geography, this concept is important. Teaching at any level of education and type of school, private, or public has the sole purpose of ensuring that all learners can acquire information and apply those skills (Guirguis & Pankowski, 2017). Therefore, it is incumbent upon all educators, to not only know their teaching style so that teaching has a two-fold purpose where teachers teach and students learn. Consequently, knowing how your students learn, and what strategies best fit your classroom and school are fundamental in the process of learning. The skill of teachers' perception in recognising and accommodating for diverse learning styles, in private and public secondary schools students need enhancement for better performance in sciences. However, just as people possess individual learning styles, teachers also have teaching styles that seem to works best for them. According to Neuro-Linguistic Programming (NLP) which is the science and art of communicating, to ourselves and others (Bandler, 2008; Molden & Hutchinson, 2008), we communicate in almost the same way we receive, perceive and process information (Losier, 2009).

Christenson (2010) defines teaching styles as a set of attitudes and actions that open a formal and informal world of learning to students. Teaching style is a pervasive quality in behaviour of an individual, way of approaching the learners, a quality that persists though the content may change and might be consistent with several methods of teaching (Felder & Brent, 2017). These styles are founded on traditional teaching methods lectures, discussions, demonstrations, laboratories, projects, inquiry problem solving, and activities (Akhtar & Saeed, 2017). The traditional teaching styles are either teacher centred or student centred who believe students have definite and fixed perceptions and ideas of their own roles and those of their teachers and includes the expert, formal authority and personal model styles, facilitator and delegator teaching styles (Mohanty, 2015). Mwangu, and Sibanda, (2017) observed that teachers used both teacher-centred and student-centred methods in teaching Biology practical lessons and various factors constrained the teaching of practical lessons in Zimbabwe**.** In Kenyan Secondary Schools, the prescribed traditional teaching style is ASEI-PDSI (Activity-focused Student–centred learning Experiment Improvisation - Plan, Do, See, Improve) approach in teaching which have not yielded the expected high performance in the recent past (Makewa *et al.*, 2011).

2.3.1 Expert Teaching Style Styles

This refers to display of knowledge, expertise and strives by teachers to challenge students to enhance their competence. It stems from lecture method of teaching, which is an instructional procedure through which the teacher seeks to create interest, to stimulate, to influence or build opinions, to promote learning opinions, develop critical thinking and promote learning among students. The teachers who revert to using this style end up leaving behind some of the learners who do not match their preferred learning style. According to Khurshid and Aurangzeb (2012), these teachers possess knowledge and expertise required by students. However, they strive to maintain status by displaying detailed knowledge and by challenging students to enhance their competence.

In addition, they focus on facts, knowledge, and transmission of information. Teachers with an expert preferred style are subject oriented and seek efficiency in information sharing mainly through lectures (Maclellan & Soden, 2002). Grasha (2002) further observed that, these teachers oversee, guide, and direct learners to ensure they are well prepared. Teachers who persist on using this style favour sensing learners who like to learn facts and solve

problems by well-established methods (Janet, 2008). On the other hand, their dominance in teaching learning process discourage reflective learners who learn best from activities where, allowed or encouraged to watch / think or ponder on activities and have time to think before acting and assimilate before commenting (Zywno & Waalen, 2012).

Shapiro et al. (2001) note that this is more so where the teachers use authoritative questioning technique, which is directive, assertive, interventionist, giving information, suggestions and advice. This display of knowledge and information can be intimidating to average and less experienced students (Khurshid & Aurangzeb, 2012) especially where teachers do not show underlying thought processes that produced the answers.

In addition, the kinaesthetic learners who prefer to absorb information best by experiencing touching, doing, moving and being active in some manner are as well discouraged (Janet, 2008). The teachers with expert styles, like experts in any field, are able to use many of their elements of their skills without a high degree of conscious awareness (Khurshid & Aurangzeb, 2012).This is because the automatic mental control processes take over and operate without conscious awareness. They include well-rehearsed modes of thinking, speaking and behaving and are labelled autopilot, tacit knowledge schemas and mental script (Grasha, 2002). Such processes allow teachers to conserve their limited conscious processing capabilities for those instances when absolutely needed especially by less knowledgeable learners. This creates the need to investigate whether there are students left behind due to their inability cope with superior knowledge of their teachers, which intimidate them during their expression of scientific concepts.

2.3.2 Formal Authority Teaching Style

This refer to approach of students by controlling the flow of the content, providing positive and negative feedback, establishing learning goals, expectations and rules of conduct for them. According to Ramadhan et al. (2017) the teachers who revert using this style in teaching biology are concerned with providing positive and negative feedback, establishing learning goals, expectations and rules of conduct for students. They focus on content, clear expectation and acceptable ways of doing things (Shapiro *et al*., 2001). Moreover, Khurshid and Aurangzeb, (2012) points out these teachers are more concerned with proper provision of structure required by the students for learning and sets acceptable standards for them. However, due to increasing time constraints, teaching faculty tends to be more directive

(authoritative) and less interactive (collaborative) with learners regardless of individual learner needs (Shapiro *et al*., 2001). On the other hand, despite the focus on prescribed acceptable standards and expectations in sciences that are assumed to be clear to the students, Shapiro et al. (2001) further argues that this style of teaching may become standardized and rigid which does not encourage students to employ alternative strategies for deeper and more flexible learning.

Grasha (2002) points out that this style is generally teacher-centred, where the teacher feels responsible for providing and controlling the flow of the content, and on the other hand, students receive the content. This discourages active learners who learn by trying things out, working in a group, and discussing (Zywno & Waalen, 2012). The supposed correct, acceptable, and standard ways they practice and structure provided may not necessarily meet the needs of every learner in a normal class. Shapiro et al. (2001) points out that, these teachers focus on rules and expectations for learners, supervises learners closely with critical eye toward standard practices and procedures, and focus on clear expectations and acceptable ways of doing things which helps in accurate acquisition of practical skills in sciences. However, this discourages global learners who absorb information almost randomly, in no apparent logical sequence and not timely match the set standards (Wang & Mendori, 2015).

Grasha (2002) postulates that, the teachers with this teaching style are not as concerned with building relationships with their students nor are it important that their students form relationships with other students. Whereas the learning of sciences require much discussion for learners to internalize scientific concepts, this type of teacher does not usually require much student peer participation in class. A strong investment in this style can lead to potentially rigid standardized and less flexible ways of managing learners and their concerns. This leaves behind verbal learners who prefer a rapport of relationship in discussion in the process of transfer of knowledge and mastery of content (Mubia *et al.,* 2014).

2.3.3 Demonstrator or Personal Model Teaching Style

The teachers who employ this style believe in teaching by personal example and suggest prototypes for how to think and behave (Abu-Asba *et al.,* 2014). A Personal Model teacher also encourages students to observe, and then emulate the instructor’s approach. The advantage is an emphasis on direct observation and emulation of a role model. The disadvantage is that some teachers may believe that their approach is the best way, leading

some students to feel inadequate if they cannot live up to the expectations and standards of the method they see. The teacher explains scientific concepts, demonstrates experiments, and expects leaners to replicate the same proceedings. However, this leaves behind intuitive scientific mind, which prefers originality and self-discovery of content (Komakech & Osuu, 2014). In addition, the teacher acts as a role model by demonstrating skills and processes and then acts as a coach or guide in helping students develop and apply these skills and knowledge (Himmelstein *et al.,* 2017) which benefits the scientific sensing learners in mastery of hands-on activities. In addition, these teachers oversee, guide, and show learners how to do things. They want learners to observe and emulate the instructors approach, emphasis is on hand-on, direct observation and in following a role model (mentor relationship) (Grasha, 2002).

Komakech and Osuu (2014) observed that instructors with this teaching style are interested in encouraging student participation and adapting their presentation to include various learning styles. Teachers expect students to take some responsibility for learning what they need to know and ask for help when they do not understand something otherwise there is no rephrasing of concepts to enhance facilitation of different students' learning styles through this teaching style (Akbari & Tavassoli, 2011). This discourages global learners who absorb information almost randomly, in no apparent logical sequence and may not match prototypes for how to immediately think and inquire on unclear scientific concepts (Narayani, 2014). Abu-Asba et al. (2014) noted that, some teachers may feel their approach is the best way leading some learners to feel inadequate if they cannot live up to such expectations and standards. This implies that teachers who are not sensitive of presence global learners in their class leaves them behind which is reflected in their performance.

2.3.4 Facilitator Teaching Style

Teachers who employ this style emphasize personal nature of teacher-student's interactions. They lead students into an inquiry based learning style guiding their learning via resources, which they find for and with the students (Elkaseh *et al.,* 2014). In Nigeria as sighted by Mwangu, and Sibanda, (2017) Obiekwe and Chinwe observed some teachers teach biological concepts using the 5E (Engagement, Exploration, Explanation, Elaboration and Evaluation) model. In Kenya, recommended ASEI-PDSI (Activity-focused Student–centred learning Experiment Improvisation - Plan, Do, See, Improve) approach in teaching has element of facilitating in teaching.The style is displayed by who use inquiry problem solving, and

activities methods of teaching. This benefits the sensing scientific learners who derive most of their understanding of concepts from experimentation (Gacheri & Ndege, 2014). They show personal flexibility, focus on student's needs and goals, and the willingness to explore options and alternative courses of action (Grasha, 2002).

This fosters creativity, innovativeness, critical thinking in problem solving and originality of ideas necessary in scientific discovery (Njoroge *et al.*, 2014). However, this style leaves behind the sequential learners who learn in orderly small incremental steps that require constant mediation of the teacher (Narayani, 2014). Teachers who employ this style guide or direct students by asking questions, exploring options, suggesting alternatives and encouraging them to develop criteria to make informed choices (Stanford, 2014). Their overall goal is to develop in students the capacity for independent action, initiative, and responsibility. They work with students on projects in a consultative fashion and provide as much support and encouragement as possible.

Efficacy refers to people's beliefs about their capacity to perform at a given level of achievement. Highly efficacious teachers persist in the face of troubling and unmotivated students and positively influence their academic development by effective teaching. In facilitation, teachers typically design group activities, which necessitate active learning, student-to-student collaboration, and problem solving behavior. Grasha (2002) explains that this type of teacher will often try to design learning situations and activities that require student processing and application of course content in creative and original way. This style is often time consuming when employed in a more direct approach. Mortensen and Thoron (2012) noted that this type of teaching style works best for students who are comfortable with independent learning and who can actively participate and collaborate with other students. On the other hand, global learners are on the losing end with this style of teaching because they need constant guidance to catch up and make critical connection of the content covered in class (Zywno & Waalen, 2012). This style can make students uncomfortable if not employed in a positive and affirming manner (Mortensen & Thoron, 2012).

2.3.5 Delegator Teaching Style

According to Elkaseh et al. (2014) teachers who have a delegator teaching style tend to place much control and responsibility for learning on individuals or groups of students especially in the use of e-learning. The results of their study showed that there were statistically significant

differences between the four types of perceived learning styles towards the behavioural intent to use e learning in Libyan higher education. However, there were no significant differences in the preferred teaching and learning styles, which affect the behavioural intention to use e learning in Libyan higher education. This implies that most teachers and students in Libyan higher education regardless of preferred teaching and learning styles have intention to use e-learning for teaching and learning respectively which means e learning can be tailored to all types of learners without creating mismatch.

Teachers who employ this style are concerned with developing students' capacity to function in an autonomous fashion (Grasha, 2002). However, this leaves behind global learners who need constant repetition of content for them to grasp and sequential learners who need systematic guidance of the teacher. They help students to perceive themselves as independent learners (Mortensen & Thoron, 2012). According to Stanford, (2014) this type of teacher will often give students a choice of designing and implementing their own complex learning projects and will act in a consultative role. Fahim and Zargaran (2014) in a study on correlation of teaching styles and critical thinking, a the case of Iranian teachers point out that in use of Delegator Teaching Style the students work independently on projects or part of autonomous team while the teacher is available at the request of the students as a resource person.

Delegator Teaching Style can adopt Co-operative Learning Approach, which is an instructional strategy in which small groups of students of mixed abilities and gender work together on a common task (Waiganjo *et al.,* 2014). The students are encouraged to work together to help one another learn. When peers work together, there is a great deal of modelling, emotional stability, feedback and perspective taking that emerges as students explain and receive explanations from their colleagues. However, this approach of leaners does not consider individual preferences. Grasha (2002) postulates that a teacher using this style may misread student's readiness for independent work, which results, to poor performance. On the other hand some students may become anxious when given autonomy and global learners are on the losing end with this type of teaching style because they are often left to work on their own before making the right conception of the content (Rahadian & Budiningsih, 2017).

Resent research (Westwell, 2010) indicated that these traditional teaching styles (Expert, Formal Authority, Demonstrator, Facilitator, and Delegator Teaching Style) are fashioned by personal preferences, training and findings from early neuroscience research which was often stretched and distorted resulting in unhelpful conceptions. Such conceptions include distinction between "left-brain" and "right-brain" thinkers or thinking; only 10% of brain capacity is ever used; windows of opportunity when learning must take place and a universal difference between the brains of males and females. However, It is well established that the brain changes in response to environmental demands (Blakemore & Frith, 2005; The Royal Society, 2011), forming and strengthening some connections between brain cells whilst weakening and eliminating others (a characteristic called plasticity). While the formation of these connections occurs at prodigious rate in infancy, the process continues throughout childhood, maturity, and old age.

A study by Chumba and Kiprop (2014) on teacher preparation, challenges and mitigation in public universities in Kenya, made a recommendation that educators and policymakers must find ways to ensure that prospective teachers acquire not only adequate knowledge of a subject, but also up to date knowledge of how to teach it. The pedagogy plays key role in teacher preparation because preparation in a given subject does not necessarily develop understanding of how particular concepts and procedures related to that subject are best learned. The traditional way of teaching needs to be devolved to embrace the modern scientific way of brain targeted teaching models. There remains a gap in study of effect of teaching students according to their preferred learning styles on performance in biology and geography in Kenya, which this study purposed to bridge.

2.4 Gender Differences in Relation to Preferred Learning Styles and Performance

Most studies on gender in relation to learning styles have been done to establish gender preferences to different learning styles tertiary institutions and not gender preferred learning styles in relation to academic performance secondary schools. For instance in a study by Yemane et al. (2017) on gender, differences on learning styles preferences among regular undergraduate students of Mekelle University Collage of Health Science indicated no significant gender differences. Unimodal way of learning was dominantly chosen by both genders. Out of which most of the students were visual learners with the least students preferring kinaesthetic way of learning. This was the same for both Male and female students', both of which preferring the unimodal, out of which most were visual learners. Ora

et al. (2018) in their study on Learning Styles and the Hybrid Learning observed that gender does not have an impact of learning style.

In a study by Shuib and Azizan (2015) on learning style preferences among male and female students in Universiti-Sains Malaysia the results indicated that, there is a strong representation of visual learners from both male and female respondents. On the other hand, the respondents, irrespective of the gender difference, are well-balanced in the dimensions of sensing/intuitive, active/reflective, and sequential/global. In addressing the gender difference, it was found in this study that there is no significant difference between male and female students in their preferred learning. Thus, this study revealed that, gender does not help differentiate students' learning preferences. Female students have the same preferences as male students. Geetha and Praveena (2017) in their study on learning styles of secondary school students and their interest in biology in Karnataka, India observed that there are no significant differences in learning styles preference among male and female student's interest in biology. This seems to suggest the differences in males and females in relation to biology geography performance are created by society.

Scherpereel and Bowers (2014) observed that gender significantly correlated with self-evaluation, indicating that boys rated their performance in calibration in a more optimal fashion than girls did. In addition, in relation to gender differences, Zulekha and Aqil (2015) found that there are particular learning modes preferred by female and male students who reflect their attitudes toward sciences. The contributions of this study shows that even with less than a 1% variance in knowledge of science concepts, gender differences in self-beliefs were statistically significant and of meaningful size (Lusweti *et al*., 2018). Both teachers and parents reported that they were more inclined to interpret the performance of girls as an attribute of their hard work, while they expressed surprise that boys' performance was so high in relation to their lack of work. Shields (2010) concluded that messages from parents, teachers, and peers given to students might be intrinsically affecting students' self-efficacy beliefs. According to Seifert (2016), a mother's beliefs about her children's capabilities have a stronger predictive value for math achievement than the children's actual grades in math. This lends credence to the existing math and science gap between males and females in that the socialization and emerging self-concepts related to specific gender abilities in boys and girls formulate at a very young age (Steffens *et al.,* 2010).

As early as elementary school, far before high school or college, there exist disparities in math and science aspirations for young female students when compared to their male counterparts (Riegle-Crumb *et al.,* 2010). This impact on the girl child even when exposed to similar preferred learning styles like boys. Amirali (2010) found strong self-regulation contributes to positive self-efficacy; the lack thereof may cause students to develop diminished engagement in that subject, thus impairing their decision-making related to that subject. Negative early experiences produce the result of a negative attitude about math and science. McCoach (2007) found that the correct educational strategies were conducive to increasing science literacy self-efficacy beliefs, thus supporting the fact that these constructs of self-efficacy are not static, but rather can be changed and improved.

On gender differences, a study by Orora et al. (2014) to find out whether there were gender differences in achievement when students were exposed to cooperative e-learning teaching strategy, analysis of Biology Achievement Test mean scores indicated that boys and girls were not at the same level of achievement at the start of the treatment. Boys had significantly higher mean achievement scores compared to that of girls (mean scores for boys and girls was statistically significant; $t(85) = 3.50$, $p < 0.05$). However, there were no statistically significant differences between the mean scores of boys and girls after the treatment; $t(85) = 1.25$; $P > 0.05$. In Kenya, no studies have been done on effect of gender on performance in sciences of students taught in their preferred learning styles. This created the need to investigate the differences in performance in sciences, in terms of gender among those students taught in their preferred learning styles, from those taught without considering their learning styles.

2.5 Effects of School Type on Students' Performance in Biology and Geography

A number of studies have been carried to determine differences in performance in sciences in public and private schools. In Pakistan Barrera-Osorio et al. (2017) in their study, found out that private school produce higher test scores than government schools. The high-test scores in sciences were attributed to more consistency in provision learning resources, high cost-effectiveness, and teaching effectiveness. In Kenya, Mwangi *et al.*, (2018) suggested that different type of schools private and public support academic resilience of their students, which make them perform higher in biology and other sciences.

Academic resilience is students' ability to successfully deal with academic drawbacks, challenges and academic pressure (grades, exam pressure), stress and difficulties in the academic or school life. Academically resilient students are intrinsically motivated, are optimistic, self-regulated, and flexible, show agency toward being solution-focused, exercise reciprocity, have determination, are assertive, and possess good communication skills (Zolkoski& Bullock, 2012). Ferguson and Wolkow, (2012) assert that type of school may affect academic resilience, and the consequent academic achievement.

Rong'uno (2017) observed that in Uganda, government-aided schools are finding it rough maintaining the high level of academic race. Studies show that the effect of Universal Primary Education (UPE) weighs down most of the public schools. Implementation of UPE has seen public schools enrol high number of pupils leading to large classes that have overwhelmed the teaching force. Consequently, performance has continued to drop. On the other hand, private schools have an edge over their counterparts as they are more organized in terms of pupil enrolment and teaching/learning facilities. Rong'uno further noted that teachers in private schools work tirelessly from early in the morning to late in the evening in order to produce attractive academic results as a prerequisite for retaining the job. Those in public schools work with some laxity, as there is no strict supervision or punishment against non-performers.

A study in Ghana by Harry (2016) revealed that private schools had better resourced, had parents of pupils whose socioeconomic status was higher, and were more involved in their children's education. Public schools had more professionally qualified teachers than the private schools and recommended teachers to improvise the teaching and learning resources, which were not available in the schools to enhance the quality of education in the country. These studies revealed that the teacher and parent interaction with the learner influenced significantly the performance of students in sciences rather than the institutions.

According to Etxeberria et al. (2017) school climate is linked to teachers' commitment to educational work, involvement, teamwork, and participatory management. The private but public funded schools (often-religious schools) are more effective than comparable public owned and funded schools with the same students, parents, and social composition in terms of reading, mathematics, and science abilities. The main explanation of this higher effectiveness is the better school climate in the former, in comparison to the latter. However,

private owned and funded schools are less effective than public schools with the same students, parents, and social composition because of limitation of funding. The main explanation of their initially higher effectiveness is the better social compositions of these schools. This created the need to find the effect of teaching according to preferred learning styles on their performance in biology and geography.

2.6 Theoretical Framework

The theoretical framework of this study was based on, Felder and Brent (2017) Learning Style and Teaching Style Theory by Grasha (2002).

2.6.1 Learning Style Theory

The Perceptual Learning Style Theory by Felder and Brent (2017) describes learning style as the way a student prefers to perceive, receive, and process information and progress into understanding of knowledge. The tenets of this theory are that it categorises learning styles into four different learning dimensions.

The sensing/intuitive dimension, which deals with the preferred way of perceiving information, either through senses or through thinking. The visual/verbal dimension, which deals with the preferred channel of receiving information visually and verbally. The active/reflective dimension either which deals with the preferred way of processing information into knowledge actively or reflectively. In addition, the sequential/global dimension which deals with the preferred order of progressing the processing of information in learning either sequentially –systematically or globally- holistic in large leaps. The strength of Perceptual Learning Style Theory is that it focuses on aspects of learning styles that are particularly significant in science education especially in scientific observations, experimentation, and drawing inferences and as well is relevant in teaching science disciplines.

Perceptual Learning Style Theory was applicable in this study because its tenets prescribed well the preferred learning styles of learners. Sensing learners are practical, oriented towards facts and procedures, and favour information arriving through their senses. This is relevant to sciences, which are practical oriented. Intuitive learners are conceptual, innovative, oriented towards theories and meanings, and favour information that arise internally through memory, reflection, and imagination, which helps in learning and assessment of assimilation of

scientific theories. The visual/verbal dimension deals with preferred channels of receiving information, and the presentation of both visually, and verbally which dominate the practice of teaching. Active/Reflective dimension deals with the way information is processed. Active learners learn by trying things out, working in a group, and discussing. Reflective learners learn by thinking things through, and working alone. This is relevant in manipulation scientific equipment and discovery.

The sequential/global dimension deals with order of understanding or processing information. Sequential learners are linear, orderly; learn in small incremental steps, which is necessary for articulation of systematic procedures in science. Global learners are holistic, systems thinkers and learn in large leaps and the model helps in assessment of scientific innovators. This theory is also relevant to this study because Wang and Mendori (2015) have defined a score, which suggests individuals of 1-3 to characterize a fairly well balanced preference on the two dimensions, who can match all teaching styles. Individuals of 5-7 on the scale to characterize moderate preference for one of the dimensions who can be strongly affected by mismatch and 9-11 as having very strong preference for one dimension on the scale who can be very strongly affected by mismatch of teaching style. However, Perceptual Learning Style Theory is limited, as it seems not to articulate aspects of learning that are motivational which critically influence learning. This necessitated the researcher to interweave this theory with Personality Patterns Model of learning.

2.6.2 Teaching Style Theory

The proponents of Teaching Style Theory were Felder, Brent, and Grasha, which describes teaching style as a pervasive quality in behaviour of an individual, way of approaching the learners, a quality that persists though the content may change and might be consistent with several methods of teaching. The tenets of this theory are that, there are five teaching styles that is, expert teaching style, formal authority teaching style, personal model teaching style, facilitator-teaching style, and delegator teaching style that are displayed by most teachers (Grasha, 2002). The expert teaching style refers to display of knowledge, expertise and strives by teachers to challenge students to enhance their competence. These teachers possess knowledge and expertise required by students. However, they strive to maintain status by displaying detailed knowledge and by challenging students to enhance their competence (Khurshid & Aurangzeb, 2012).The formal authority teaching style refer to approach of

students by controlling the flow of the content, providing positive and negative feedback, establishing learning goals, expectations and rules of conduct for them.

These teachers are more concerned with proper provision of structure required by the students for learning and sets acceptable standards for them. However, due to increasing time constraints, teaching faculty tends to be more directive (authoritative) and less interactive (collaborative) with learners regardless of individual learner needs (Shapiro *et al*., 2001). The personal model teaching style believes in teaching by personal example and suggests prototypes for how to think and behave (Abu-Asba *at el.* 2014). A Personal Model teacher encourages students to observe, and then emulate the instructor's approach. The facilitator teaching style emphasize on personal nature of teacher-student's interactions. They lead students into an inquiry based learning style guiding their learning via resources, which they find for and with the students (Elkaseh *et al.,* 2014). The delegator teaching style proponents place much control and responsibility for learning on individuals or groups of students especially in the use of programmed learning and e -learning with minimum interaction (Elkaseh *et al*., 2014). Teachers who employ this style are concerned with developing students' capacity to function in an autonomous fashion. The strength of Teaching Style Theory is that it displays a comprehensive spectrum of styles of teaching. It articulates the preferences of teachers in management of their career that seem to works best for them.

Teaching Style Theory was applicable in this study because it suggests the inclination of teachers and their strengths that favour particular preferred learners and create a match or mismatch in learning. The interplay of the three theories Teaching Style Theory, Personality Patterns Theory of learning and Perceptual Learning Style Theory anchored well in demystifying the concepts of teaching and learning, which enhances performance of students in biology and geography.

Everyone who teaches possesses each of the five teaching styles to a varying degree. This model is relevant to this study because it suggests individual teachers who prefer to use one or some of styles end up creating mismatch in delivery of study content to learners whose learning styles do not match their preferences. The theory displays a comprehensive spectrum of styles of teaching. It is limited in some aspects, which are abstract to measure, which limits its application.

2.7 Conceptual Framework

Teaching styles (Preferred or traditional) as independent variables match or mismatch with preferred learning styles (active reflective, sensing intuitive sequential global, visual or verbal) of students' to determine performance in biology and geography as dependent variables. The variables that interact in learning process are conceptualised as teaching styles and preferred learning styles to determine performance of students in biology and geography, which are the dependent variables. Matching teaching with preferred perception, conversion of information into knowledge, use of preferred channel and progress in understanding indicate preferred teaching styles and expert, formal authority, personal model, facilitator, or delegator styles indicate traditional teaching styles. High achievement test scores, correct answers to questions and proper expression of opinions in scientific concepts indicate performance in Biology and Geography while large teaching workload and inability to decode learning styles are intervening variables. Figure 2.1 indicates summary of the variables that interact in the process of learning and determine the performance in biology and geography.

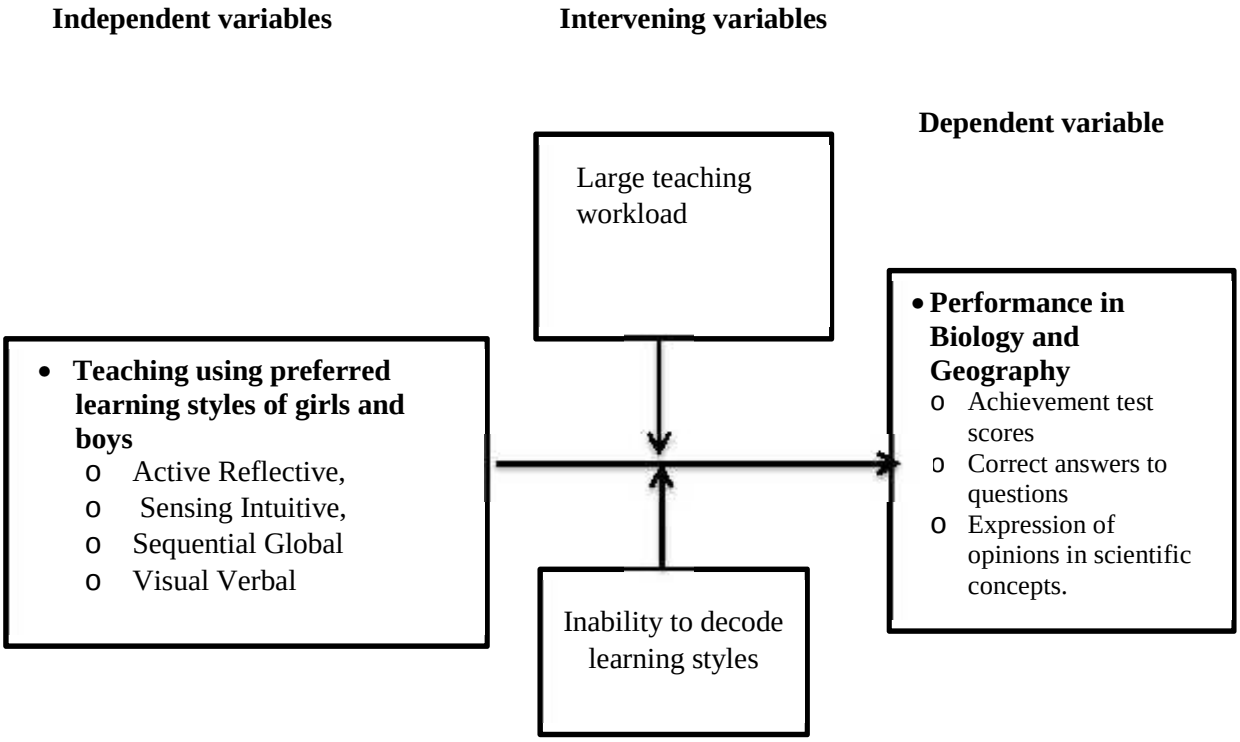

Figure 1: Determinants of Performance of learners in biology and geography

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter describes the procedures the researcher used in carrying out the study. It includes the research design, the location of study, and population of study, sampling procedure, and sample size. In addition describes, research instruments and methods of data analysis used and method of testing research hypothesis.

3.2 Research Design

The study employed quasi-experimental research design. The entry behaviour of the subjects was established before the commencement of the programme by a t-test of control and experimental groups on geography and biology. This was important because one of the assumptions of a standard independent test is that the two groups have equal variance. The design adopted pre-test-post-test non-equivalent control group design. This allowed random selection of sample from the population without random assignment of individual cases to the comparison groups (Burns & Grove, 2007). The design used two groups one that received the treatment and one that did not. Intact classes were randomly assigned to either experimental or control conditions followed by administration of a pre-test and post-test diagrammed thus:

Group	Pre-test	Treatment	Post-test
E	O_1	X	O_2
C	O_3		O_4

Where E- Represents Experimental Group

C- Control Group

O- Measurement of dependent variables (pre-test and post-test).

X – Represents treatment

- - Broken line indicates the groups have not been equated by randomization.

The design was selected because experimental and quasi-experimental researches are the most appropriate when studying a relationship of cause and effect Dutra (2016). This was due to the characteristics of the interventions carried out in during the field study. The design allowed use of existing intact comparison groups of unassured equivalence, which ensured internal validity because the assignment of treatment to one group or the other was assumed

random, and under the experimenter's control. On the other hand, the factors that could jeopardize internal validity such as general historical events that might have produced an O_1-O_2 difference would also produce an O_3-O_4 difference. This also ensured testing effects of taking a test upon the scores of a second testing where students taking the test for a second time, usually do better than those taking the test for the first time affected both control and experimental groups and were not confused as treatment effects (Toulany *et al.,* 2013).

Three private and three public schools were randomly selected, one from each category boys, girls and mixed schools. One or two streams depending on size school of Form Two class were assigned to experimental treatment and the others to control group. The researcher gave the experimental treatment and the control groups a Pilot-test from topics already taught by conventional teachers (in geography weather and in biology cell biology) to determine whether they of the same level of performance (APPENDIX B). The experimental groups filled questionnaires to determine their preferred learning styles. The experimental and the control groups were given a Pre-test on another topic taught by their teachers (in geography earth and the solar system and biology cell physiology) (APPENDIX C).

The characteristics of each learner in experimental group were analysed and used to develop a teaching module of each concept tested. Each concept was analysed and assigned the preferred perception by intuitive/sensing learners, preferred processing by active/reflective learners, preferred receiving Chanel by visual/verbal learners and preferred progressing to understanding by global and sequential learners. The researcher taught the topic earth and the solar system in geography and cell physiology in biology the experimental group using the preferred teaching styles while the control group learnt the same topics for one week with the conventional teachers. The researcher then administered a post-test after two weeks for each group to establish their performances.

3.3 Location of the Study

The study was carried out in eight secondary schools in Nairobi County of Kenya. Nairobi County is one of the 47 Counties in the Republic of Kenya. It borders Kiambu County to the North and West, Kajiado to the South and Machakos to the East. Among the three neighbouring Counties, Kiambu County shares the longest boundary with Nairobi County. The County has a total area of 696.1 Km^2 and is located between longitudes 36^o 45' East and latitudes 1^0 18' South. It lies at an altitude of 1,798 metres above sea level. Nairobi County

was chosen because has schools with wide range of performance in sciences, some with extremely low performance and others with extremely high performance, which is representative to national performance. Three private and three public schools one from each category boys, girls and mixed schools were used as study site to represent the categories of schools in Nairobi County. Streamed Form 2 classes were used to create homogeneous study group from the schools. In Four-streamed, classes one pair was randomly selected as experimental and the other control group through toss of coin

3.4 Population of Study

The Target population was all students in Secondary Schools in Nairobi County (Table 3).

Table 3: Population Distribution of Secondary Schools Students

Type of school	**Gender**		**Total**
	Boys	**Girls**	
Public	25,009	19,972	44,981
Private	12,452	12,501	24,953
Total	37,461	**32,473**	**69,934**

Source: Basic education statistical booklet 2014

The Population Distribution of Secondary Schools by Gender and Type of School was analysed to facilitate selection of schools (Table 4)

Table 4: Population Distribution of Target Secondary Schools

Type of School	**Public**			**Private**			
	Gender			**Gender**			
	Boys	**Girls**	**Mixed**	**Boys**	**Girls**	**Mixed**	**Total**
No.of schools	21	22	35	11	14	122	225

Source: Basic education statistical booklet 2014

3.5 Sampling Procedure and Sample Size

3.5.1 Sampling Procedure

The Form Two Students of target schools (Table 5) were purposively chosen for the study. This was because they had stayed in secondary school system for a reasonable period, and matured compared to form ones. They were exposed to all the sciences compared form three students and examination classes who had selected the electives.

Table 5: Population Distribution of Form Two Secondary Schools Students

Type of school		Gender	Total
	Boys	**Girls**	
Public	6,671	5,429	12,100
Private	3,195	3,241	6,436
Total	9,866	**8,670**	**18,536**

Source: Basic education statistical booklet 2014

The accessible population of study was all the Form 2 students from Secondary Schools done *KCSE by 2014* in Nairobi County (Table 6).

Table 6: Distribution by Type of Secondary Schools that had done KCSE by 2014

Type of school		Gender	Total
	Boys	**Girls**	
Public	6,671	5,429	12,100
Private	1,616	1,721	3,337
Total	**8,287**	**7,150**	**15,437**

Source: Basic education statistical booklet 2014

Stratified random sampling was uses to select the schools. This ensured each subgroup of the schools was included in the study. Analysis of distribution of Secondary Schools by Gender and Type of school that had done KCSE by 2014 in Nairobi County was done to facilitate sampling (Table 7.The schools were purposively grouped into two categories private and public (Appendix D). In addition, they were further grouped into Boys, Girls, and Mixed schools.

Table 7: Gender Distribution for Secondary Schools that had done KCSE by 2014

Type of school		Public		Private			
		Gender		Gender			
	Boys	Girls	Mixed	Boys	Girls	mixed	Total
No.of schools	21	22	35	5	12	57	152
Ratio	1	1	2	1	1	2	8

The number of schools from each category was delimited to one school from boys and girls schools and two schools from the mixed schools due to contrains of time-limited population and costs(Table 7). This diverse sampling fraction was done to randomly over-sample the small group (Bhat, 2017). Simple random sampling of the schools was done separately from each type of schools (boys', girls' and mixed) using computerised random number generators in windows SPSS version 22. From the list of each type of schools this was achieved by using the command 'data' > select cases > 'random sample of cases' > 'sample' > 'sample size' '% all cases' or 'exactly case from the first – cases'. The simple random sampling permitted the researcher to apply inferential statistics to the data and provided equal opportunity of selection for each element of the population (Kombo &Tromp, 2006).

3.5.1 Sample Size

In all the four-streamed, Form 2 classes one pair was randomly selected as experimental and the other control group using computerised random number generators, which minimised selection bias (Table 8). Intact streams were maintained to create homogenous experimental and control groups (Burns, & Grove, 2007).

Table 8: Gender and Type of Secondary Schools that had done KCSE by 2014

Type of school		Public		Private			
Group of students		Gender		Gender			
	Boys	Girls	Mixed	Boys	Girls	mixed	Total
Experimental	85	85	178	83	88	141	660
Control	87	86	177	85	86	141	662
Total	**172**	**171**	**355**	**168**	**174**	**282**	**1,322**

3.6 Instrumentation

In this study, the researcher used two study instruments to collect data: questionnaire and achievement test. The questionnaire had a short introduction that explains the purpose of research and was made of two sections. Section one: Bio data items, which consisted of statements seeking the respondent's background information such as gender, category of school and science subject taken. Section 2 consisted of statements adapted from Felder-Silverman Model (Wang & Mendori, 2015) designed to assess the preference of the students on four learning areas: preferred way of perceiving information-the intuitive/sensing learners, preferred processing of information- the active/reflective learners, preferred receiving Chanel of information- the visual/verbal learners and preferred progressing to understanding the global and sequential learners. It had had forty-four questions, which were arranged and spread randomly for each category (Table 9).

Table 9: Index of Learning Questionnaire Distribution of Questions

Sensing (a) Intuitive (b)	**Acting(a) Reflecting(b)**	**Visual(a) Verbal (b)**	**Sequencing(a) Global (b)**
No.	**No.**	**No.**	**No.**
2	1	3	4
6	5	7	8
10	9	11	12
14	13	15	16
18	17	19	20
22	21	23	24
26	25	27	28
30	29	31	32
34	33	35	36
38	37	39	40
42	41	43	44
Total 11	11	11	11

Scoring was done by summing up the number of 'a' and 'b' responses for each dimension form scores which range from 1-11. Lower scores are subtracted from the either higher score of 'a' or 'b' which expressed the dominant preference. Wang and Mendori (2015) have

defined a score of 1- 3 to characterize a fairly well balanced preference on the two dimensions, 5-7 is characterized as having moderate preference for one of the dimensions on the scale and 9-11 as having very strong preference for one dimension on the scale. Where learners could have real difficulty in learning in an environment, which does not support that preference. Each student was assigned an 'ID Code Number to preserve his or her anonymity. Only the author knows which ID Code matched each student's name. This knowledge will be essential for generating the individualized student's analysis in relation to performance in the selected disciplines.

The achievement tests, made two parts named biology and geography tests were used to collect quantitative data. The biology test had 22 items based on cell physiology and the geography test had 16 items the earth and the solar system. The format of the questions was short answer structured questions reminiscent to the KCSE examination type. The tests were used to measure how much of the content taught during the period of study had been learned before and after the treatment

3.6.1 Treatment of Experimental Group

Treatment is what is applied to experimental units (factors) to analyse its effects (Etikan *et al.,* 2016). The treatment of experimental group followed identification of students learning styles (Appendix A) by use of questionnaires. The characteristics of each learner where analysed in each stream and used to develop a teaching module of each concept tested. Each concept was analysed and assigned the preferred perception, processing, receiving, and progressing to understanding. Preparation for teaching was by analysis of the observed learning styles of students and presenting the lesson using four-step Whole Brain-Teaching Model (Figure 2) where every step has a dichotomous activity according to preferred learning styles.

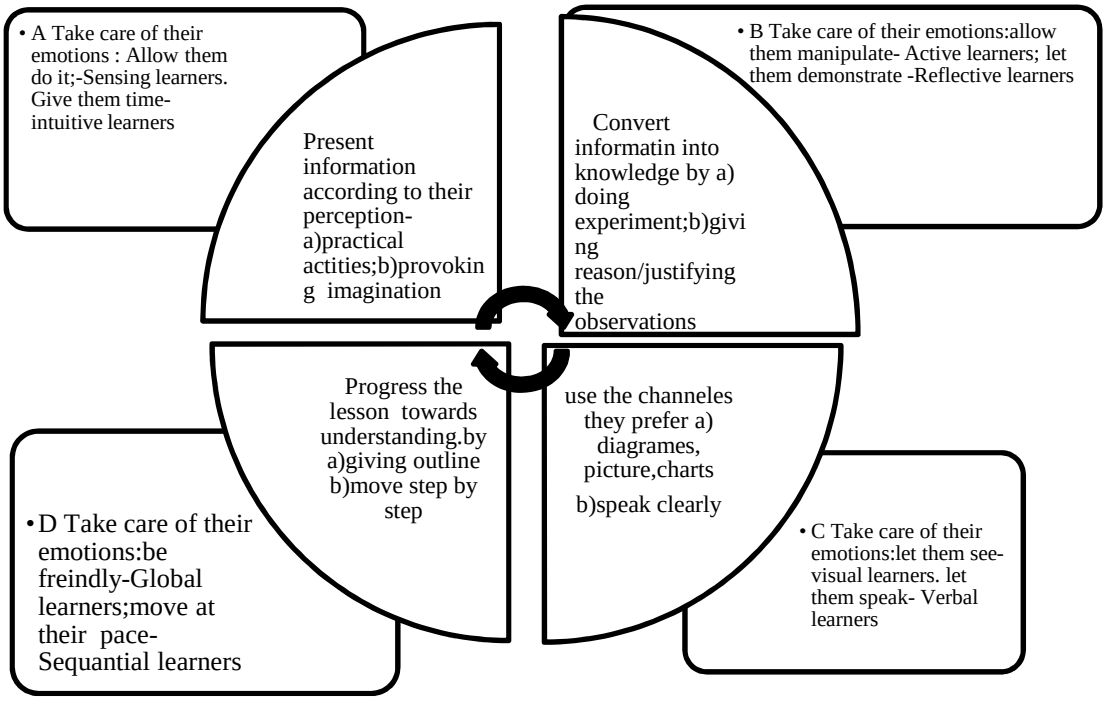

Figure 2: Whole Brain-Teaching Model

Whole Brain-Teaching Model upholds that no child should be left behind in the process of teaching and learning. Bawareh *et al.*, (2017), Herrmann (2015), Teaching Style Theory Grasha (2002), Personality Patterns Theory of learning by Keirsey (2013) and Perceptual Learning Style Theory by Felder and Brent (2017) all articulate the Whole Brain-Teaching concept. The four-step delivery of the lesson covered the four phases of learning for every learner each time taking care of their personalities by understanding their feelings and how the teacher's feelings affected them by being friendly, allowing them time to think, manipulate equipment, being orderly, letting them speak and see, demonstrating and letting them do it.

The treatment of experimental group involved presenting information according to their perception by providing practical activities for every concept and physical material for them to observe data through senses to cater for the sensing learners. Allowing them to present or demonstrate to cater for their personality. On the hand provoking the imagination of intuitive learners for them to think through how simple concepts apply in greater life. In addition giving them adequate time to think through to fulfil their personality.

The active learners were facilitated in converting information into knowledge by making them process the information through trying/doing experiment, observing, and recording

(active learning). In addition, allowed to manipulate the variables to realize their personality. On the other hand, reflective learners were assisted to convert information into knowledge by making them give reasons for the observations / justify information observed (reflective learning). In addition, allowed to demonstrate the concepts to appreciate their personality.

The information was presented using the channel they preferred to receive by using pictures, diagrams, flow charts and writing clearly for the visual learners. In addition making sure, they see clearly to satisfy their personality. On the other hand speaking clearly, explaining points and processes clearly at their pace helped the verbal learners. In addition, making sure, they speak and express their opinion in discussion fulfilled their personality.

The lesson was progressed towards their understanding by giving outline of every concept and sub topic for the global learners. In addition being friendly and helping them to discover how the concepts assist and relates to their life to uphold their personality. On the hand developed the understanding of the sequential learners by moving step-by-step in every point, analysing the concepts by giving their similarities and differences, insisting they write the points and summarise the concepts. In addition moving at their pace to enhance their personality.

3.6.2 Pilot Study

The researcher carried pilot study in two mixed secondary schools in Nairobi County, which were excluded in the final study population. The instruments were piloted on a small sample of eight boys and of eight girls from a mixed public school and eight boys and of eight girls from a private school. The schools and the list of girls and boys from Form 2 classes were randomly selected using computerised random number generators in windows SPSS version 22. The purpose of this study was to allow the researcher to ascertain the validity and reliability of the instuments and necessary udjustiments were made after the study.

3.6.3 Validity of the Instruments

Validity is the extent to which a test measures what it claims to measure (Sefik & Cogenli, 2014). The sample size was large enough 8.56% of accessed population that increased the chances of generalization. Random assignment of treatment to experimental units was done to increase the internal validity of the instruments. In addition, the design allowed use of existing intact comparison groups of unassured equivalence, which ensured internal validity

because the assignment of treatment to one group or the other was assumed random, and under the experimenter's control. On the other hand, the factors that could jeopardize internal validity such as general historical events that might have produced an O_1-O_2 difference would also produce an O_3-O_4 difference. Peer and experts in the field of education determined construct as well as face and content validity of the instruments, in terms of suitability of the measuring, construction, clarity, and unambiguity of items as well as appropriateness of difficulty level for the respondents. All four-streamed, Form Two classes in the sampled schools their members took part in the study, there were no dropouts and were given adequate time to complete the tests and fill the questionnaires which enhanced external validity. Re-organized numbering of the test items used as post-test ensured sameness of the measurement (Appendix C).

3.6.4 Reliability of the Instruments

Reliability is reproducibility or degree to which measures are free form errors and therefore yield consistent results (Sefik, & Cogenli, 2014). The reliability was determined with test retest method whereby the same scales were administered to the same respondents after fifteen days. The scores for students were matched and computed in SPSS for windows, version 22. The reliability of treatment questionnaire and achievement tests in pilot study were estimated using the Pearson's Coefficient of Correlation method which yielded a reliability coefficient of .710 and .950 respectively which were high enough to judge the instruments as reliable (APPENDIX E).

3. 8 Data Collection Procedure

The data collection commenced after the researcher was authorised by Institute of Post Graduate Studies, Kabarak University to apply for permit from the National Commission for Science, Technology, and Innovation (NACOSTI). The Principals of selected secondary schools were contacted by the researcher to acquire permission to carry research in their schools with aid of the permit and an acknowledged letter from NACOSTI by County Commissioner and County Director of Education in Nairobi County. The actual administration of the instruments and data collection was preceded by preliminary discussion on the indented research and schedule with the teachers of biology and geography through the Principals. According to Lynch (2014), a pre-visit is an earlier message in which the research participants identify themselves, discuss the study purpose and request for co-operation. In the four-streamed, classes one pair was randomly selected as experimental and the other

control group using computerised random number generators. Each school was given two weeks from the day pre-test was given and a post-test was given at the end of second week after the regular teachers had taught the topic of study and treatment was given to the experimental groups.

3.9 Data Analysis

Three assistant researchers rather than the investigator using common marking schemes scored the data collected through questionnaires and achievement tests. This quickened the process of preparation of the data. In addition, blinding of the control and treatment groups to them avoided observer bias. The random assignment of streams to control and experimental groups was made to minimise selection interaction bias. In addition, their regular teachers rather than the investigator, which minimised interaction bias, taught all the participants in control groups. Interaction bias of treatment group by the investigator was controlled by using the assistant researchers to score the data. Baseline tests were given to both control and experimental groups and independent sample t-test done to ensure trends in treatment and comparison were similar before intervention.

Interaction effects of gender were determined before the analysis of the main effect of treatment using MANOVA (multivariate analysis of variance) in SPSS windows version 22. The data used to compare different subjects, male and female, control and experimental groups, traditional and preferred teaching styles were arranged in stacked format. From the stacked data in SPSS windows this was achieved by using the command ‘Analyse’ > ‘General Linear Model’> ‘Multivariate’ > ‘Model’ > ‘Custom’ > ‘Interaction’ > ‘Option’ > ‘Observe power’ > ‘Plot’ > ‘Add’ > Ok. MANOVA was used in :- a) analysis of different preferred learning styles of students. b) Determination of the effect of teaching students according to preferred learning as opposed to traditional teaching styles, in performance in biology and geography. c) Determination gender effect in performance in s biology and geography of students taught using their preferred learning styles. d) Establishment of the differences in performance in biology and geography between private and public secondary students taught using their preferred learning styles in secondary schools in Nairobi County. These main effects of the treatment were analysed by using the command ‘Analyse’ > ‘General Linear Model’ > ‘Multivariate’ > ‘Model’ > ‘Custom’ > ‘Main effect’ > ‘Option’ >’

Descriptive statistcs', > 'Esimate of effects' > 'Observe power' > 'Plot' > 'Add' > Ok. All the statistical tests were conducted at a significance level of 5%.

3.10 Ethical Considerations

The research was preceded by application for research permit from National Commission for Science, Technology, and Innovation after receiving approval of the research proposal by Institute of Post Graduate Studies, Kabarak University. Upon receiving the permit from NACOSTI and an acknowledged letter, from NACOSTI by County Commissioner and County Director of Education in Nairobi County, the researcher initiated access to heads of selected secondary schools. In addition, discussed fully the purpose of the research, its requirement, and the benefits that were to accrue which fully informed each administrator before granting authority to carry the research in their institution. In each school, the researcher sought informed consent from the teachers and students as their personal right as far as concerned the study after introduction by the Principals.

The researcher when executing the questionnaires affirmed to the respondents the need for observing voluntary consent and liberty of not participating and assured not to reveal the identity of respondent and guaranteed them anonymity and confidentiality as recommended by Akaranga and Makau (2016). The personal data and information was assigned pseudo names and selected schools give codes such as B1, G1, M1, M2, B2, G2, M3, and M4. Different marker than the one who marked crosschecked the scripts to ensure no falsification or fabrication of data as recommended by Akaranga and Makau (2016). Individuals not groups, using the codes were give their preferred learning styles and scripts of tests to enhance privacy and protection of personal data after the exercises as they had requested during the study to receive feedback to help them in their future studies. The same treatment given to experimental group (of determining their learning styles) was given to the control group after the study to enhance fairness of treatment and avoid withholding the potentially effective treatment.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, AND DISCUSSION

4.1 Introduction

This chapter presents the findings, interpretations, and discussion of the results of data analysis on effect of effect of teaching using preferred learning styles on students' performance in biology and geography in secondary schools in Nairobi County, Kenya. This was achieved by collection of data from four Private and four Public Secondary Schools in the County and analysing in SPSS Windows version 22. The results of analysis, carried out in both descriptive (mean and standard deviation) and inferential (Sample t-test and Multivariate Analysis of Variance) are presented according to the research objectives. The answer to the research objectives, were sought and the hypothesis were tested at 5% level of significance.

The chapter has been organized into six main sections, demographic information, baseline test and the findings, interpretations, identification of different preferred learning styles of students and discussion of the following objectives :- a) Determination of the differences in effect of traditional teaching and teaching according to preferred learning styles on students' performance in biology and geography. b) Determination of the effect of gender differences in performance in biology and geography of students taught using their preferred learning styles. In addition, c) Establishment of the differences in performance in biology and geography between private and public secondary students taught using their preferred learning styles in secondary schools in Nairobi County.

4.2 General and Demographic Information

The general information comprised of respond rate of respondents and demographic characteristics of sampled population.

4.2.1 General Information

Respond Rate of Respondents.

The total number of learning style questionnaires distributed to experimental group were 660 and all returned and marked which represented 100% response rate. The total number test scripts distributed and returned during pre-test were 1,322 however, 1317 were distributed during post-test because three boys from one public school were send home due to;

Table 10: Questionnaires and test Scripts for Experimental and Control Groups

Type of school	**Public**			**Private**				
Respondents	**No. of Distributed questionnares and scripts**							**Usable (%**
Gender	**Boys**	**Girls**	**Mixed**	**Boys**	**Girls**	**mixed**	**Total**	**No.usable %**
Questionnares Experimental	85	85	178	83	88	141	660	100
Pre-test scripts Experimental	85	85	178	83	88	141	660	100
Post-test scripts Experimental	85	85	177	83	87	141	658	99.70
Pre-test scripts Control	87	86	177	85	86	141	662	100
Post-test scripts Control	84	86	177	85	86	141	659	99.55
Total	**426**	**423**	**887**	**419**	**435**	**705**	**3,299**	**99.85**

indiscipline while one girl from a private school fell sick and one boy from mixed public school opted not to take the post-test (Table 10). The respond rate was 99.85%, attributed to method of data collection where organised classes in a common siting were used. The main challenge was five respondents were missing in the post-test who had to be excluded from the analysis due to lack of matching scores.

4.2.2 Demographic Data

The eight selected schools had the following population of Form Twos, B_1- 169, G_1- 171, M_1- 176, M_2-178 from Public schools and, B_2 -168, G_2-173, M_3- 110, and M_4- 172 from Private schools, which were analysed into gender distribution in control and experimental groups (Table 11)

Table 11: Distribution by Gender in Control and Experimental Groups

Type of school		**Public**				**Private**			**Total**
	Boys'	**Girls'**	**Mixed**		**Boys'**	**Girls'**	**Mixed**		
Gender	**Male**	**Female**	**Male**	**Femle**	**Male**	**Female**	**Male**	**Female**	
Experimental	85	85	91	86	83	87	68	73	658
Control	84	86	89	88	85	86	69	72	659
Total	**169**	**171**	**180**	**174**	**168**	**173**	**137**	**145**	**1,317**

The sample comprised of 49.66% males and 50.34% females.

4.3 Baseline Test Analysis

An important component of the quasi-experimental study was the use of pretesting or analysis of prior achievement to establish group equivalence (Ibrahim, 2015). The entry behaviours of the subjects were established before the commencement of the programme by a t-test of control and experimental groups on geography and biology. This test was important because one of the assumption of a standard independent test is that the two groups have equal variance.

4.3.1 Differences in Performance in Baseline Tests

The researcher sought first to know the differences in performance of students in control and experimental groups in baseline test (Appendix). An independent-samples t-test was conducted, to compare baseline test scores for control and experimental group in both geography and biology. The descriptive (Table 12) showed that mean differences were relatively small in geography 49.3% and 49.5% control and experimental group respectively and in biology 48.3% and 49.8% control and experimental group respectively. The differences in standardized errors in control and experimental groups were equally small in the two tests.

Table 12: Means in Baseline Tests

	Group	N	Mean	Std. Deviation	Std. Error Mean
Geography	Control	659	49.3429	9.78263	.38108
	Experimental	658	49.5289	9.84383	.38375
Biology	Control	659	49.2564	8.37292	.32616
	Experimental	658	49.7660	8.36369	.32605

The testing of homogeneity of variance in Control and Experimental Groups was important because if variances of observed groups appeared to be significantly unequal, this could affect the Type I error rate control (protection against incorrectly identifying a difference among two or more variances when they are the same) (Jelaska, 2016).

Table 13: Levene's Test of Variances in Control and Experimental Groups

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Geog	Equal variances assumed	.012	.913	-.344	1315	731	-.18593	.54082	-1.24689	.87503
	Equal variances not assumed			-.344	1314.92	.731	-.18593	.54082	-1.24689	.87503
Biol	Equal variances assumed	.223	.637	-1.105	1315	.269	-.50951	.46118	-1.41425	.39523
	Equal variances not assumed			-1.105	1315.00	.269	-.50951	.46118	-1.41425	.39523

*The mean difference is significant at the 0.05 level

The Levene's Test for Equality of Variances (Table 13) indicated that there was homogeneity of variance in geography control and experimental groups given significant value > .05 were F (1,1315) = .012, p = .913. There were no significant differences in scores for the control group (M = 49.3 SD = 9.78) and experimental group (M = 49.5, SD = 9.84: t (1315) = -.344, p = .731). The sig value was .731, which is greater than .05. These results showed the two groups experimental and control group where at the same level of performance in Geography at the beginning of the experiment.

Likewise, in biology the Levene's Test for Equality of Variances (Table 13) results indicated there was homogeneity of variance in control and experimental groups' tests given observed significant value > .05 were F (1,1315) = .223, p = .637). There were no statistically significant differences in scores for the control group (M = 49.3, SD = 8.37) and experimental group (M = 49.8, SD = 8.36: t (1315) = -1.11, p = .269,). The sig value was .269, which was greater than .05. The assumption of homogeneity of variance was met. The researcher considered the two groups suitable for the study using quasi-experimental design since were at the same level of performance at the beginning of the experiment.

4.3.2 Gender Differences in Performance of Students in Baseline Tests

The gender differences in performance in biology and geography baseline test were also analysed. The descriptive (Table 14) showed that mean differences were small in geography 49.6% and 49.3% Males, Female groups respectively, biology 49.2% and 49.8% Males, and Female groups respectively.

Table 14: Means of Geography and Biology by Gender in Baseline Tests

Test	Gender	N	Mean	Std. Deviation	Std. Error Mean
Geography	Male	654	49.5535	10.17095	.39772
	Female	663	49.3198	9.44664	.36688
Biology	Male	654	49.2263	8.22338	.32156
	Female	663	49.7919	8.50709	.33039

The differences in standardized errors in control and experimental groups were small in the two tests however, there were higher standard deviation 10.2 in geography compared to the females 9.45.

The Levine's Test for Equality of Variances (Table 15) indicated that there was homogeneity of variance in geography in Male and Female groups' test given observed significant value > .05 were F (1,1315) = 2.81, p = .094. There were no significant differences in scores for the Males (M = 49.6 SD = 10.2) and Females (M = 49.3, SD = 9.45: t (1315) = .432, p = .666). The sig value was .666, which is greater than .05. This test showed the two groups Males and Females groups where at the same level of performance in Geography at the beginning of the experiment.

Table 15: Levene's Test for Equality of Variances by Gender

Independent Samples Test

		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
									95% CI interval of the Difference	
Test		**F**	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Geog	Equal variances assumed	2.806	.094	.432	1315	.666	.23376	.54082	-.82720	1.29471
	Equal variances not assumed			.432	1305.035	.666	.23376	.54109	-.82774	1.29526
Biol	Equal variances assumed	1.026	.311	-1.226	1315	.220	-.56556	.46115	-1.47022	.33911
	Equal variances not assumed			-1.227	1314.462	.220	-.56556	.46104	-1.47001	.33890

*The mean difference is significant at the 0.05 level

Likewise, in biology the Levene's Test for Equality of Variances (Table 15) results indicated there was homogeneity of variance in Males and Female groups given observed significant value > .05 were F (1,1315) = 1.03, p = .311. There were no statistically significant differences in scores for the Males (M = 49.2, SD = 8.22) and Females' group (M = 49.8, SD = 8.51: t (1315) = 1.03, p = .220. The sig value .122, which was greater than .05. The assumption of homogeneity of variance was met. The researcher considered the two groups suitable for the study using quasi-experimental design since were on the same level of performance at the beginning of the experiment.

4.3.3 Performance of Students in Private and Public schools in Baseline Tests

The researcher sought first to know the differences in performance of students in Private and Public schools in baseline tests. The descriptive (Table 16) showed that mean differences were small in geography 49.4% and 49.5% in public and private groups respectively, biology 49.6% and 49.3% public and private groups respectively.

Table 16: Means of Geography and Biology in Private and Public Schools

Test	School	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Geography	Public	694	49.3790	10.20690	.38745
	Private	623	49.4992	9.35575	.37483
Biology	Public	694	49.6282	8.66834	.32905
	Private	623	49.3804	8.02737	.32161

The Levene's Test for Equality of Variances (Table 17) indicated that that there was homogeneity of variance in geography between the private and public schools' means in geography and biology' given observed significant value > .05 were F (1, 1315) = 3.43, p = .064 and F (1, 1315) = 2.90 , p = .089 respectively.

Table 17: Levene's Test for Equality of Variances in Private and Public Schools

Independent Samples Test

		Levene's Test for Equality of Variances		est for Equality of Means						
									95% Confidence Interval of the Difference	
Test		**F**	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Geog	Equal variances assumed	3.434	.064	-.222	1315	.824	-.12023	.54162	-1.18277	.94230
	Equal variances not assumed			-.223	1314.424	.824	-.12023	.53909	-1.17780	.93733
Biol	Equal variances assumed	2.904	.089	.536	1315	.592	.24782	.46202	-.65855	1.15420
	Equal variances not assumed			.539	1313.722	.590	.24782	.46011	-.65481	1.15046

*The mean difference is significant at the 0.05 level

The mean scores were not significantly different in geography, in Public schools (*M*= 49.4 *SD* = 10.2) and Private schools (*M* = 49.5, *SD* = 9.36: *t* (1315) = -.222, *p* = .824). In biology, Public schools (*M* = 49.6 *SD* = 8.67 and Private schools (*M* = 49.4 SD = 8.03: *t* (1315) = .536, *p* = .592). The results described above (Table 17) suggested the two types schools were on the same level of performance at the beginning of the experiment (Mara & Cribbie, 2014).

4.3.4 Different Preferred Learning Styles of Students

As a prerequisite to carry the quasi-experimental study determination of the different preferred learning styles of secondary schools students in Nairobi County was done. The data collected using learning style questionnaires was analysed in General Linear Model in SPSS windows using the command 'Analyse' > 'General Linear Model'> 'Univariate or

Multivariate' > 'Model' > 'full factorial' > 'Option' > 'Display descriptive statistics' > 'Observe power' > 'Continue' > 'Post hock' > 'Tukey' > 'Continue' > Ok. The data was organised in terms of preferred learning styles in perception of information, processsing, prefferred channel and progressing to understanding. Both Univariate and multivariate analysis of variance was done to capture the different preferred styles of learning in perception of information, processsing, receiving and progressing in understanding. A)

a) Preferred way of perceiving information in learning.

The researcher wanted to find whether the students of private and public secondary schools in Nairobi County had different preferred styles of learning in perception of information. Univariate analysis of variance of responses from 659 respondents done descriptive statistics (Table 18), revealed that 59.5 % (392) are sensing learners (that is they prefer to perceive information through the senses) while 40.5 % (267) are intuitive learners who prefer to perceive information through thinking or internally through memory, reflection and imagination (Awla, 2014). The distribution of preferences varied across gender, private, and public schools. The data indicated 58.2%(191) of the males are sensing learners and 41.8% intuitive learners .On the other hand 60.7% (201) of the females are sensing learners and 39.3%(130) intuitive learners . In public schools, 63.7% (221) are sensing learners and 36.3% (126) intuitive learners. In private schools, 54.8% (171) are sensing learners and 45.2% (141) intuitive learners. In private schools 26.3% (82) having balanced, 58% (181) moderate preference for two of the dimensions and 15.7% (49) very strong preference for one of the dimensions. In public schools 25% (87) having balanced, 59.7% (207) moderate preference for two of the dimensions and 15.3% (53) very strong preference for one of the dimensions. In addition, of the total treatment sample 659 the data indicated 25.6% (169) had balanced preference for two of the dimensions, 58.9% (388) had moderate preference for two of the dimensions, and 15.5 % (102) had very strong preference to one of the dimensions (Table 18).

Table 18: Descriptive Statistics of Perceiving Information in Learning

Gender	School	Preferred style of Learning	Perception choice	N	Mean	Std. Deviation
Male	Public	Balanced Preference for two of the dimensions	Sensing	26	2.3846	1.09825
			Intuitive	21	1.9524	1.02353
			Total	47	2.1915	1.07619
		Moderate Preference for two of the dimensions	Sensing	72	3.3333	2.09627
			Intuitive	36	3.1667	2.04939
			Total	108	3.2778	2.07267
		Very strong Preference for one of the dimensions	Sensing	17	4.5294	2.40098
			Intuitive	4	4.0000	3.46410
			Total	21	4.4286	2.54109
		Total	Sensing	115	3.2957	2.05612
			Intuitive	61	2.8033	1.95635
			Total	176	3.1250	2.03013
	Private	Balanced Preference for two of the dimensions	Sensing	16	1.8750	1.02470
			Intuitive	25	2.4400	.91652
			Total	41	2.2195	.98773
		Moderate Preference for two of the dimensions	Sensing	47	3.6383	1.91590
			Intuitive	37	3.5405	1.98038
			Total	84	3.5952	1.93334
		Very strong Preference for one of the dimensions	Sensing	13	6.3846	3.30501
			Intuitive	14	5.4286	2.84779
			Total	27	5.8889	3.05505
		Total	Sensing	76	3.7368	2.48391
			Intuitive	76	3.5263	2.15081
			Total	152	3.6316	2.31804
	Total	Balanced Preference for two of the dimensions	Sensing	42	2.1905	1.08736
			Intuitive	46	2.2174	.98687
			Total	88	2.2045	1.03011
		Moderate Preference for two of the dimensions	Sensing	119	3.4538	2.02421
			Intuitive	73	3.3562	2.00949
			Total	192	3.4167	2.01391

		Very strong Preference for one of the dimensions	Sensing	30	5.3333	2.92826
			Intuitive	18	5.1111	2.94836
			Total	48	5.2500	2.90634
		Total	Sensing	191	3.4712	2.24029
			Intuitive	137	3.2044	2.09038
			Total	328	3.3598	2.17966
Female	Public	Balanced Preference for two of the dimensions	Sensing	24	2.5833	1.66594
			Intuitive	16	2.7500	1.00000
			Total	40	2.6500	1.42415
		Moderate Preference for two of the dimensions	Sensing	63	4.3651	2.20923
			Intuitive	36	4.4444	2.00634
			Total	99	4.3939	2.12765
		Very strong Preference for one of the dimensions	Sensing	19	7.2105	2.97357
			Intuitive	13	7.6154	2.36426
			Total	32	7.3750	2.70901
		Total	Sensing	106	4.4717	2.68047
			Intuitive	65	4.6615	2.48921
			Total	171	4.5439	2.60364
	Private	Balanced Preference for two of the dimensions	Sensing	27	2.4074	1.21716
			Intuitive	14	2.7143	1.54066
			Total	41	2.5122	1.32518
		Moderate Preference for two of the dimensions	Sensing	58	2.9310	1.79534
			Intuitive	39	3.4103	1.66572
			Total	97	3.1237	1.75153
		Very strong Preference for one of the dimensions	Sensing	10	5.2000	3.19026
			Intuitive	12	5.0000	3.07482
			Total	22	5.0909	3.05363
		Total	Sensing	95	3.0211	1.98922
			Intuitive	65	3.5538	2.07689
			Total	160	3.2375	2.03580
	Total	Balanced Preference for two of the dimensions	Sensing	51	2.4902	1.43349
			Intuitive	30	2.7333	1.25762
			Total	81	2.5802	1.36807

		Moderate Preference for two of the dimensions	Sensing	121	3.6777	2.13781
			Intuitive	75	3.9067	1.89718
			Total	196	3.7653	2.04714
		Very strong Preference for one of the dimensions	Sensing	29	6.5172	3.14666
			Intuitive	25	6.3600	2.98440
			Total	54	6.4444	3.04474
		Total	Sensing	201	3.7861	2.48173
			Intuitive	130	4.1077	2.35015
			Total	331	3.9124	2.43239
Total	Public	Balanced Preference for two of the dimensions	Sensing	50	2.4800	1.38858
			Intuitive	37	2.2973	1.07664
			Total	87	2.4023	1.26178
		Moderate Preference for two of the dimensions	Sensing	135	3.8148	2.20307
			Intuitive	72	3.8056	2.11393
			Total	207	3.8116	2.16733
		Very strong Preference for one of the dimensions	Sensing	36	5.9444	3.00423
			Intuitive	17	6.7647	2.99018
			Total	53	6.2075	2.99588
		Total	Sensing	221	3.8597	2.44266
			Intuitive	126	3.7619	2.42464
			Total	347	3.8242	2.43308
	Private	Balanced Preference for two of the dimensions	Sensing	43	2.2093	1.16615
			Intuitive	39	2.5385	1.16633
			Total	82	2.3659	1.17076
		Moderate Preference for two of the dimensions	Sensing	105	3.2476	1.87484
			Intuitive	76	3.4737	1.81456
			Total	181	3.3425	1.84807
		Very strong Preference for one of the dimensions	Sensing	23	5.8696	3.23762
			Intuitive	26	5.2308	2.90252
			Total	49	5.5306	3.04892
		Total	Sensing	171	3.3392	2.24438
			Intuitive	141	3.5390	2.10956
			Total	312	3.4295	2.18328

Total	Balanced Preference for two of the dimensions	Sensing	93	2.3548	1.29081
		Intuitive	76	2.4211	1.12265
		Total	169	2.3846	1.21499
	Moderate Preference for two of the dimensions	Sensing	240	3.5667	2.08093
		Intuitive	148	3.6351	1.96621
		Total	388	3.5928	2.03564
	Very strong Preference for one of the dimensions	Sensing	59	5.9153	3.06981
		Intuitive	43	5.8372	2.99945
		Total	102	5.8824	3.02561
	Total	Sensing	**392**	3.6327	2.36940
		Intuitive	**267**	3.6442	2.26214
		Total	**659**	3.6373	2.32481

Estimated marginal means in an 11-point scale indicate females had higher mean scores of 4.20 with std. error of .122 compared to males 3.70 with std. error of .122 on preference of either intuition or sensing learning style in perception of information (Table 19).

Table 19: Estimated Marginal Means in Perception of Information

Dependent Variable: Perception Preference

				95% Confidence Interval	
		Mean	Std. Error	Lower Bound	Upper Bound
Gender	Male	3.701	.122	3.461	3.942
	Female	4.198	.122	3.958	4.437
School	Public	4.154	.121	3.916	4.391
	Private	3.745	.124	3.502	3.989
Perception choice	Sensing	3.902	.114	3.677	4.127
	Intuitive	3.997	.132	3.738	4.255
Preferred style of Learning	Balanced Preference for two of the dimensions	2.394	.157	2.085	2.702
	Moderate Preference for two of the dimensions	3.588	.105	3.381	3.794
	Very strong Preference for one of the dimensions	5.867	.202	5.470	6.264

On the other hand estimated marginal means indicate that students in public schools had higher mean scores of 4.15 with std. error of .121 compared to students in private schools 3.75 with std. error of .124 on preference of either intuition or sensing learning style in perception of information.

The results of Univariate Analysis of Variance (ANOVA) of tests of between-subjects effects on preferred learning style on perception of information (Table 20) showed that the preference of intuition and sensing in perception of information was not equally distributed in the schools and gender. An analysis of variance showed that difference in gender preference to categories of learning styles in perception of information was significant F (1,653) = 9.77, p = .002. In addition, private and public schools had significant differences in preference to categories of learning styles in perception of information F (1,653) = 9.77, p = .011.

Table 20: Tests of Between-Subjects Effects in Perception of Information

Dependent Variable: Perception Preference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	846.654[a]	5	169.331	40.807	.000	.238	204.034	1.000
Intercept	7508.157	1	7508.157	1809.383	.000	.735	1809.383	1.000
Gender	40.557	1	40.557	9.774	.002	.015	9.774	.877
School	27.166	1	27.166	6.547	.011	.010	6.547	.724
Preferred styles	768.635	2	384.317	92.616	.000	.221	185.233	1.000
Perception choice	1.401	1	1.401	.338	.561	.001	.338	.089
Error	2709.668	653	4.150					
Total	12275.000	659						
Corrected Total	3556.322	658						

a. R Squared = .238 (Adjusted R Squared = .232)

b. Computed using alpha = .05

Post hoc analyses, (Table 21), indicate that in perception of information, learners with balanced preference for two dimensions of learning styles (intuitive and sensing) had significantly lower mean scores (M = 2.38, SD = 1.21, *p* =.000) compared to individuals with moderate preference (M = 3.59, SD = 2.04) and very strong preference for a particular dimension of learning style (M = 5.88, SD = 3.03). In addition, learners with very strong preference for a particular dimension of learning style had significantly higher mean scores (M = 5.88, SD = 3.03, *p* = .000) compared to individuals with moderate preference (M = 3.59, SD = 2.04) and balanced preference for two dimensions of learning styles (M = 2.38, SD = 1.21).

This suggests that different learners have different styles of perceiving information in the learning process. This implies that in teaching process teachers should present information to learners according to their perception. In every lesson teachers and instructors, should analyse the teaching content to identify the relevant practical activities for every concept and physical materials necessary for them to observe data through senses to cater for the sensing learners. At the same time allowing them to manipulate as well as present or demonstrate the skills to cater for their personality. On the hand, the teachers should provoke the imagination of intuitive learners by challenging them to analyse, synthesize, and evaluate the concepts for them to think through how the simple concepts apply in greater life. In addition giving them adequate time to think through to fulfil their personality.

Table 21: Post Hoc Tests in Perception of Information (Multiple Comparisons)

Dependent Variable: Perception Preference

Tukey HSD

(I) Preferred style of Learning	(J) Preferred style of Learning	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Balanced Preference for two of the dimensions	Moderate Preference for two of the dimensions	-1.2082*	.18775	.000	-1.6492	-.7671
	Very strong Preference for one of the dimensions	-3.4977*	.25541	.000	-4.0977	-2.8978
Moderate Preference for two of the dimensions	Balanced Preference for two of the dimensions	1.2082*	.18775	.000	.7671	1.6492
	Very strong Preference for one of the dimensions	-2.2896*	.22666	.000	-2.8220	-1.7571
Very strong Preference for one of the dimensions	Balanced Preference for two of the dimensions	3.4977*	.25541	.000	2.8978	4.0977
	Moderate Preference for two of the dimensions	2.2896*	.22666	.000	1.7571	2.8220

Based on observed means.

The error term is Mean Square (Error) = 4.150.

*. The mean difference is significant at the .05 level.

The finding of this study demonstrates and supports Wouter and Katrien (2018) that assessment of concept learning styles needed a more appropriate articulation of the discourse to help reduce misunderstandings in the preference of learning styles. Past research work held that the assumption that people can be clustered in different groups is not supported by

empirical evidence (Alavi &Toozandehjani, 2017; Wouter & Katrien, 2018). The clustering contributed to the misunderstandings. This study demonstrates that all learners display specific preferred learning styles in perception of information, processing information, preferred channel of receiving in formation and order of progressing the processing information rather than possessing only one of the learning styles.

b) Preferred way of processing information in learning

The researcher wanted to find whether the students of private and public secondary schools in Nairobi County had different preferred styles of processing of information. Univariate analysis of variance of responses from 659 respondents done. Descriptive statistics (Table 22), revealed that 71.5 % (471) are active learners (that is they prefer to process information by trying things out, working in a group, and discussing) while 28.5 % (188) are reflective learners who prefer to process information by thinking things through and working alone (Rivera, 2016). The distribution of preferences varied across gender, private, and public schools. The data indicated 71.0%(233) of the males are active learners and 29.0% (95) reflective learners .On the other hand 71.9% (238) of the females are active learners and 28.1%(93) reflective learners . In public schools, 70.9% (246) are active learners and 29.1% (101) reflective learners. In private schools, 72.1% (225) are active learners and 27.9% (87) reflective learners. In private schools 26.3% (82) having balanced, 58% (181) moderate preference for two of the dimensions and 15.7% (49) very strong preference for one of the dimensions. In public schools 25% (87) having balanced, 59.7% (207) moderate preference for two of the dimensions and 15.3% (53) very strong preference for one of the dimensions. In addition, of the total treatment sample 659 the data indicated 25.6% (169) had balanced preference for two of the dimensions, 58.9% (388) had moderate preference for two of the dimensions, and 15.5 % (102) had very strong preference to one of the dimensions (Table 22).

Table 22: Descriptive statistics of Processing Information in Learning

Gender	School	Preferred style of Learning	Processing choice	N	Mean	Std. Deviation
Male	Public	Balanced Preference for two of the dimensions	Active	30	1.8000	.99655
			Reflective	17	1.8235	1.01460
			Total	47	1.8085	.99211
		Moderate Preference for two of the dimensions	Active	81	3.8642	2.04788
			Reflective	27	3.0000	1.56893
			Total	108	3.6481	1.96851
		Very strong Preference for one of the dimensions	Active	17	6.2941	3.15762
			Reflective	4	7.0000	2.82843
			Total	21	6.4286	3.04256
		Total	Active	128	3.7031	2.42805
			Reflective	48	2.9167	2.01941
			Total	176	3.4886	2.34457
	Private	Balanced Preference for two of the dimensions	Active	25	2.4400	.91652
			Reflective	16	1.8750	1.02470
			Total	41	2.2195	.98773
		Moderate Preference for two of the dimensions	Active	62	3.0968	2.06223
			Reflective	22	3.9091	1.82337
			Total	84	3.3095	2.02381
		Very strong Preference for one of the dimensions	Active	18	5.1111	3.66042
			Reflective	9	5.6667	3.46410
			Total	27	5.2963	3.53896
		Total	Active	105	3.2857	2.37663
			Reflective	47	3.5532	2.42100
			Total	152	3.3684	2.38562
	Total	Balanced Preference for two of the dimensions	Active	55	2.0909	1.00504
			Reflective	33	1.8485	1.00378
			Total	88	2.0000	1.00573
		Moderate Preference for two of the dimensions	Active	143	3.5315	2.08213
			Reflective	49	3.4082	1.73107
			Total	192	3.5000	1.99476
		Very strong Preference for one of the dimensions	Active	35	5.6857	3.42801
			Reflective	13	6.0769	3.22649
			Total	48	5.7917	3.34510
		Total	Active	233	3.5150	2.40885
			Reflective	95	3.2316	2.23822
			Total	328	3.4329	2.36082
Female	Public	Balanced Preference for two of the dimensions	Active	28	2.2857	1.73967
			Reflective	12	1.8333	1.02986
			Total	40	2.1500	1.56156
		Moderate Preference	Active	69	3.6087	1.91908

		for two of the dimensions	Reflective	30	3.6667	1.76817
			Total	99	3.6263	1.86584
		Very strong Preference for one of the dimensions	Active	21	5.1905	3.57238
			Reflective	11	4.2727	3.25856
			Total	32	4.8750	3.44309
		Total	Active	118	3.5763	2.42637
			Reflective	53	3.3774	2.18585
			Total	171	3.5146	2.34986
	Private	Balanced Preference for two of the dimensions	Active	35	2.4857	1.40108
			Reflective	6	2.0000	1.09545
			Total	41	2.4146	1.35970
		Moderate Preference for two of the dimensions	Active	67	3.0299	2.01487
			Reflective	30	3.1333	2.09652
			Total	97	3.0619	2.03006
		Very strong Preference for one of the dimensions	Active	18	3.1111	2.42266
			Reflective	4	3.0000	.00000
			Total	22	3.0909	2.18019
		Total	Active	120	2.8833	1.92805
			Reflective	40	2.9500	1.89399
			Total	160	2.9000	1.91387
	Total	Balanced Preference for two of the dimensions	Active	63	2.3968	1.55065
			Reflective	18	1.8889	1.02262
			Total	81	2.2840	1.45975
		Moderate Preference for two of the dimensions	Active	136	3.3235	1.98096
			Reflective	60	3.4000	1.94152
			Total	196	3.3469	1.96431
		Very strong Preference for one of the dimensions	Active	39	4.2308	3.23193
			Reflective	15	3.9333	2.81493
			Total	54	4.1481	3.09843
		Total	Active	238	3.2269	2.21211
			Reflective	93	3.1935	2.06555
			Total	331	3.2175	2.16888
Total	Public	Balanced Preference for two of the dimensions	Active	58	2.0345	1.41379
			Reflective	29	1.8276	1.00246
			Total	87	1.9655	1.28903
		Moderate Preference for two of the dimensions	Active	150	3.7467	1.98716
			Reflective	57	3.3509	1.69549
			Total	207	3.6377	1.91548
		Very strong Preference for one of the dimensions	Active	38	5.6842	3.39400
			Reflective	15	5.0000	3.29502
			Total	53	5.4906	3.34907
		Total	Active	246	3.6423	2.42312
			Reflective	101	3.1584	2.11060

		Total	347	3.5014	2.34382
Private	Balanced Preference for two of the dimensions	Active	60	2.4667	1.21386
		Reflective	22	1.9091	1.01929
		Total	82	2.3171	1.18507
	Moderate Preference for two of the dimensions	Active	129	3.0620	2.03006
		Reflective	52	3.4615	2.00452
		Total	181	3.1768	2.02532
	Very strong Preference for one of the dimensions	Active	36	4.1111	3.22293
		Reflective	13	4.8462	3.10500
		Total	49	4.3061	3.17677
	Total	Active	225	3.0711	2.15355
		Reflective	87	3.2759	2.20301
		Total	312	3.1282	2.16585
Total	Balanced Preference for two of the dimensions	Active	118	2.2542	1.32811
		Reflective	51	1.8627	1.00039
		Total	169	2.1361	1.24850
	Moderate Preference for two of the dimensions	Active	279	3.4301	2.03246
		Reflective	109	3.4037	1.84149
		Total	388	3.4227	1.97836
	Very strong Preference for one of the dimensions	Active	74	4.9189	3.38310
		Reflective	28	4.9286	3.14970
		Total	102	4.9216	3.30522
	Total	Active	**471**	3.3694	2.31357
		Reflective	**188**	3.2128	2.14886
		Total	**659**	3.3247	2.26729

Estimated marginal means in an 11-point scale indicate males had higher mean scores of 3.59 with std. error of .131 compared to females 3.33 with std. error of .130 on preference of either active or reflective learning styles in processing of information (Table 23).

Table 23: Estimated Marginal Means of Processing Information in Learning.

Dependent Variable: Processing Preference

			Std.	95% Confidence Interval	
		Mean	Error	Lower Bound	Upper Bound
Gender	Male	3.592	.131	3.336	3.849
	Female	3.327	.130	3.072	3.582
School	Public	3.640	.128	3.389	3.891
	Private	3.279	.133	3.018	3.540
Processing choice	Active	3.522	.107	3.312	3.733
	Reflective	3.397	.159	3.083	3.710
Preferred style of Learning	Balanced Preference for two of the dimensions	2.100	.165	1.777	2.423
	Moderate Preference for two of the dimensions	3.384	.113	3.162	3.607
	Very strong Preference for one of the dimensions	4.894	.211	4.480	5.308

On the other hand estimated marginal means indicate that students in public schools had higher mean scores of 3.64 with std. error of .128 compared to students in private schools 3.28 with std. error of .133 on preference of either active or reflective learning style in processing of information (Table 23).

The results of Univariate Analysis of Variance (ANOVA) of tests of between-subjects effects on preferred learning styles on processing of information (Table 24) showed that gender preferences to active and reflective learning styles in processing of information were not significantly different $F(1,653) = 2.65$, $p = .104$

Table 24: Tests of Between-Subjects Effects in Processing of Information

Dependent Variable: Processing Preference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	537.962[a]	5	107.592	24.699	.000	.159	123.496	1.000
Intercept	5030.601	1	5030.601	1154.836	.000	.639	1154.836	1.000
Gender	11.546	1	11.546	2.651	.104	.004	2.651	.369
School	21.325	1	21.325	4.895	.027	.007	4.895	.598
Preferred style	504.318	2	252.159	57.886	.000	.151	115.772	1.000
Processing choice	2.128	1	2.128	.488	.485	.001	.488	.107
Error	2844.544	653	4.356					
Total	10667.000	659						
Corrected Total	3382.507	658						

a. R Squared = .159 (Adjusted R Squared = .153)

b. Computed using alpha = .05

However, students in private and public schools had significant differences in preference to active and reflective learning styles in processing of information F (1,653) = 4.99, p = .027 (Table 24).

Post hoc analyses, (Tables 25), indicate that in processing of information, learners with balanced preference for two dimensions of learning styles (active and reflective) had significantly lower mean scores (M = 2.14 SD = 1.25, p = .000) compared to individuals with moderate preference (M = 3.42, SD = 1.98) and very strong preference for a particular dimension of learning style (M = 4.92, SD = 3.31).

Table 25: Post Hoc Tests of Processing Information (Multiple Comparisons)

Dependent Variable: Processing Preference Active/Reflective

Tukey HSD

(I) Preferred style of Learning	(J) Preferred style of Learning	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Balanced Preference for two of the dimensions	Moderate Preference for two of the dimensions	-1.2866*	.19236	.000	-1.7385	-.8347
	Very strong Preference for one of the dimensions	-2.7855*	.26169	.000	-3.4002	-2.1707
Moderate Preference for two of the dimensions	Balanced Preference for two of the dimensions	1.2866*	.19236	.000	.8347	1.7385
	Very strong Preference for one of the dimensions	-1.4989*	.23224	.000	-2.0444	-.9533
Very strong Preference for one of the dimensions	Balanced Preference for two of the dimensions	2.7855*	.26169	.000	2.1707	3.4002
	Moderate Preference for two of the dimensions	1.4989*	.23224	.000	.9533	2.0444

Based on observed means.

The error term is Mean Square (Error) = 4.356.

*. The mean difference is significant at the .05 level.

In addition, learners with very strong preference for a particular dimension of learning style had significantly higher mean scores (M = 4.92, SD = 3.31, p < .000) compared to individuals with moderate preference (M = 3.42, SD = 1.98) and balanced preference for two dimensions of learning styles (M = 2.14 SD = 1.25).

This suggests that different learners have different styles of processing scientific information in the learning process. This implies that in teaching process teachers should facilitate conversion of information into knowledge by making active learners process the information through trying/doing experiments, observing, and recording. In addition, allowing the students to manipulate the variables by doing something physical with presented material like calculations of dimensions to realize their personality. On the other hand, the teachers should assist reflective learners to convert information into knowledge by making them give reasons for the observations / justify information observed. In addition, according them time to think before acting and to assimilate before commenting or demonstrating the concepts to appreciate their personality.

This study support several studies (Alavi & Toozandehjani, 2017; Sreenidhi & Taychinyi, 2017), that most people have a preference to identifiable method of interacting with, taking in, and processing information. In addition, the study agrees with findings of Kaushik (2017) in his study that attempts to bridge David Kolb's theory of Learning Styles with Gardner's Theory of Multiple Intelligences to overcome criticisms to both that different learners have a preferred way of thinking, processing, and understanding information. This further implies that understanding the student's level, developmental stage and preferred style of processing information help the instructors choose the best teaching style to achieve the negotiated goals.

c) Preferred Styles of Receiving Information in Learning.

The researcher wanted to find whether the students of private and public secondary schools in Nairobi County had different preferred channels of receiving information. Univariate analysis of variance of responses from 659 respondents done descriptive statistics (Table 26) revealed that 53.0 % (349) are visual learners (that is they prefer to use sight as the sensory channel to receive external information) while 47.0 % (310) are verbal learners who prefer to hear external information in the process of learning.

The distribution of preferences varied across gender, private, and public schools. The data indicated 51.8 % (170) of the males are visual learners and 48.2% (158) verbal learners. On the other hand, 54.1% (179) of the females are visual learners and 45.9 % (152) verbal learners. In public schools, 55.3% (192) are visual learners and 44.7% (155) verbal learners. In private schools, 50.3% (157) are visual learners and 49.7% (155) verbal learners. In private

schools 26.3% (82) having balanced, 58% (181) moderate preference for two of the dimensions and 15.7% (49) very strong preference for one of the dimensions. In public schools 25% (87) having balanced, 59.7% (207) moderate preference for two of the dimensions and 15.3% (53) very strong preference for one of the dimensions. In addition, of the total treatment sample 659 the data indicated 25.6% (169) had balanced preference for two of the dimensions, 58.9% (388) had moderate preference for two of the dimensions, and 15.5 % (102) had very strong preference to one of the dimensions (Table 26).

Table 26: Descriptive Statistics of Receiving Information in Learning

Gender	School	Preferred style of Learning	Receiving	N	Mean	Std. Deviation
Male	Public	Balanced Preference for two of the dimensions	Visual	25	1.8000	1.00000
			Verbal	22	1.8182	1.00647
			Total	47	1.8085	.99211
		Moderate Preference for two of the dimensions	Visual	65	2.4462	2.01580
			Verbal	43	1.7907	1.24515
			Total	108	2.1852	1.77284
		Very strong Preference for one of the dimensions	Visual	9	4.1111	3.48010
			Verbal	12	3.3333	3.49892
			Total	21	3.6667	3.42540
		Total	Visual	99	2.4343	2.06112
			Verbal	77	2.0390	1.79503
			Total	176	2.2614	1.95372
	Private	Balanced Preference for two of the dimensions	Visual	23	1.6957	.97397
			Verbal	18	1.5556	.92178
			Total	41	1.6341	.94223
		Moderate Preference for two of the dimensions	Visual	38	2.6316	1.96484
			Verbal	46	2.7826	1.94266
			Total	84	2.7143	1.94237
		Very strong Preference for one of the dimensions	Visual	10	2.4000	2.31900
			Verbal	17	3.5882	3.06306
			Total	27	3.1481	2.82440
		Total	Visual	71	2.2958	1.79200

			Verbal	81	2.6790	2.15538
			Total	152	2.5000	1.99669
	Total	Balanced Preference for two of the dimensions	Visual	48	1.7500	.97849
			Verbal	40	1.7000	.96609
			Total	88	1.7273	.96760
		Moderate Preference for two of the dimensions	Visual	103	2.5146	1.98950
			Verbal	89	2.3034	1.70830
			Total	192	2.4167	1.86265
		Very strong Preference for one of the dimensions	Visual	19	3.2105	2.97357
			Verbal	29	3.4828	3.19174
			Total	48	3.3750	3.07789
		Total	Visual	170	2.3765	1.94891
			Verbal	158	2.3671	2.00748
			Total	328	2.3720	1.97432
Female	Public	Balanced Preference for two of the dimensions	Visual	22	1.9091	1.19160
			Verbal	18	1.5556	.92178
			Total	40	1.7500	1.08012
		Moderate Preference for two of the dimensions	Visual	58	2.5517	2.05343
			Verbal	41	2.7561	1.79973
			Total	99	2.6364	1.94545
		Very strong Preference for one of the dimensions	Visual	13	3.0000	3.16228
			Verbal	19	2.4737	1.98238
			Total	32	2.6875	2.49435
		Total	Visual	93	2.4624	2.08806
			Verbal	78	2.4103	1.73905
			Total	171	2.4386	1.93133
	Private	Balanced Preference for two of the dimensions	Visual	21	2.2381	1.17918
			Verbal	20	1.9000	1.02084
			Total	41	2.0732	1.10432
		Moderate Preference for two of the dimensions	Visual	56	2.5000	1.95402
			Verbal	41	2.9512	1.97422
			Total	97	2.6907	1.96512
		Very strong Preference	Visual	9	6.7778	3.07318

		for one of the dimensions	Verbal	13	5.1538	3.41189
			Total	22	5.8182	3.30420
		Total	Visual	86	2.8837	2.34354
			Verbal	74	3.0541	2.34019
			Total	160	2.9625	2.33617
	Total	Balanced Preference for two of the dimensions	Visual	43	2.0698	1.18312
			Verbal	38	1.7368	.97770
			Total	81	1.9136	1.09770
		Moderate Preference for two of the dimensions	Visual	114	2.5263	1.99650
			Verbal	82	2.8537	1.87986
			Total	196	2.6633	1.95038
		Very strong Preference for one of the dimensions	Visual	22	4.5455	3.59533
			Verbal	32	3.5625	2.92859
			Total	54	3.9630	3.22117
		Total	Visual	179	2.6648	2.21827
			Verbal	152	2.7237	2.07220
			Total	331	2.6918	2.14940
Total	Public	Balanced Preference for two of the dimensions	Visual	47	1.8511	1.08305
			Verbal	40	1.7000	.96609
			Total	87	1.7816	1.02781
		Moderate Preference for two of the dimensions	Visual	123	2.4959	2.02595
			Verbal	84	2.2619	1.60661
			Total	207	2.4010	1.86657
		Very strong Preference for one of the dimensions	Visual	22	3.4545	3.26201
			Verbal	31	2.8065	2.65103
			Total	53	3.0755	2.90787
		Total	Visual	192	2.4479	2.06882
			Verbal	155	2.2258	1.77116
			Total	347	2.3487	1.94194
	Private	Balanced Preference for two of the dimensions	Visual	44	1.9545	1.09872
			Verbal	38	1.7368	.97770
			Total	82	1.8537	1.04376
		Moderate Preference	Visual	94	2.5532	1.94890

	for two of the dimensions	Verbal	87	2.8621	1.94800
		Total	181	2.7017	1.94920
	Very strong Preference for one of the dimensions	Visual	19	4.4737	3.45396
		Verbal	30	4.2667	3.25823
		Total	49	4.3469	3.30121
	Total	Visual	157	2.6178	2.12595
		Verbal	155	2.8581	2.24603
		Total	312	2.7372	2.18622
Total	Balanced Preference for two of the dimensions	Visual	91	1.9011	1.08582
		Verbal	78	1.7179	.96561
		Total	169	1.8166	1.03312
	Moderate Preference for two of the dimensions	Visual	217	2.5207	1.98857
		Verbal	171	2.5673	1.80844
		Total	388	2.5412	1.90900
	Very strong Preference for one of the dimensions	Visual	41	3.9268	3.34955
		Verbal	61	3.5246	3.03099
		Total	102	3.6863	3.15281
	Total	Visual	**349**	2.5244	2.09340
		Verbal	**310**	2.5419	2.04398
		Total	**659**	2.5326	2.06875

Estimated marginal means in preference of receiving information in an 11-point scale indicate females had higher mean scores of 2.83 with std. error of .117 compared to males 2.55 with std. error of .118 on preference of either visual or verbal learning styles in receiving of information (Table 27).

Table 27: Estimated Marginal Means in Preference of Receiving Information

Dependent Variable: Receiving Preference

			Std.	95% Confidence Interval	
		Mean	Error	Lower Bound	Upper Bound
Gender	Male	2.552	.118	2.320	2.785
	Female	2.826	.117	2.595	3.056
School	Public	2.493	.116	2.266	2.720
	Private	2.885	.120	2.648	3.121
Receiving choice	Visual	2.736	.119	2.503	2.968
	Verbal	2.642	.118	2.410	2.874
Preferred style of Learning	Balanced Preference for two of the dimensions	1.824	.152	1.525	2.123
	Moderate Preference for two of the dimensions	2.547	.101	2.349	2.746
	Very strong Preference for one of the dimensions	3.695	.197	3.309	4.081

The results of Univariate Analysis of Variance (ANOVA) of tests of between-subjects effects on preferred learning styles of receiving of information (Table 28) showed that gender preferences to visual and verbal learning styles in receiving of information were not significantly different $F(1,653) = 3.15$, $p = .077$

Table 28: Tests of Between-Subjects Effects of Receiving information

Dependent Variable: Receiving Preference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	261.674[a]	5	52.335	13.379	.000	.093	66.894	1.000
Intercept	3550.574	1	3550.574	907.668	.000	.582	907.668	1.000
Gender	12.310	1	12.310	3.147	.077	.005	3.147	.425
School	25.097	1	25.097	6.416	.012	.010	6.416	.715
Preferred style	220.819	2	110.409	28.225	.000	.080	56.450	1.000
Receiving choice	1.413	1	1.413	.361	.548	.001	.361	.092
Error	2554.375	653	3.912					
Total	7043.000	659						
Corrected Total	2816.049	658						

a. R Squared = .093 (Adjusted R Squared = .086)

b. Computed using alpha = .05

However, students in private and public schools had significant differences in preference to visual and verbal learning styles in receiving of information F (1,653) = 6.42, p = .012 (Table 28).

Post hoc analyses, (Tables 29), indicate that in receiving of information, learners with balanced preference for two dimensions of learning styles (visual and verbal) had significantly lower mean scores (M = 1.82 SD = 1.03, p =.000) compared to individuals with moderate preference (M = 2.42, SD = 1.91) and very strong preference for a particular dimension of learning style (M = 3.69, SD = 3.15).

Table 29: Post Hoc Tests in Receiving of Information (Multiple Comparisons)

Dependent Variable: Receiving Visual/Verbal

Tukey HSD

(I) Preferred style of Learning	(J) Preferred style of Learning	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Balanced Preference for two of the dimensions	Moderate Preference for two of the dimensions	-.7247*	.18229	.000	-1.1529	-.2965
	Very strong Preference for one of the dimensions	-1.8697*	.24799	.000	-2.4522	-1.2872
Moderate Preference for two of the dimensions	Balanced Preference for two of the dimensions	.7247*	.18229	.000	.2965	1.1529
	Very strong Preference for one of the dimensions	-1.1450*	.22007	.000	-1.6620	-.6281
Very strong Preference for one of the dimensions	Balanced Preference for two of the dimensions	1.8697*	.24799	.000	1.2872	2.4522
	Moderate Preference for two of the dimensions	1.1450*	.22007	.000	.6281	1.6620

Based on observed means.

The error term is Mean Square (Error) = 3.912.

*. The mean difference is significant at the .05 level.

In addition, learners with very strong preference for a particular dimension of learning style had significantly higher mean scores (M = 3.69, SD = 3.15, p = .000) compared to individuals with moderate preference (M = 2.42, SD = 1.91) and balanced preference for two dimensions of learning styles (M = 1.82 SD = 1.03).

This suggests that different learners have different preferred styles/channels of receiving of scientific information in the learning process. This implies that in teaching process teachers should use the channel the learners prefer by presenting information inform of pictures, diagrams, graphs, flow charts, experiments, demonstrations, using legible writing on

instructional boards as well encouraging the visual learners to write legibly in their note books because they remember best what they have seen. In addition, proper lighting of the study rooms should be ensued to make them see clearly to satisfy their personalities. On the other hand speaking clearly, explaining points and processes clearly at their pace and by clarifying written assignment verbally help the verbal learners. In addition, making sure, they have opportunity to speak and express their opinion in discussions to fulfil their personality.

d) Preferred Order of Progressing the Processing of Information in Learning.

The researcher wanted to find whether the students of private and public secondary schools in Nairobi County had different preferred order of progressing the processing of information into knowledge in learning. Univariate analysis of variance of responses from 659 respondents done descriptive statistics (Table 30) revealed that 73.7 % (486) are sequential learners (that is they prefer to gain understanding in a linear fashion, with each new piece of information building logically from previous pieces) while 26.3 % (173) are global learners who absorb information almost randomly, in no apparent logical sequence. The distribution of preferences varied across gender, private, and public schools. The data indicated 72.0 % (236) of the males are sequential learners and 28.0% (92) global learners. On the other hand, 75.5% (250) of the females are sequential learners and 24.5 % (81) global learners. In public schools, 72.6% (252) are sequential learners and 27.4% (95) global learners. In private schools, 75.0% (252) are sequential learners and 25.0% (78) global learners. In private schools 26.3% (82) having balanced, 58% (181) moderate preference for two of the dimensions and 15.7% (49) very strong preference for one of the dimensions. In public schools 25% (87) having balanced, 59.7% (207) moderate preference for two of the dimensions and 15.3% (53) very strong preference for one of the dimensions. In addition, of the total treatment sample 659 the data indicated 25.6% (169) had balanced preference for two of the dimensions, 58.9% (388) had moderate preference for two of the dimensions, and 15.5 % (102) had very strong preference to one of the dimensions (Table 30).

Table 30: Preferred Order of Processing Information in Learning

Gender	School	Preferred style of Learning	Progressing	N	Mean	Std. Deviation
Male	Public	Balanced Preference for two of the dimensions	Sequential	28	1.4286	.83571
			Global	19	1.5263	.90483
			Total	47	1.4681	.85595
		Moderate Preference for two of the dimensions	Sequential	85	3.0235	2.05853
			Global	23	3.3478	2.22810
			Total	108	3.0926	2.08930
		Very strong Preference for one of the dimensions	Sequential	16	3.7500	2.29492
			Global	5	2.2000	1.78885
			Total	21	3.3810	2.24669
		Total	Sequential	129	2.7674	2.02528
			Global	47	2.4894	1.93225
			Total	176	2.6932	1.99919
	Private	Balanced Preference for two of the dimensions	Sequential	28	2.6429	1.44566
			Global	13	2.0769	1.32045
			Total	41	2.4634	1.41594
		Moderate Preference for two of the dimensions	Sequential	58	2.5172	1.92163
			Global	26	3.2308	1.90384
			Total	84	2.7381	1.93334
		Very strong Preference for one of the dimensions	Sequential	21	3.5714	3.17130
			Global	6	3.6667	2.42212
			Total	27	3.5926	2.97760
		Total	Sequential	107	2.7570	2.14054
			Global	45	2.9556	1.88240
			Total	152	2.8158	2.06331
	Total	Balanced Preference for two of the dimensions	Sequential	56	2.0357	1.32066
			Global	32	1.7500	1.10716
			Total	88	1.9318	1.24841
		Moderate Preference for two of the dimensions	Sequential	143	2.8182	2.01276
			Global	49	3.2857	2.04124
			Total	192	2.9375	2.02504

		Very strong Preference for one of the dimensions	Sequential	37	3.6486	2.79102
			Global	11	3.0000	2.19089
			Total	48	3.5000	2.65779
		Total	Sequential	236	2.7627	2.07386
			Global	92	2.7174	1.91194
			Total	328	2.7500	2.02696
Female	Public	Balanced Preference for two of the dimensions	Sequential	28	2.3571	1.63785
			Global	12	1.6667	.98473
			Total	40	2.1500	1.49443
		Moderate Preference for two of the dimensions	Sequential	75	2.6533	1.87078
			Global	24	2.9167	1.99819
			Total	99	2.7172	1.89543
		Very strong Preference for one of the dimensions	Sequential	20	3.6000	2.52149
			Global	12	4.6667	3.05505
			Total	32	4.0000	2.73567
		Total	Sequential	123	2.7398	1.96626
			Global	48	3.0417	2.35163
			Total	171	2.8246	2.07894
	Private	Balanced Preference for two of the dimensions	Sequential	32	2.0625	1.24272
			Global	9	2.3333	1.00000
			Total	41	2.1220	1.18733
		Moderate Preference for two of the dimensions	Sequential	78	3.6154	2.28621
			Global	19	3.6316	2.40856
			Total	97	3.6186	2.29784
		Very strong Preference for one of the dimensions	Sequential	17	5.0000	3.08221
			Global	5	6.2000	3.34664
			Total	22	5.2727	3.10425
		Total	Sequential	127	3.4094	2.36829
			Global	33	3.6667	2.53311
			Total	160	3.4625	2.39729
	Total	Balanced Preference for two of the dimensions	Sequential	60	2.2000	1.43562
			Global	21	1.9524	1.02353
			Total	81	2.1358	1.33934

		Moderate Preference for two of the dimensions	Sequential	153	3.1438	2.14113
			Global	43	3.2326	2.19129
			Total	196	3.1633	2.14688
		Very strong Preference for one of the dimensions	Sequential	37	4.2432	2.84220
			Global	17	5.1176	3.12014
			Total	54	4.5185	2.93155
		Total	Sequential	250	3.0800	2.20113
			Global	81	3.2963	2.43128
			Total	331	3.1329	2.25775
Total	Public	Balanced Preference for two of the dimensions	Sequential	56	1.8929	1.37085
			Global	31	1.5806	.92283
			Total	87	1.7816	1.23350
		Moderate Preference for two of the dimensions	Sequential	160	2.8500	1.97532
			Global	47	3.1277	2.10194
			Total	207	2.9130	2.00295
		Very strong Preference for one of the dimensions	Sequential	36	3.6667	2.39046
			Global	17	3.9412	2.92555
			Total	53	3.7547	2.54880
		Total	Sequential	252	2.7540	1.99276
			Global	95	2.7684	2.16083
			Total	347	2.7579	2.03699
	Private	Balanced Preference for two of the dimensions	Sequential	60	2.3333	1.36129
			Global	22	2.1818	1.18065
			Total	82	2.2927	1.30987
		Moderate Preference for two of the dimensions	Sequential	136	3.1471	2.19943
			Global	45	3.4000	2.11488
			Total	181	3.2099	2.17565
		Very strong Preference for one of the dimensions	Sequential	38	4.2105	3.17216
			Global	11	4.8182	3.02715
			Total	49	4.3469	3.11950
		Total	Sequential	234	3.1111	2.28553
			Global	78	3.2564	2.19466
			Total	312	3.1474	2.26054

Total	Balanced Preference for two of the dimensions	Sequential	116	2.1207	1.37781
		Global	53	1.8302	1.06943
		Total	169	2.0296	1.29296
	Moderate Preference for two of the dimensions	Sequential	296	2.9865	2.08298
		Global	92	3.2609	2.10112
		Total	388	3.0515	2.08784
	Very strong Preference for one of the dimensions	Sequential	74	3.9459	2.81333
		Global	28	4.2857	2.94212
		Total	102	4.0392	2.83864
	Total	Sequential	**486**	2.9259	2.14396
		Global	**173**	2.9884	2.18342
		Total	**659**	2.9423	2.15290

Estimated marginal means in preferred order of progressing the processing of information in an 11-point scale indicate females had higher mean scores of 3.25 with std. error of .129 compared to males 2.91 with std. error of .128 on preference of either sequential or global learning styles in order of progressing the processing of information (Table 31).

Table 31: Marginal Means Preferred Order of Progressing Information

Dependent Variable: Progressing Preference

			Std.	95% Confidence Interval	
		Mean	Error	Lower Bound	Upper Bound
Gender	Male	2.911	.128	2.660	3.163
	Female	3.251	.129	2.998	3.505
School	Public	2.884	.126	2.637	3.131
	Private	3.279	.132	3.020	3.537
Progressing choice	Sequential	3.006	.105	2.800	3.212
	Global	3.157	.161	2.841	3.473
Preferred style of Learning	Balanced Preference for two of the dimensions	2.071	.161	1.754	2.387
	Moderate Preference for two of the dimensions	3.103	.115	2.878	3.328
	Very strong Preference for one of the dimensions	4.071	.207	3.665	4.477

On the other hand estimated marginal means indicate that students in private schools had higher mean scores of 3.28 with std. error of .132 compared to students in public schools 2.88 with std. error of .127 on preference of either sequential or global learning style in order of progressing the processing of information (Table 31).

The results of Univariate Analysis of Variance (ANOVA) of tests of between-subjects effects on preferred learning styles on order of progressing the processing of information (Table 32) showed that gender preferences to sequencing and global learning styles in the order of progressing the processing of information were significantly different F (1,653) = 4.53, p = .034

Table 32: Effects of Preferred Order of Progressing (Between-Subjects)

Dependent Variable: Progressing Preference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	315.434[a]	5	63.087	15.066	.000	.103	75.329	1.000
Intercept	3895.464	1	3895.464	930.282	.000	.588	930.282	1.000
Gender	18.971	1	18.971	4.531	.034	.007	4.531	.566
School	25.544	1	25.544	6.100	.014	.009	6.100	.694
Preferred style	266.242	2	133.121	31.791	.000	.089	63.582	1.000
Progressing choice	2.881	1	2.881	.688	.407	.001	.688	.132
Error	2734.374	653	4.187					
Total	8755.000	659						
Corrected Total	3049.809	658						

a. R Squared = .103 (Adjusted R Squared = .097)

b. Computed using alpha = .05

In addition, students in private and public schools students had significant differences in preference to sequential and global learning styles in order of progressing the processing of information F (1,653) = 6.10, p = .014 (Table 32).

Post hoc analyses, (Tables 33), indicate that in preferred order of progressing the processing of information, learners with balanced preference for two dimensions of learning styles (sequential and global) had significantly lower mean scores (M = 1.82 SD = 1.03, p =.000) compared to individuals with moderate preference (M = 2.42, SD = 1.91).

Table 33: Preferred Order of Progressing the Processing (Multiple Comparisons)

Dependent Variable: Progressing Preference

Tukey HSD

(I) Preferred style of Learning	(J) Preferred style of Learning	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Balanced Preference for two of the dimensions	Moderate Preference for two of the dimensions	-1.0220*	.18860	.000	-1.4650	-.5789
	Very strong Preference for one of the dimensions	-2.0096*	.25657	.000	-2.6123	-1.4069
Moderate Preference for two of the dimensions	Balanced Preference for two of the dimensions	1.0220*	.18860	.000	.5789	1.4650
	Very strong Preference for one of the dimensions	-.9877*	.22770	.000	-1.5225	-.4528
Very strong Preference for one of the dimensions	Balanced Preference for two of the dimensions	2.0096*	.25657	.000	1.4069	2.6123
	Moderate Preference for two of the dimensions	.9877*	.22770	.000	.4528	1.5225

Based on observed means.

The error term is Mean Square (Error) = 4.187.

In addition, learners with very strong preference for a particular dimension of learning style had significantly higher mean scores (M = 3.69, SD = 3.15, p = .000) compared to individuals with moderate preference (M = 2.42, SD = 1.91) and balanced preference for two dimensions (sequential and global) of learning styles (M = 1.82 SD = 1.03).

This suggests that different learners have different preferred order of progressing the processing of scientific information in the learning process. This implies that in teaching process teachers should order the style of presentation and development of lessons towards the understanding of global learners who are holistic, systems thinkers and learn in large leaps by giving outline of every concept and sub topic. In addition, being friendly and patient in helping them slowly discover how the concepts assist and relates to their life to uphold their personality. On the hand developed the understanding of the sequential learners who gain understanding in a linear orderly fashion by moving step-by-step in every point, analysing the concepts by giving their similarities and differences, insisting they write the points and summarise the concepts. In addition moving at their pace to enhance their personality.

This study support several studies Mona et al. (2017) that different students have different preferred styles of order of progressing the assimilation of information, further that teachers in secondary schools must consider both the structure of the content, and the order different students prefer to assimilate the content as new knowledge. The global learners need to grasp the big picture before they have any chance to understand the details of the subject. However, if there is no picture it may difficult to them to study. They may feel stupid when they are struggling to master material with which most of their contemporaries seem to have little trouble. Some eventually become discouraged with education and drop out if there is no proper support school system (Narayani, 2014). On the other hand, Narayani further observed that the mean value of academic achievement of sequential learners is greater than the mean value of academic achievement of global learners. They learn in a logical progression and small incremental steps. Generally, they have more learning success because the majority of books and teaching strategies used by schoolteachers are sequential (Narayani, 2014).

4.3.5 Interaction Effects of variables in Conceptual Framework

This was made to measure the degree the results of treatment differed from effect of treatment due to interaction effect of independent variables that is differences in their readiness to profit treatment process. Included complex of personal characteristics identified before and during treatment that accounts for a person's end state after a particular treatment. This was analysed in General Linear Model'> 'Multivariate' > 'Model' > 'Custom' > 'Interaction' > 'Option' > OK.

The interaction effects of variables in conceptual framework of effect teaching using preferred learning styles and categories of preferred learning styles (Table 34) indicated that-

Table 34: Interaction of Preferred Learning Styles and Performance

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Post-test Geography	57.887[a]	2	28.943	.879	.415
	Post-test Biology	19.453[b]	2	9.726	.346	.708
Intercept	Post-test Geography	2678266.125	1	2678266.125	81383.978	.000
	Post-test Biology	2661097.610	1	2661097.610	94527.361	.000
Preferred style	Post-test Geography	57.887	2	28.943	.879	.415
	Post-test Biology	19.453	2	9.726	.346	.708
Error	Post-test Geography	21588.311	656	32.909		
	Post-test Biology	18467.458	656	28.152		
Total	Post-test Geography	3626927.000	659			
	Post-test Biology	3592622.000	659			
Corrected Total	Post-test Geography	21646.197	658			
	Post-test Biology	18486.910	658			

a. R Squared = .003 (Adjusted R Squared = .000)

b. R Squared = .001 (Adjusted R Squared = -.002)

There were no significant interaction between independent variables of teaching using preferred learning styles and categories of learning styles in performance in geography F (1, 656) = .879, p = .415 and biology F (1, 656) = .346, p = .708. The interaction of matching teaching with preferred perception, conversion of information into knowledge, use of preferred channel and progress in understanding with observed differences in person-situation

interaction terms in preferred learning styles did not significantly influence results of teaching according to preferred learning styles.

4.4 Effect of Teaching Style on Students' Performance

The first objective of this study was to determine the differences in effect of traditional teaching and teaching according to preferred learning styles, on students' performance, in biology and geography in secondary schools in Nairobi County. Determination of interaction effects of gender and school preceded the analysis of the main effect of treatment using MANOVA (multivariate analysis of variance) in SPSS windows version 22.

4.4.1 Effect of Gender and School Performance in Biology and Geography

The data used to compare different subjects, male and female, type of schools, traditional and preferred teaching styles were arranged in stacked format. Multivariate analysis of variance (MANOVA) of stacked data in SPSS windows was analysed using the command 'Analyse' > 'General Linear Model'> 'Multivariate' > 'Model' > 'Custom' > 'Interaction' > 'Option' > 'Observe power' > 'Plot' > 'Add' > Ok. A statistical interaction occurs when the effect of one independent variable on the dependent variable changes depending on the level of another independent variable. It is determined in every experimental design to ensure that any changes observed in treatment in not attributed to other factors other than the treatment (Liou & Cheng, 2018). The factors analysed for interaction effect in include gender, type of school and teaching styles. Descriptive statistics (Table 34) revealed that in gender females had higher estimated mean scores 63.5 Std. Error .282 compared to males 63.011 Std. Error .284 in post-test geography. In post-test biology, males' higher estimated mean scores 63.2 Std. Error .273 compared to females 63.1 Std. Error .273.

Table 35: Mean-Scores of Effects of Gender and School on Performance

N = 1317

				95% Confidence Interval	
Dependent Variable	**Gender**	**Mean**	**Std. Error**	**Lower Bound**	**Upper Bound**
Post-test Geography	Male	63.011	.284	62.454	63.568
	Female	63.450	.282	62.897	64.003
Post-test Biology	Male	63.199	.273	62.663	63.734
	Female	63.060	.271	62.528	63.591

In addition descriptive statistics (Table 35) revealed that in type of school students in public schools had higher estimated mean scores 63.4 Std. Error .275 compared to students in private schools 63.0 Std. Error .291 in post-test geography. In post-test biology students in private schools had, higher estimated mean scores 63.2 Std. Error .279 compared to students in public schools 63.1 Std. Error .265.

Table 36: Mean Scores of Interaction Effects of Type of School on Performance

				95% Confidence Interval	
Dependent Variable	**School**	**Mean**	**Std. Error**	**Lower Bound**	**Upper Bound**
Post-test Geography	Public	63.430	.275	62.889	63.970
	Private	63.031	.291	62.461	63.602
Post-test Biology	Public	63.088	.265	62.568	63.607
	Private	63.171	.279	62.623	63.719

Using general linear model (GLM) multivariate analysis of variance (MANOVA) of statistical interaction effect of teaching style and gender on the performance in geography and biology was done. The results (Table 36) revealed that there was no significant interaction between gender and teaching style in performance in geography F (1, 1313) = 1.204, p = .273 Likewise the results (Table 36) revealed that there was no significant interaction between gender and teaching style in performance in biology F (1, 1313) = .130, p = .718

Table 37: Effects of Teaching Styles of Gender and Type of School on Performance

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[c]
Corrected Model	Post-test Geography	151268.674[a]	3	50422.891	957.528	.000	2872.585	1.000
	Post-test Biology	145325.859[b]	3	48441.953	996.719	.000	2990.157	1.000
Intercept	Post-test Geography	5249890.982	1	5249890.982	99695.179	.000	99695.179	1.000
	Post-test Biology	5233071.691	1	5233071.691	107673.229	.000	107673.229	1.000
Gender	Post-test Geography	63.416	1	63.416	1.204	.273	1.204	.195
	Post-test Biology	6.337	1	6.337	.130	.718	.130	.065
School	Post-test Geography	52.161	1	52.161	.991	.320	.991	.169
	Post-test Biology	2.276	1	2.276	.047	.829	.047	.055
Teaching style	Post-test Geography	151171.007	1	151171.007	2870.730	.000	2870.730	1.000
	Post-test Biology	145312.502	1	145312.502	2989.882	.000	2989.882	1.000
Error	Post-test Geography	69141.827	1313	52.659				
	Post-test Biology	63813.663	1313	48.601				
Total	Post-test Geography	5486590.000	1317					
	Post-test Biology	5455987.000	1317					
Corrected Total	Post-test Geography	220410.501	1316					
	Post-test Biology	209139.522	1316					

a. R Squared = .686 (Adjusted R Squared = .686)
b. R Squared = .695 (Adjusted R Squared = .694)
c. Computed using alpha = .05

Graphical presentation (Figure 2) showed that the lines on gender have approximately the same slope and are parallel to each other in performance in geography.

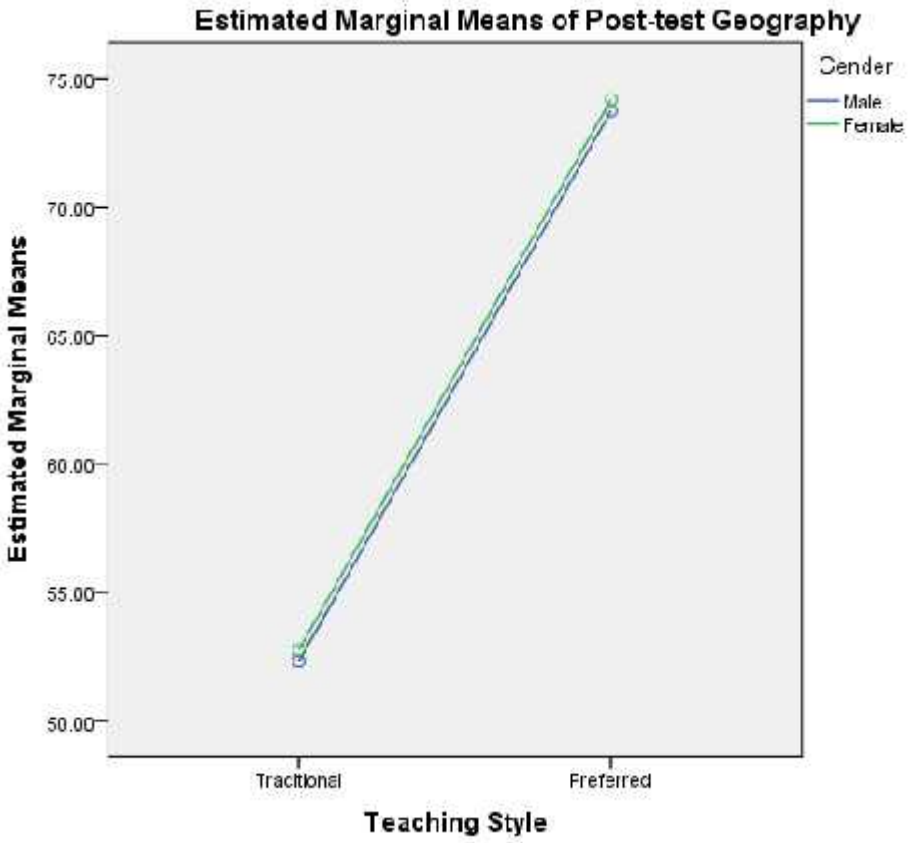

Figure 3: Effect of Gender and Teaching Styles on Performance in Geography.

Likewise, graphical presentation (Figure 3) showed that the lines on gender have approximately the same slope and are parallel to each other in performance in biology.

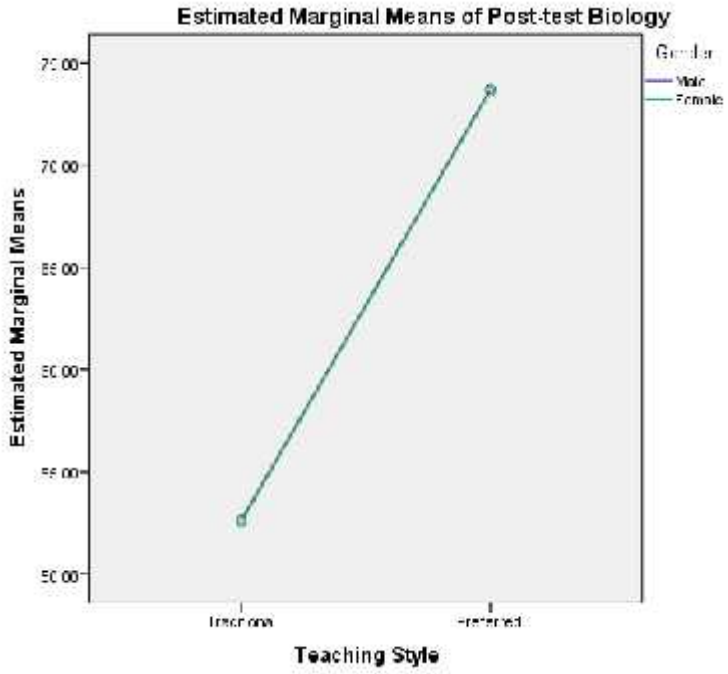

Figure 4: Effect of Gender and Teaching Styles on Performance in Biology.

On the other hand, results (Table 36) revealed that there was no significant interaction between type of school and teaching style in performance in geography F (1, 1313) = .991, p = .320. In addition, there was no significant interaction between type of school and teaching style (Table 36) in performance in biology F (1, 1313) = .047, p = .829. Graphical presentation (Figure 4) showed that the lines on private and public schools have approximately the same slope and are parallel to each other in performance in geography.

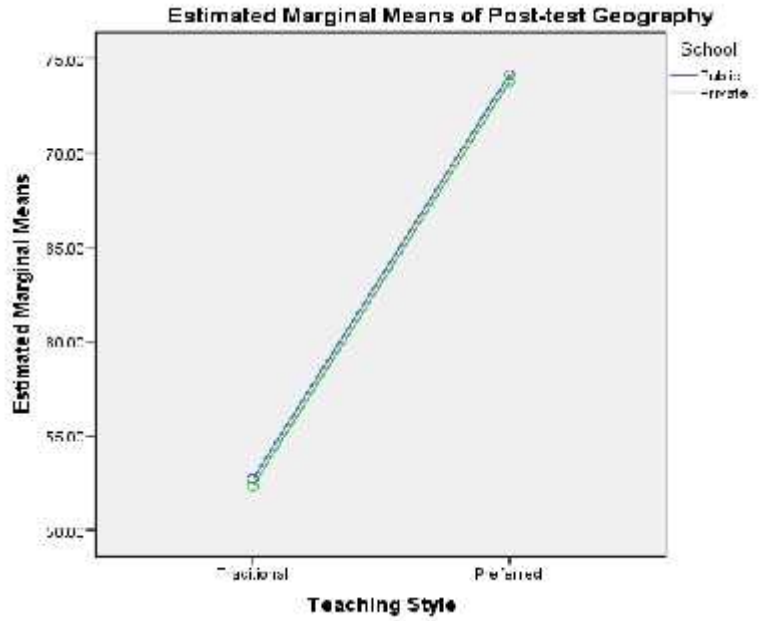

Figure 5: Effect of Teaching Styles on Performance in Geography

Likewise, graphical presentation (Figure 5) showed that the lines on private and public schools have approximately the same slope and are parallel to each other in performance in biology.

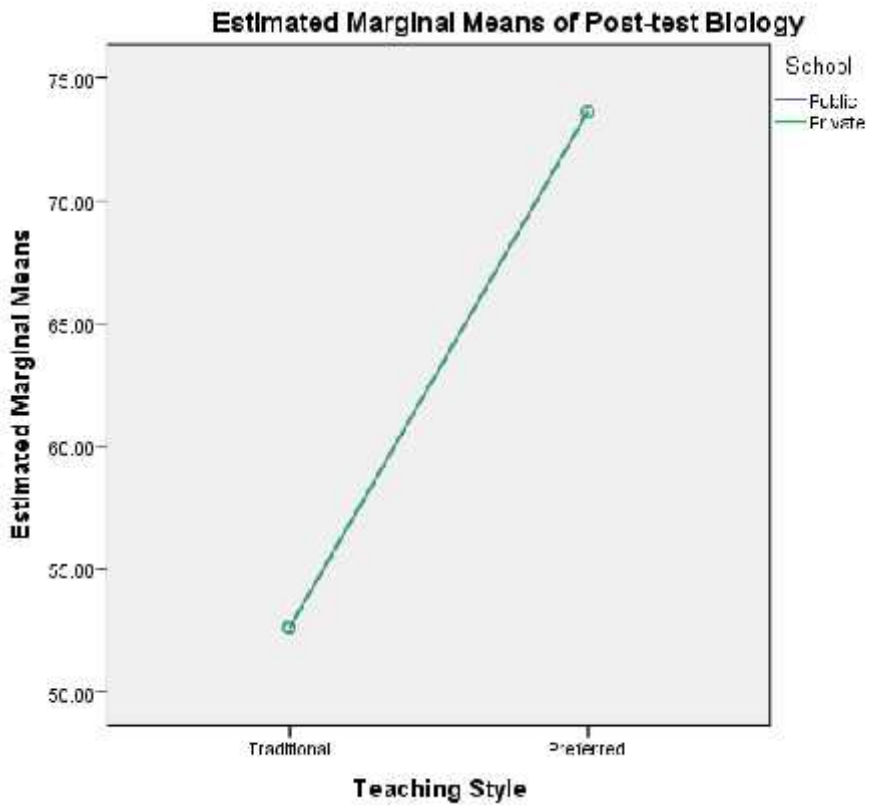

Figure 6: Effect of type of school and Teaching Styles on Performance in Biology

4.4.2 The Main Effect of Teaching Styles on Students' Performance

The researcher wanted to find the differences in main effect of traditional teaching and teaching according to preferred learning styles on performance in biology and geography of students in private and public secondary schools in Nairobi County. The data used to compare, main effect traditional and preferred teaching styles was arranged in stacked format. Multivariate analysis of variance (MANOVA) of stacked data in SPSS windows was analysed using the command 'Analyse' > 'General Linear Model' > 'Multivariate' > 'Model' > 'Custom' > 'Main effect' > 'Option' >' Descriptive statistcs', > 'Esimate of effects' > 'Observe power' > Ok .

Table 38: Descriptive Statistics of Traditional and Preferred Learning Styles

Sciences	Teaching style	N	Mean	Std. Deviation
Post-test Geography	Traditional	659	52.5296	8.50926
	Preferred	658	73.9559	5.73538
	Total	1317	63.2346	12.94161
Post-test Biology	Traditional	659	52.6222	8.30268
	Preferred	658	73.6307	5.30117
	Total	1317	63.1185	12.60637

Descriptive statistics (Table 37) revealed that students taught according to preferred learning styles had higher means scores in geography (M = 74.0, SD = 5.74) and biology (M = 73.6, SD = 5.30) compared to students taught according to traditional teaching styles in geography (M = 52.5, SD = 8.51) and biology (M = 52.6, SD = 8.30).

Using general linear model (GLM) multivariate analysis of variance (MANOVA) of performance of students that taught according to traditional and preferred learning styles (Table 38) indicated that main effect of teaching according to preferred learning style on performance on performances of sciences was significant($p < .001$).

Table 39: Multivariate Analysis of Students Performance

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	Post-test Geography	151154.606[a]	1	151154.606	2870.056	.000	.686	2870.056	1.000
	Post-test Biology	145317.345[b]	1	145317.345	2994.137	.000	.695	2994.137	1.000
Intercept	Post-test Geography	5267531.435	1	5267531.435	100017.534	.000	.987	100017.534	1.000
	Post-test Biology	5248170.563	1	5248170.563	108133.954	.000	.988	108133.954	1.000
Teaching style	Post-test Geography	151154.606	1	151154.606	2870.056	.000	.686	2870.056	1.000
	Post-test Biology	145317.345	1	145317.345	2994.137	.000	.695	2994.137	1.000
Error	Post-test Geography	69255.895	1315	52.666					
	Post-test Biology	63822.176	1315	48.534					
Total	Post-test Geography	5486590.000	1317						
	Post-test Biology	5455987.000	1317						
Corrected Total	Post-test Geography	220410.501	1316						
	Post-test Biology	209139.522	1316						

a. R Squared = .686 (Adjusted R Squared = .686)

b. R Squared = .695 (Adjusted R Squared = .695)

c. Computed using alpha = .05

Students taught according to preferred learning styles had significantly higher mean scores compared to students taught according traditional styles in geography F (1, 1315) = 2870.1, p = .000) and in biology F (1, 1315) = 2994.1, p = .000). Regression analysis to determine how the teaching styles influenced performance in geography (Table 40)

Table 40: Linear Regression Model Summary for Geography

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.828[a]	.686	.686	7.25714

a. Predictors: (Constant), Teaching styles

The adjusted r square (r2 = .686) revealed that 68.6% of variation in performance in geography is determined by model. Teaching according to preferred learning styles explains 68.6% of the performance in geography. The ANOVA results (Table 40) shows that-

Table 41: ANOVA of Teaching Styles and Performance in Geography

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	151154.606	1	151154.606	2870.056	.000[b]
	Residual	69255.895	1315	52.666		
	Total	220410.501	1316			

a. Dependent Variable: Post-test Geography

b. Predictors: (Constant), Teaching styles

The model was a significant predictor of performance in geography F (1, 1315) = 2870.056, p = .000.

The unstandardized beta coefficients for the model (the β values) (Table 42) indicated the relationships between the outcome and predictor variables.

Table 42: Coefficients of Teaching Styles on Performance in Geography

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	31.103	.632		49.196	.000
	Teaching style	21.426	.400	.828	53.573	.000

a. Dependent Variable: Post-test Geography

The β coefficient (Table 41) is 21.426, which indicate there is a positive effect of teaching using preferred leaning styles. In addition, this indicated that performance of students taught using preferred learning styles is 21.426 higher among those taught using preferred leaning styles compared to those taught using traditional teaching styles. The results of the regression indicated that the model explained 68.6% of the variance and that the model was a significant predictor of performance in geography, F (1, 1315) = 2870.056, p = .000. While teaching using preferred learning styles contributed significantly to the model (β = 21.426, p = .000). The final predictive model was:

Geography score = 31.103+ (21.426* Teaching using preferred learning styles). Linear regression analysis to determine how the teaching styles influenced performance in biology (Table 43) indicted that:-

Table 43: Linear Regression Model Summary for Biology

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.834[a]	.695	.695	6.96663

a. Predictors: (Constant), Teaching style

The adjusted r square (r^2 = .695) revealed that 69.5% of variation in performance in biology is determined by the model (teaching according to preferred learning styles). Teaching according to preferred learning styles explains 69.5% of the performance in biology. The ANOVA results (Table 44)

Table 44: ANOVA of Teaching Styles and Performance in Biology

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	145317.345	1	145317.345	2994.137	.000[b]
	Residual	63822.176	1315	48.534		
	Total	209139.522	1316			

a. Dependent Variable: Post-test Biology

b. Predictors: (Constant), Teaching style

The model was a significant predictor of performance in biology F (1, 1315) = 2994.137, p = .000.

The unstandardized beta coefficients for the model (the β values) (Table 45) indicated the relationships between the outcome and predictor variables.

Table 45: Coefficients of Teaching Styles on Performance in Biology

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	31.614	.607		52.089	.000
	Teaching style	21.009	.384	.834	54.719	.000

a. Dependent Variable: Post-test Biology

The β coefficient (Table 44) is 21.009, which indicate there is a positive effect of teaching biology using preferred leaning styles. In addition, this indicated that performance of students

taught biology using preferred learning styles is 21.009 higher among those taught using preferred leaning styles compared to those taught using traditional teaching styles. The results of the regression indicated that the model explained 69.5% of the variance and that the model was a significant predictor of performance in biology, F (1, 1315) = 2994.137, p = .000. While teaching using preferred learning styles contributed significantly to the model (β = 21.009, p = .000). The final predictive model was: Biology score = 31.614+ (21.009* Teaching using preferred learning styles).

In conclusion, both multivariate analysis of variance and linear regression analysis showed statistically significant effect on performance of students taught using preferred learning styles in geography and biology. Given multivariate analysis of variance in geography F (1, 1315) = 2870.1, p = .000) and in biology F (1, 1315) = 2994.1, p = .000), and in addition linear regression analysis in geography, F (1, 1315) = 2870.056, p = .000, and in biology, F (1, 1315) = 2994.137, p = .000. Thus the null hypotheses was rejected there are no statistically significant effects in performance in biology and geography between students taught in their preferred learning styles and those taught using traditional teaching styles in secondary schools in Nairobi County.

This study shows that teaching students according to their preferred learning styles enhances their performance while teaching students in the traditional styles without considering their preferred learning styles creates mismatch, which lowers their performance in sciences. The finding of this study implies that when teachers establish the preferred learning styles of students and match their styles of teaching to these preferences it improves significantly the performance of their students in sciences. This study supports the findings of Akbarzadeh and Fatemipour (2014) when students' learning styles match with appropriate teaching approaches, then their motivation, performances, and achievement will increase. The study likewise was in agreement with findings of Bastable (2008), and Deeksha et al. (2017) that matching teaching pedagogy with learning styles of students enhances their academic performance. On the other hand, the gap between matching students' learning styles and teachers' instructional styles lead to low retention rates and affect students' academic performance.

4.5 Gender Differences on Performance in Biology and Geography

The second objective of this study was to determine effect of gender on performance of students in biology and geography taught using preferred learnings styles in secondary schools in Nairobi County. The data used to compare, main effect of gender differences on performance in biology and geography of students taught using their preferred learning styles in secondary schools in Nairobi County was arranged in stacked format. Multivariate analysis of variance (MANOVA) and linear regression were used in SPSS windows. Multivariate analysis of variance (MANOVA) was analysed using the command 'Analyse' > 'General Linear Model' > 'Multivariate' > 'Model' > 'Custom' > 'Main effect' > 'Option' >' Descriptive statistcs', > 'Esimate of effects' > 'Observe power' > Ok . Descriptive statistics of gender differences on performance in biology and geography of students taught using their preferred learning styles (Table 46) indicated that males had higher mean scores in geography (M = 74.0, SD = 5.94) and biology (M = 73.8, SD = 5.02) compared to female students in geography (M = 73.9, SD = 5.53) and biology (M = 73.5, SD = 5.57).

Table 46: Descriptive Statistics of Gender Differences on Performance

Test	Gender	N	Mean	Std. Deviation
Post-test Geography	Male	328	74.0030	5.94496
	Female	331	73.9275	5.52906
	Total	659	73.9651	5.73559
Post-test Biology	Male	328	73.8049	5.01725
	Female	331	73.4864	5.57013
	Total	659	73.6449	5.30053

Analysis firstly was done using general linear model (GLM) multivariate analysis of variance (MANOVA) (Table 47).

Table 47: Multi Variate Analysis of Gender Differences (Between-Subjects)

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	Post-test Geography	.940[a]	1	.940	.029	.866	.000	.029	.053
	Post-test Biology	16.709[b]	1	16.709	.594	.441	.001	.594	.120
Intercept	Post-test Geography	3605222.852	1	3605222.852	109429.583	.000	.994	109429.583	1.000
	Post-test Biology	3574131.380	1	3574131.380	127134.746	.000	.995	127134.746	1.000
Gender	Post-test Geography	.940	1	.940	.029	.866	.000	.029	.053
	Post-test Biology	16.709	1	16.709	.594	.441	.001	.594	.120
Error	Post-test Geography	21645.257	657	32.946					
	Post-test Biology	18470.201	657	28.113					
Total	Post-test Geography	3626927.000	659						
	Post-test Biology	3592622.000	659						
Corrected Total	Post-test Geography	21646.197	658						
	Post-test Biology	18486.910	658						

a. R Squared = .000 (Adjusted R Squared = -.001)

b. R Squared = .001 (Adjusted R Squared = -.001) c. Computed using alpha = .05

Multivariate analysis of variance (MANOVA) (Table 45) indicated that there were no significant gender differences in performance in geography F (1, 657) = .029, p = .866) and in biology F (1, 657) = .594, p = .441). In addition, linear regression analysis of effect of gender on performance of students in geography taught using preferred learnings styles (Table 48) indicated that:

Table 48: Effect of Gender on Performance in Geography

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.007[a]	.000	-.001	5.73983

a. Predictors: (Constant), Gender

The adjusted r square (r^2 = .000) revealed that 0% of variation in performance in geography is determined by gender differences of students taught using preferred learning styles. The ANOVA results (Table 49) showed that

Table 49: ANOVA of Gender effect on Performance in Geography

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.940	1	.940	.029	.866[b]
	Residual	21645.257	657	32.946		
	Total	21646.197	658			

a. Dependent Variable: Post-test Geography

b. Predictors: (Constant), Gender

there were no statistically significant contribution of gender differences in performance of students taught using preferred learning style in geography F (1, 657) = .029, p = .866

Table 50: Gender Performance in Geography after Preferred Learning Styles

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	74.079	.708		104.626	.000
	Gender	-.076	.447	-.007	-.169	.866

a. Dependent Variable: Post-test Geography

The β coefficient (Table 50) was -.076, which indicated there was a negative association of gender and performance of students taught using preferred learning style in geography. One unit increase in gender (i.e. moving from man to woman) there is a decrease in performance in geography by .076 units.

The results of the regression indicated that the model explained 0% of the variance and that the model was not a significant predictor of performance in geography, F (1, 657) = .029, p = .866 While gender did not contributed significantly to the model (β = -.076, p = .866). The final predictive model was geography score = 74.079 + (-.076* Gender differences). This indicated the differences in gender performance in geography of students taught according their preferred learning style were statistically non-significant.

Linear regression analysis of effect of gender on performance of students in biology taught using preferred learnings styles (Table 51) indicated that:

Table 51: Linear Regression Model for Effect of Gender on Performance in Biology

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.030[a]	.001	-.001	5.30216

a. Predictors: (Constant), Gender

The adjusted r square (r^2 = .001) revealed that 0.1% of variation in performance in biology is explained by gender differences of students taught using preferred learning styles. The ANOVA results (Table 52) showed that

Table 52: ANOVA effect of Gender on Performance in Biology

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.709	1	16.709	.594	.441[b]
	Residual	18470.201	657	28.113		
	Total	18486.910	658			

a. Dependent Variable: Post-test Biology

b. Predictors: (Constant), Gender

There were no statistically significant contribution of gender differences in performance of students taught using preferred learning style in biology F (1, 657) = .594, p = .441.

Table 53: Determination of Effect of Gender on Performance in Biology

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	74.123	.654		113.331	.000
	Gender	-.318	.413	-.030	-.771	.441

a. Dependent Variable: Post-test Biology

The β coefficient (Table 53) was -.0318, which indicated there was a negative association of gender and performance of students taught using preferred learning style in biology. One-unit increase in gender (i.e. moving from man to woman) there is a decrease in performance in biology by .0318. The results of the regression indicated that the model explained 0.1% of the variance and that the model was not a significant predictor of performance in biology, F (1, 657) = .594, p = .441 While gender did not contributed significantly to the model (β = -.318, p = .441). The final predictive model was biology score = 74.123 + (-.318* Gender difference). This indicated the differences in gender performance in biology of students taught according their preferred learning styles were statistically non-significant.

In conclusion, the multivariate analysis of variance and linear regression analysis showed that gender differences had no statistically significant effect on performance of students taught using preferred learning styles in geography and biology. Given multivariate analysis of variance in geography F (1, 657) = .029, p = .866) and in biology F (1, 657) = .594, p = .441) linear regression in geography, F (1, 657) = .029, p = .866 and in biology, F (1, 657) = .594, p = .441. Thus the null hypotheses was accepted that there are no statistically significant

effects of gender differences on performance in biology and geography of students taught according to their preferred learning styles, in secondary schools in Nairobi County.

This study shows that when students are taught according to their preferred leaning styles both males and females perform equally well in sciences. This clearly shows that mismatch of teaching to their preferred learning styles causes observed gender differences among students in performance in sciences. This study supports Olatoye et al. (2013) in their study of Female Students' Participation and Performance in Science Subjects in Senior Secondary Schools in Katsina State, Nigeria. The results showed that female students are still under-represented in biology, chemistry, and physics with percentage enrolment as 31.8, 30.5%, and 31.6% respectively. However, there were no significant differences between male and female students' overall performance in biology, chemistry and physics ($t = 0.296$, $p > 0.05$). In addition, this study agrees with Ahmed et al. (2017) that significant difference does not exist between the biology performance of male and female students in boarding and day secondary schools. The researcher in this study observed that gender, as a factor does not have significant influence on preferred learning styles and performance of students in sciences. However, the result of this study differed with the findings of Parvin et al. (2015), who observed significant differences between boys and girls in reflective observation and active experimentation in performance in science and mathematics.

However, the observed difference could be due to environmental differences as observed by Alhassane (2016) that the only obstacles that affect the expression of education ability of the girl child are their cultural social aspects in our societies. Among the sociocultural aspects impeding the schooling of girls, include parental attitudes in relation to the education of a girl and the burden of domestic chores of the little girl. Further, confounded by the social conceptions of the role of women as which the female child should seek to prepare for the future wife task, mother, or should do priority, which engages them perennially in non-academic chaos. However, this study supports Bruer (2001) that, men and women show important differences most clearly in sexual anatomy and in cultural roles, which lead to differences for men and women in every culture. On the other hand, neither boys nor girls have any inherent advantage in general. When exposed to their preferred learning style, they perform equally well in sciences.

4.6 Differences in Performance of Biology and Geography

The third objective of this study was to establish the differences in performance in biology and geography between private and public secondary schools students taught using their preferred learning styles in Nairobi County. The data used to compare, main effect of type of school on performance in biology and geography of students taught using their preferred learning styles in secondary schools in Nairobi County was arranged in stacked format. Multivariate analysis of variance (MANOVA) of stacked data in SPSS windows was analysed using the command ‘Analyse’ > ‘General Linear Model’ > ‘Multivariate’ > ‘Model’ > ‘Custom’ > ‘Main effect’ > ‘Option’ >’ Descriptive statistcs’, > ‘Esimate of effects’ > ‘Observe power’ > Ok . Descriptive statistics of performance in sciences in private and public secondary schools of students taught according to preferred learning styles (Table 54) indicated that public schools had slightly higher mean scores in geography (*M* = 74.3, *SD* = 6.09) compared to private schools (*M* = 73.6, *SD* = 5.29). However, in biology the schools registered similar mean scores Public (*M* = 73.6, *SD* = 5.33) Private (*M* = 73.6, *SD* = 5.26).

Table 54: Descriptive Statistics of Performance in Biology and Geography

Dependent Variable	**School**	**N**	**Mean**	**Std. Deviation**
Post-test Geography	Public	347	74.3343	6.09065
	Private	312	73.5545	5.29244
	Total	659	73.9651	5.73559
Post-test Biology	Public	347	73.6427	5.33548
	Private	312	73.6474	5.26995
	Total	659	73.6449	5.30053

The researcher did multivariate analysis of variance (MANOVA) using general linear model (GLM) to determine the main effect of type of school on performance in biology and geography of students taught using their preferred learning styles (Table 55).

Table 55: Multivariate Analysis of Variance (MANOVA) of Performance effect

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	Post-test Geog.	99.902[a]	1	99.902	3.046	.081	.005	3.046	.414
	Post-test Biology	.004[b]	1	.004	.000	.991	.000	.000	.050
Intercept	Post-test Geog.	3593098.42	1	3593098.421	109562.484	.000	.994	109562.484	1.000
	Post-test Biology	3564065.63	1	3564065.630	126662.137	.000	.995	126662.137	1.000
School	Post-test Geog.	99.902	1	99.902	3.046	.081	.005	3.046	.414
	Post-test Biology	.004	1	.004	.000	.991	.000	.000	.050
Error	Post-test Geog.	21546.296	657	32.795					
	Post-test Biology	18486.907	657	28.138					
Total	Post-test Geog.	3626927.00	659						
	Post-test Biology	3592622.00	659						
Corrected Total	Post-test Geog.	21646.197	658						
	Post-test Biology	18486.910	658						

a. R Squared = .005 (Adjusted R Squared = .003)

b. R Squared = .000 (Adjusted R Squared = -.002)

The results (Table 55) indicated that there were no statistically significant differences, in performance in geography F (1, 657) = 3.046, p = .081) and biology F (1, 657) = 000, p = .991) in private and public secondary schools' students taught according to preferred learning styles.

In addition linear regression analysis (Table 56) to establish the differences in performance in biology between private and public secondary schools students taught using their preferred learning styles showed that-

Table 56: Effect of School Type on Performance in Biology

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.000[a]	.000	-.002	5.30456

a. Predictors: (Constant), School Type

The adjusted r square (r^2 = .000) revealed that 0% of variation in performance in biology is determined by differences in type of school of students taught using preferred learning styles. The ANOVA results (Table 57) showed that

Table 57: Significance Effect of School Type on Performance in Biology

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.004	1	.004	.000	.991[b]
	Residual	18486.907	657	28.138		
	Total	18486.910	658			

a. Dependent Variable: Post-test Biology

b. Predictors: (Constant), School Type

There were no statistically significant contributions of school type on performance in biology of students taught using their preferred learning styles F (1, 657) = .000, p =. *991*

Table 58: Coefficients of Effect of School Type on Performance

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	73.638	.644		114.370	.000
	School Type	.005	.414	.000	.012	.991

a. Dependent Variable: Post-test Biology

The B coefficient (Table 58) was .005, which indicated there was a positive association of school type and performance of students taught using preferred learning style in biology. One-unit increase in school type (i.e. moving from private to public) there is increase in performance in biology by 0.005 units. The results of the regression indicated that the model explained 0% of the variance and that the model was not a significant predictor of performance in biology, F (1, 657) = .000, p =. *991*. While school type did not contributed significantly to the model (β = .005, p = .991). The final predictive model was biology score = 73.638 + (.005* school type). This indicated the difference in performance in biology of students in private and public secondary schools taught according their preferred learning style were statistically non-significant. Linear regression analysis (Table 59) to establish the differences in performance in geography between private and public secondary schools students taught using their preferred learning styles showed that-

Table 59: Linear Regression Model for Effect of School Type on Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.068[a]	.005	.003	5.72669

a. Predictors: (Constant), School Type

The adjusted r square (r^2 = .005) revealed that 0.5% of variation in performance in geography is determined by differences in type of school of students taught using preferred learning styles (see Table 60)

Table 60: Effect of Performance in Geography

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	99.902	1	99.902	3.046	.081[b]
	Residual	21546.296	657	32.795		
	Total	21646.197	658			

a. Dependent Variable: Post-test Geography

b. Predictors: (Constant), School

There were no statistically significant contributions of school type on performance in geography of students taught using their preferred learning styles F (1, 657) = 3.046, p = .081

Table 61: Coefficients of Determination of Effect School Type on Performance

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	75.114	.695		108.064	.000
	School type	-.780	.447	-.068	-1.745	.081

a. Dependent Variable: Post-test Geography

The β coefficient (Table 61) was -.780, which indicated there was a negative association of school type and performance of students taught using preferred learning style in geography. One-unit increase in school type (i.e. moving from private to public) there is decrease in performance in geography by .780 units. The results of the regression indicated that the model explained 0.5% of the variance and that the model was not a significant predictor of

performance in geography, F (1, 657) = 3.046, p = .081. While school type did not contributed significantly to the model (β = -.780, p = .081). The final predictive model was geography score = 75.114 + (-.780* School type). This indicated the differences in performance of students in private and public secondary schools taught according their preferred learning style were statistically non-significant.

In conclusion, the multivariate analysis of variance and linear regression analysis showed that school type (private or public) differences had no statistically significant effect on performance of students taught using preferred learning styles in geography and biology. Given multivariate analysis of variance in geography F (1, 657) = 3.046, p = .081) and biology F (1, 657) = 000, p = .991) and linear regression in geography, F (1, 657) = 3.046, p = .081 and in biology, F (1, 657) = .000, p =. 991. This shows that teaching students according to their preferred learning styles makes students perform equally well in both private and public secondary schools in biology and geography. Therefore, the null hypothesis was accepted that there are no statistically significant differences in performance in biology and geography between private and public secondary students taught using their preferred learning styles in secondary schools in Nairobi County.

The researcher observed that type of school has insignificant effect on performance of students in biology and geography taught according to their preferred leaning style. The study supports Ndaji et al. (2016) study in England, similar to those carried in Australia and the United States that found little or no significant differences between the educational outcomes of independent and state schools in science, mathematics and reading tests. After controlling factors such as gender, ethnicity, disability status, English language learner status, school size and location the differences in public and private students in Sciences, Mathematics and Reading tests were not statistically significant. However, the findings of this study differs with Bonsu (2016) observation that in the academic performance of pupils in the public and private basic schools in Ghana, private basic schools were performing better than public basic schools academically. However, Bonsu further observed that the use of teaching and learning materials indicated that teachers did not use laboratories and equipment for practical because they were not available and adequate in the public schools and a few were available and adequate in the private schools. This still indicates that mismatch due inadequate equipment for practical explains the difference in academic performance between private and public schools.

CHAPTER FIVE
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction.

This chapter presents the summery of the major findings of the study. It also highlights the conclusions, policy recommendations, and recommendation for further research.

5.2 Summary

The purpose of this study was to establish the effect of teaching using preferred leaning styles on students' performance in biology and geography in private and public secondary schools in Nairobi County. This County was chosen because of unsatisfactorily performance in sciences including biology and geography. The study was based on Felder Learning Style Theory, and Grasha Teaching Style Theory. The study was guided by three objectives from which three hypothesis were drawn and used a quasi-experimental research design, which utilised a pre-test, treatment of experimental group and a post-test to estimate impact of an intervention of mismatch of teaching styles to the preferred leaning styles on target population of secondary schools in Nairobi County. A purposive sample of 1,322 students from 18,536 Form Two Students in private and public schools randomly selected for the study. Descriptive and inferential statistics generated for variables including learning styles, gender and performance in biology and geography were analysed in SPSS for windows version 22 at a significance level of 5%. The following results were achieved:

i) Effect of teaching styles on students' performance in biology and geography

The finding of this study revealed that, both multivariate analysis of variance and linear regression analysis showed statistically significant effect on performance of students taught using preferred learning styles in geography and biology. Given multivariate analysis of variance in geography F (1, 1315) = 2870.1, p = .000) and in biology F (1, 1315) = 2994.1, p = .000), and in addition linear regression analysis in geography, F (1, 1315) = 2870.056, p = .000, and in biology, F (1, 1315) = 2994.137, p = .000. Thus the null hypotheses was rejected there are no statistically significant effects in performance in biology and geography between students taught in their preferred learning styles and those taught using traditional teaching styles in secondary schools in Nairobi County.

ii) Effect of Gender on students' Performance in Biology and Geography

The finding of this study revealed that, the multivariate analysis of variance and linear regression analysis showed that gender differences had no statistically significant effect on performance of students taught using preferred learning styles in geography and biology. Given multivariate analysis of variance in geography F (1, 657) = .029, p = .866) and in biology F (1, 657) = .594, p = .441) linear regression in geography, F (1, 657) = .029, p = .866 and in biology, F (1, 657) = .594, p = .441. Thus the null hypotheses was accepted that there are no statistically significant effects of gender differences on performance in biology and geography of students taught according to their preferred learning styles, in secondary schools in Nairobi County.

iii) Differences in students' performance in biology and geography

The finding of this study revealed that, the multivariate analysis of variance and linear regression analysis showed that school type (private or public) differences had no statistically significant effect on performance of students taught using preferred learning styles in geography and biology. Given multivariate analysis of variance in geography F (1, 657) = 3.046, p = .081) and biology F (1, 657) = 000, p = .991) and linear regression in geography, F (1, 657) = 3.046, p = .081 and in biology, F (1, 657) = .000, p =. 991. This shows that teaching students according to their preferred learning styles makes students perform equally well in both private and public secondary schools in biology and geography. Therefore, the null hypothesis was accepted that there are no statistically significant differences in performance in biology and geography between private and public secondary students taught using their preferred learning styles in secondary schools in Nairobi County.

5.3 Conclusions

Based on findings of this study the following conclusions were made:

All Students in Private and Public Secondary Schools in Nairobi County have specific preferred learning styles in perception of information, processing information, preferred channel of receiving in formation and order of progressing the processing information. The students taught according to their preferred leaning styles performed statistically higher compared to the students taught according to traditional teaching styles without considering their preferred learning styles. This implies mismatch of teaching styles to preferred leaning styles, affects negatively performance of students in biology and geography in secondary

schools in Nairobi County. There are no gender differences on performance in biology and geography of students taught according their preferred learning styles in secondary schools in Nairobi County. This study shows that when students are taught according to their preferred leaning styles both males and females perform equally well in sciences. Students in private and public secondary schools performed equally well in biology and geography when taught according to their preferred learning styles. This shows that teaching students according to their preferred learning styles makes students perform equally well in both private and public secondary schools in biology and geography.

5.4 Recommendations

Based on the findings and conclusions of this study, the following recommendations are made:

i) Every teacher and instructor should endeavour to assess and identify the preferred learning styles their learners before commencement of instructions and teach their learners according to their preferred learning styles in order to enhance their academic performance in biology and geography

ii) There should be no gender discrimination in teaching learners because all learners can perform equally well in biology and geography when taught according to their preferred learning styles.

iii) All teachers in private and public schools should endeavour to teach their learners according to their preferred learning styles in order to enhance their performance because the type school does not significantly determine the performance of students in biology and geography.

5.4.1 Policy Recommendations

The ministry of education science and technology in Kenya should consider to in-service and train teachers to acquire the skills of detecting learning style preferences of students and to develop their capacity to teach according to these styles.

5.4.2 Recommendations for Further Research

The following are suggestions for further research:

i). In the course of this study the researcher realized that many learners were insensitive of their own learning styles and suggests further research on sensitisation of the learners to exploited the hidden treasure, which could otherwise empower them to understand how to adequately be prepared for continuous learning.

ii) A research-based study on methods of implementation of teaching learning styles in education institutions.

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APPENDIX I: INDEX OF LEARNING STYLES QUESTIONNAIRE

Dear Respondent,

I am a PhD candidate in Kabarak University and currently currying out a field research. The focus of the questionnaire is preferred learning styles of science students in Secondary Schools of Nairobi County. Do not write your name on the questionnaire since all the responses are confidential and will be used only for the research. Kindly respond to all the questions as they apply to you to make this research a success.

Yours cordially,

Simon Sila Kaitho

(Researcher)

INSTRUCTIONS

SECTION ONE: BIO DATA

Instructions: Put tick [√] in the bracket that you fall in

1.Gender- Male ( ) Female ( )

2. Category of your school -Public ( ) Private ( )

3. Science subjects that you take - Biology ( ) Geography ( )

SECTION TWO: PREFERRED LEARNING STYLES INVENTORY

Instructions: Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently.

1. I understand something better after

[ ] **(a)** Try it out

[ ] (**b)** think it through.

2. When I try questions I find myself

[ ] (**a)** careful but slow to finish

[ ] (**b)** quick but make careless mistakes

3. When I think about new people I met in the past, I am most likely remember their

[ ] (**a)** faces

[ ] (**b)** names

4. I find it

[ ] (**a)** difficult to explain how a process operates before I know the role played by each component parts

[ ] (**b)** easy to explain deeper connection of an issue once I get the overall picture

5. When I am learning something new, it helps me to

[ ] (**a)** talk about it.

[ ] (**b)** think about it.

6. If I were a teacher, I would rather teach a course

[ ] **(a)** that deals with facts and real life situations.

[ ] **(b)** that deals with ideas and theories.

7. I prefer to get new information in

[ ] **(a)** pictures, diagrams, graphs, or maps.

[ ] **(b)** written directions or verbal information.

8. Once I understand

[ ] **(a)** all the parts, I understand the whole thing.

[ ] **(b)** the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to

[ ] **(a)** jump in and contribute ideas.

[ ] **(b)** sit back and listen.

10. I find it easier

[ ] **(a)** to learn facts.

[ ] **(b)** to learn a process.

11. When I study, I like to

[ ] **(a)** use highlighters to emphasize points

[ ] **(b)** use a chanting rhythm to memorize

12. When I solve math problems

[ ] **(a)** I usually work my way to the solutions one-step at a time.

[ ] **(b)** I often just see the solutions but then have to struggle to figure out the steps to get to them.

13 When revising for exams I understand more if

[ ] **(a)** I explain information to someone else

[ ] **(b)** I form acronym to chunk difficult information

14. In reading nonfiction, I prefer

[ ] **(a)** something that teaches me new facts or tells me how to do something.

[ ] **(b)** something that gives me new ideas to think about which are original

15. I like teachers

[ ] **(a)** who put many diagrams on the board.

[ ] **(b)** who spend a lot of time explaining.

16. When I am analysing a story or a novel

[ ] **(a)** I think of the incidents and try to put them together to figure out the themes.

[ ] **(b)** I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to

[ ] **(a)** start working on the solution immediately.

[ ] **(b)** try first then do it after fully understanding the problem.

18. I prefer

[ ] **(a)** short answer questions

[ ] **(b)** essay questions where I have to explain deeper concepts

19. I remember best

[ ] **(a)** what I see.

[ ] **(b)** what I hear.

20. It is more important to me that a teacher

[ ] **(a)** lay out the material in clear sequential steps.

[ ] **(b)** give me an overall picture and relate the material to other topics

21. I prefer to study

[ ] **(a)** in a study group so as to listen to others

[ ] **(b)** alone in a quiet place

22. I am more likely to be considered

[ ] **(a)** careful about the details of my work.

[ ] **(b)** creative about how I do my work.

23. When I get directions to a new place, I prefer

[ ] **(a)** a map.

[ ] **(b)** written instructions.

24. I prefer a teacher who

[ ] **(a)** moves systematically while explaining a concept

[ ] **(b)** gives me the freedom to devise my own methods of solving problems rather than being forced to stick to one way of solving problems

25. I would rather first

[ ] **(a)** try things out.

[ ] **(b)** think about how I am going to do it.

26. When I am reading for enjoyment, I like writers to

[ ] **(a)** clearly say what they mean.

[ ] **(b)** say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember

[ ] **(a)** the picture of the real thing I saw

[ ] **(b)** what the teacher said about it.

28. When considering a body of information, I am more likely to

[ ] **(a)** focus on details and miss the big picture.

[ ] **(b)** try to understand the big picture before getting into the details.

29. I more easily remember

[ ] **(a)** something I have done.

[ ] **(b)** something I have thought a lot about.

30. When I have to perform a task, I prefer to

[ ] **(a)** master one way of doing it.

[ ] **(b)** come up with new ways of doing it.

31. When someone is showing me data, I prefer

[ ] **(a)** charts or graphs.

[ ] **(b)** text summarizing the results.

32. I tend to learn

[ ] **(a)** new information in linear steps where each step follows logically from the previous one.

[ ] **(b)** tend to learn in large jumps by absorbing material in a random order without necessarily seeing any connections until I have grasped the whole concept.

33. When I have to work on a group project, I first want to

[ ] **(a)** have "group brainstorming" where everyone contributes ideas.

[ ] **(b)** brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone

[ ] **(a)** sensible.

[ ] **(b)** imaginative.

35. When I meet people at a party, I am more likely to remember

[ ] **(a)** what they looked like.

[ ] **(b)** what they said about themselves.

36. When I am learning a new subject, I prefer to

[ ] **(a)** stay focused on that topic, learning as much about it as I can.

[ ] **(b)** try to make connections between that topic and related topics.

37. I am more likely to be considered

[ ] **(a)** outgoing -confident and friendly in social situation

[ ] **(b)** reserved-Slow or unwilling to show feeling or express opinion

38. I prefer topics that emphasize

[ ] **(a)** concrete material (facts, data).

[ ] **(b)** abstract material (concepts, theories).

39. For entertainment, I would rather

[ ] **(a)** watch television.

[ ] **(b)** read a book.

40. Some teachers start their teaching with an outline of what they will cover. Such outlines are

[ ] **(a)** somewhat helpful to me.

[ ] **(b)** very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,

[ ] **(a)** appeals to me.

[ ] **(b)** does not appeal to me.

42. When I am doing long calculations,

[ ] **(a)** I tend to repeat all my steps and check my work carefully.

[ ] **(b)** I find checking my work tiresome and have to force myself to do it.

43. I remember things best when

[ ] **(a)** I write them down and read them back

[ ] **(b)** I listen when others explain

44. When solving problems in a group, I would be more likely to

[ ] **(a)** think of the steps in the solution process.

[ ] **(b)** think of possible consequences or applications of the solution in a wide range of areas.

APPENDIX II: PILOT ACHIEVEMENT TESTS

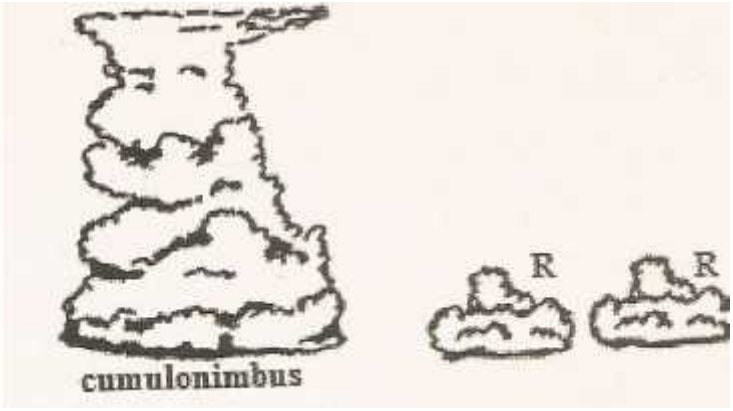
Geography- Weather :- Answer all the Questions

1.(a) Name two elements of weather that can be recorded at a school weather station. (2 marks)

(b) Give three reasons why the recording of data at a school weather station may be inaccurate. (3 marks)

2. (a) State two conditions that are necessary for the formation of fog (2 marks)

(b) The diagram below shows some types of clouds. Use it to answer the questions that follow



(i) Name the clouds marked R

(ii) Give two weather conditions associated with cumulonimbus clouds.

3. (a) State three characteristics of the Inter-tropical Convergence Zone. (Three marks)

(b) With the aid of a labelled diagram, describe how relief rainfall is formed. (Six marks)

4. The table below represents rainfall and temperature of station x. study the table and answer questions (a) and (b).

Station X

Mon t	J	F	M	A	M	J	J	A	S	O	N	D
Tem in ^{0}c	30	31	31	31	30	29	28	28	29	29	29	30
Rain mm	250	250	325	300	213	25	25	25	100	257	380	200

a) Calculate the mean annual range of temperature (2 marks)

b) Calculate the annual rainfall (2 marks)

c) Describe the climatic characteristics of this station (6 marks)

d) Describe how convectional rainfall is formed (6 marks)

e) Explain two problems associated with convectional rainfall in Lake Region of Kenya (4 marks)

5. Name three instruments to match three elements of weather that can be measured at a school weather station. (3 marks)

6. (i) Describe a suitable site where you would locate a weather station in your School (3 marks)

(ii) Give reasons why a Stevenson's screen is:

Painted white. (2 marks)

Has louvers (2 marks)

7. You are supposed to carry out a field study on the weather within your school compound

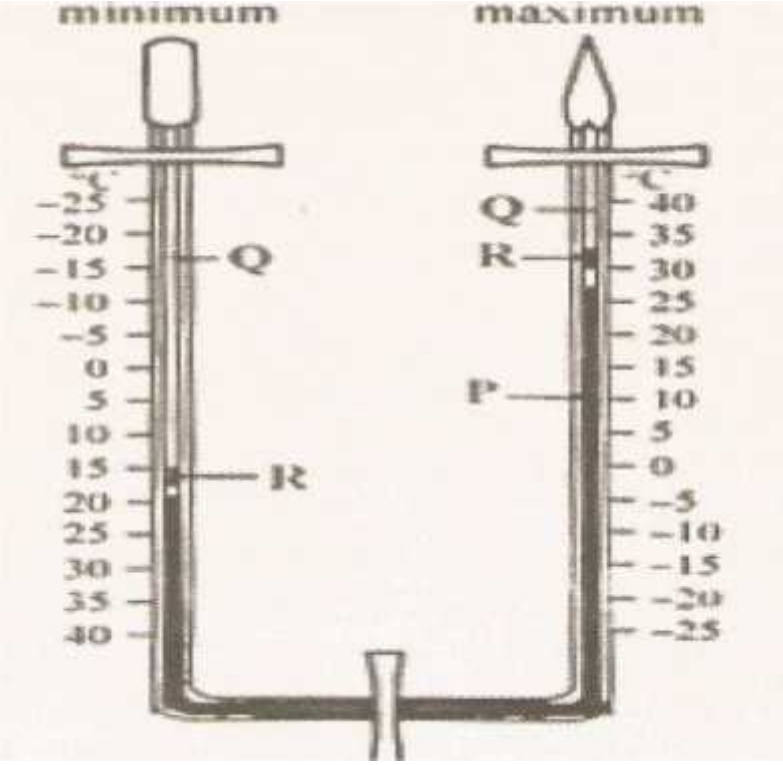
i) Describe how you would use the following instruments during the field study:

- The hygrometer (3 marks)

- The rain gauge (3 marks)

ii)State two way in which the information collected during the field study would be useful to the local community (2 marks)

8. (a) The diagram below shows a six's Thermometer. Name the parts marked P, Q and R (3 marks



9. The table below shows temperature readings at a weather station for one week

Temp/Day	Mon.	Tue.	Wed.	Thurs.	Fri.	Sat.	Sun.
Max. ^{0}c	28	27	28	26	29	29	26
Min. ^{0}c	18	18	20	16	22	21	19

Calculate the following

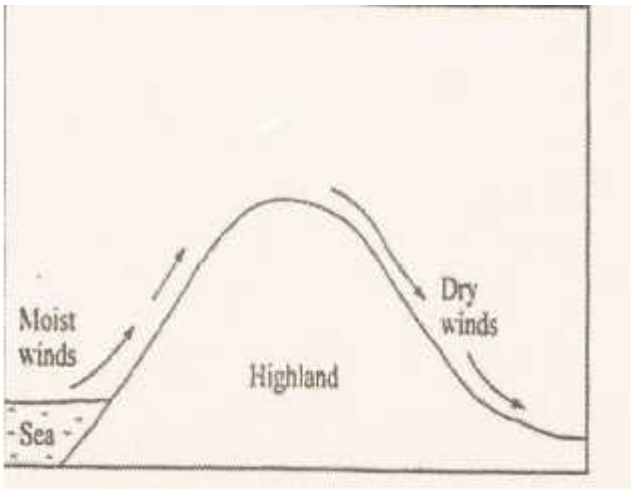
i) The diurnal range of temperature for Tuesday. (2 marks) (ii) The mean temperature for Saturday. (2 marks)

10. (a) Apart from water vapour, name two other substances that are suspended in the atmosphere. (2 marks)

(b) (i) Give two factors that are considered when classifying clouds (2 marks)

(ii) Name two types of clouds that give rise to rainfall in the tropical regions (2 marks)

11.Use the diagram below to answer the questions that follow



Outline the process through which the moisty winds shown go through to eventually become dry winds. (5 marks)

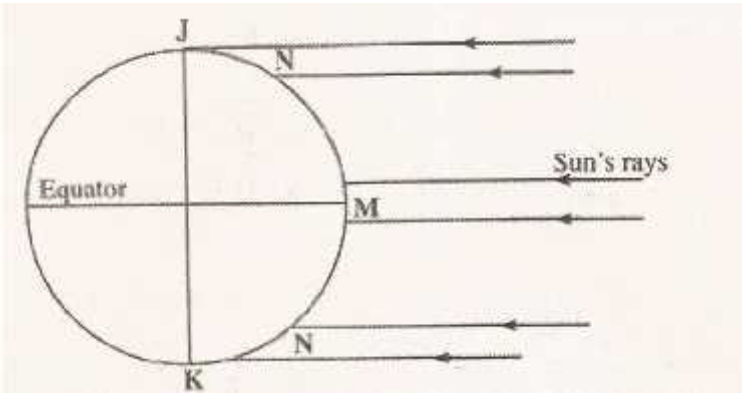
12. a) Outline the steps followed when measuring humidity using a thermometer. (3 marks)

b) Give two factors that influence relative humidity . (2 marks)

13. a) What is breeze ? (2 marks)

b) Give two ways in which sea breeze influence the adjacent land (2 marks)

14. The diagram below shows the angles of sun's rays at different latitudes when the sun is at the equator. Use it to answer questions (a) and (b).



a) Name the part of earth's surface marked J and K (2 marks)

b) Give two reasons why the intensity of the insolation is higher at M and N (2 marks)

15. a) State three conditions that are necessary for siting a weather station (3 marks)

b) Give four reasons why weather forecasting is important (4 marks)

Biology - Cell Biology Answer all the Questions

1. Name the organelle in which protein synthesis takes place. (1 mark)

2. State the function of the organelles:

(a) Lysosomes

(b) Golgi apparatus

(2 marks)

3. (a) What is the formula for calculating linear magnification of a specimen when using a hand lens? (1 mark)

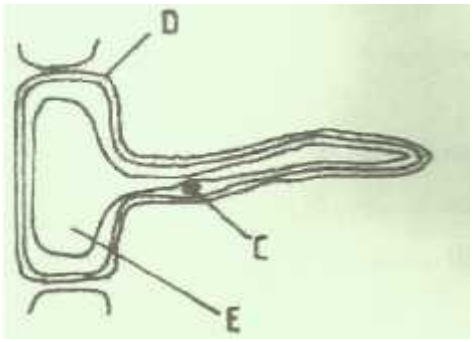
(b) Give a reason why staining is necessary when preparing specimens for observation under the microscope (2 marks)

4. Plant cells do not burst when immersed in distilled water. Explain (2 marks)

5. State three functions of Golgi apparatus. (3 marks)

6. State two functions of the endoplasmic reticulum. (2 marks)

7. The diagram below shows a specified plant cell.



a) (i) Name the cell. (1 mark)

(ii) Name the parts labelled D and E. (2 marks)

(b) State the function of the part labelled C. (1 mark)

8. Give reasons for carrying out the following procedures when preparing Temporary wet mounts of plant tissues.

(a) Making thin plant sections. (1 mark)

(b) Adding water on the plant section. (1 mark)

(c) Placing a cover slip over the plant section (1 mark)

9. Using a microscope, a student counted 55 cells across a field of view whose Diameter was 6000 μm. Calculate the average length of cells. Show your working. (2 marks)

10. (a) Name the part of a light microscope used to bring an image of a

specimen into sharp focus. (1 mark)

(b) Why is it recommended to keep the stage of the microscope dry? (1 mark)

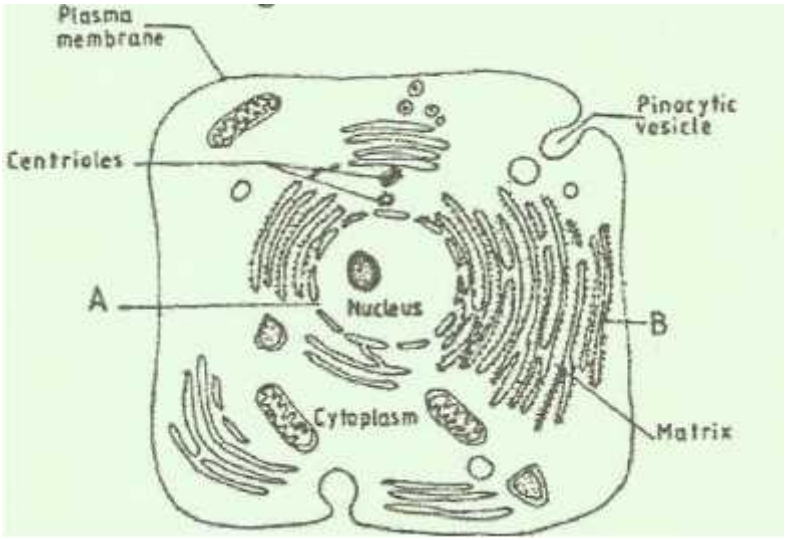
11. State one way in which each of the following is structurally adapted to its function:

(a) Neurone; (1 mark)

(b) Mitochondrion (1 mark)

12. A student drew a 6 cm long diagram of a plant flower. If the actual length of the flower was 12 cm, calculate the magnification of the drawing made by the student. Show your working. (2 marks)

13. The figure below is a fine structure of a generalised animal cell as seen under an electron microscope



(a) Name the parts labelled A and B. (2 marks)

(b) How the is structure labelled B adapted to its function? (2 marks)

14. With reference to the nucleus, state one difference between an animal and a bacterial cell (2 marks)

15. a) Name the plant organelle

i) That store chlorophyll (1 mark)

ii) Responsible for intracellular digestion (1 mark)

b) State two main functions of vacuole in amoeba (2 marks)

APPENDIX III: PRE-TEST AND POST -TEST

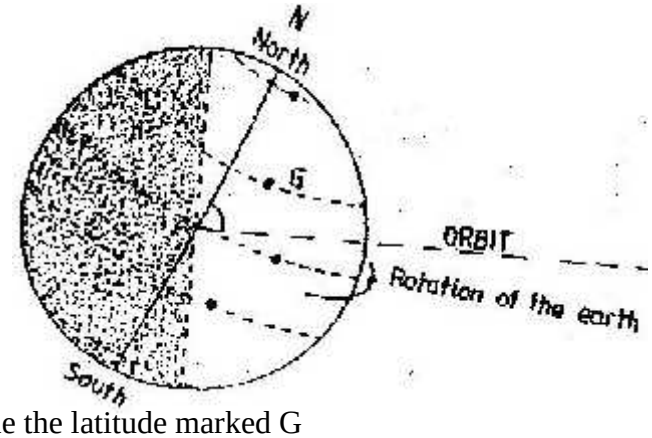
Geography Pre-Test Earth and the Solar System Time 1 Hour 40 Minutes

1. a) If the local time in Nairobi at longitude 37^{o} E is 10.00 a.m.

What will the time be at /Buchanan in Liberia at longitude 10^{o}W (2 marks)

b) What is the effect of the International Date Line on time? (2 marks)

2. The diagram below represents the earth on its axis. Use it to answer question (a)



(a) (i) Name the latitude marked G (1 mark)

(ii) What is the angle of inclination of the earth's axis from it orbit (1 mark)

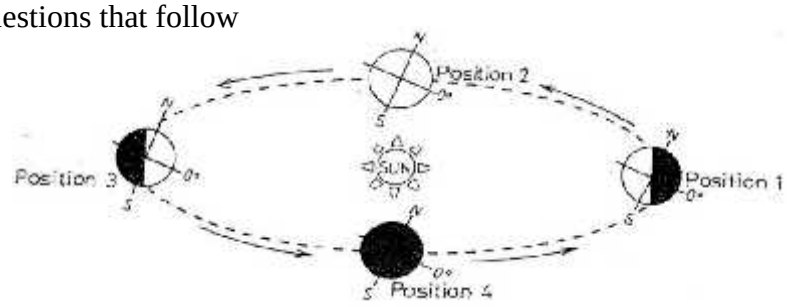
(b) State two effects of the rotation of the earth (2 marks)

3. Give four proofs that the earth is spherical (4 marks)

4.(a) (i) Give the two dates in a year during which the number of hours of darkness is equal in both the north and south poles. (2marks)

(ii) Why do the lengths of days and nights vary from one part of the earth to another? (2 marks)

5.The diagram below shows the revolution of the earth around the sun. Use it to answer the questions that follow



a) i)Give two effects of the movement represented by the diagram (2 marks)

(ii) If the earth takes 366 days to make a complete revolution during a leap year, how long will it take to move from position 1 to position (1 marks)

(iii) What season is experienced in the southern hemisphere when the earth is in Position 1?

(1 mark)

(b) State two effects of the rotation of the earth (2 marks)

6. a) What is the solar system? (1 mark)

b) Use the diagram below to answer the questions that follow.

i) What type of eclipse is represented by the diagram? (1 mark)

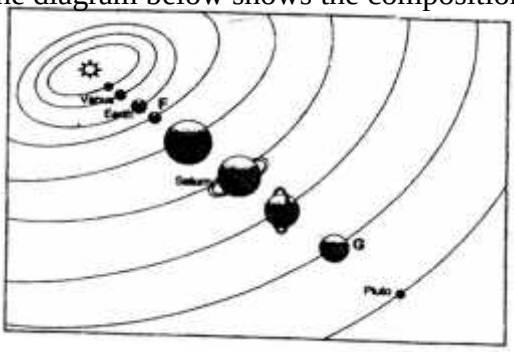
ii) Name the features marked L and M (2 marks)

7. What is latitude? (1 mark)

8. (a) Name two theories of the origin of the earth (2 marks)

(b) Name four layers of the earth's atmosphere (4 marks)

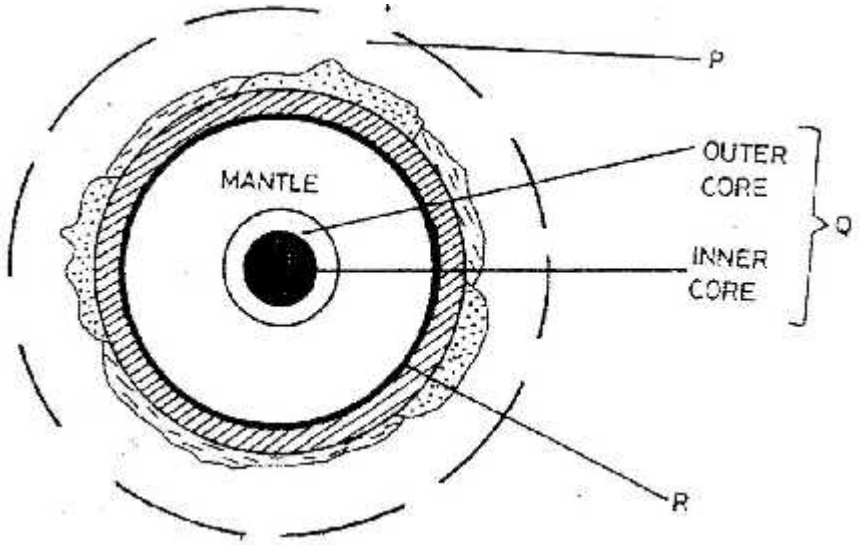
9. The diagram below shows the composition of the solar system



(a) Name the planets marked F and G (2 marks)

(b) State two reasons why Pluto was demoted from being a planet (2 marks)

10. The diagram below represents the structure of the earth. Use it to answer question



a)Name

(i) The parts marked P and Q

(2 marks)

(ii) The discontinuity marked R (1 mark)

(b) State three characteristics of the mantle (3 marks)

c) Name the minerals that make up the inner core (2 marks)

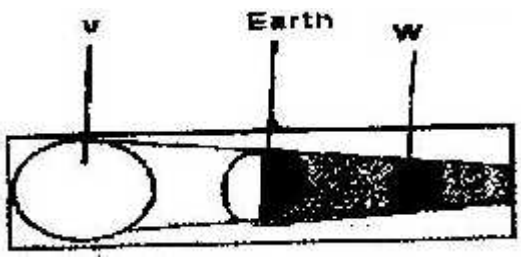
d) Describe the composition of the crust (4 marks)

11. (a) state the two types of movements of earth (2 marks)

b) Differentiate movements of earth from earths movements (2 marks)

12. The diagram below shows an eclipse.

Name the features marked V and W (2mks)



13.What is a line of longitude? (2 marks)

14.(a) Differentiate between equinox and solstice. (2 marks)

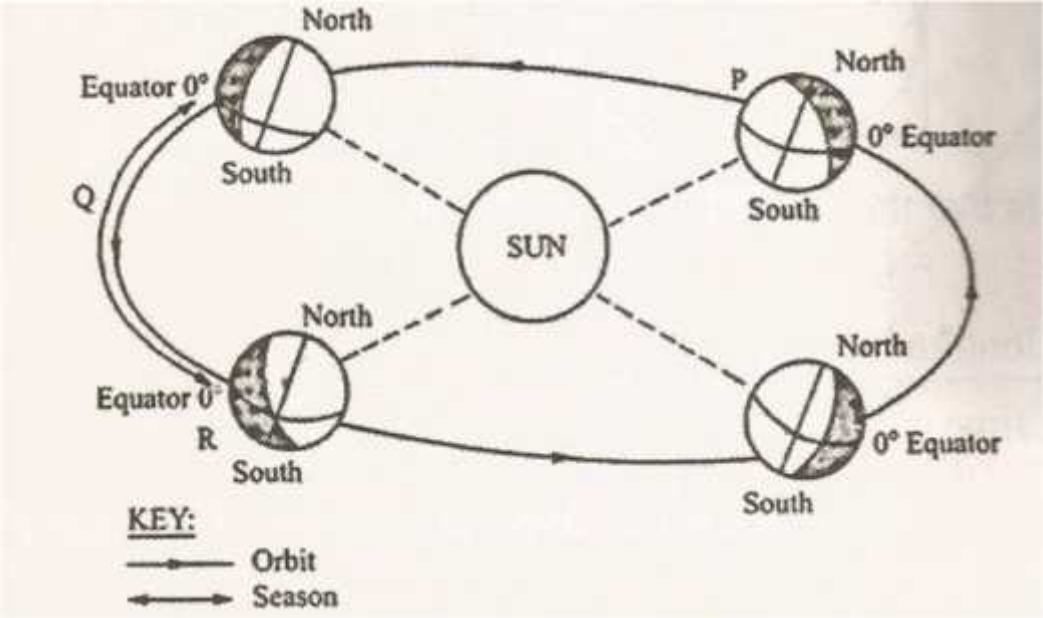
(b) Explain the origin of the earth according to the Nebula Cloud Theory. (3 marks)

15.Give three components of the solar system. (3 marks)

16. (a) A)Name the two layers of discontinuity that are part of the interior structure of earth. (2 marks)

(b) State three characteristics of the outer core in the interior structure of the earth. (3 marks)

c) The diagram below represents the revolution of the earth.



i) Name the solstice marked P (1 mark)

ii) Identify the season represented in the region marked Q (1 mark)

iii) Account for the shape of the earth (3 marks)

Geography- Post Test - Earth and The Solar System 1hour 40 Minutes

Answer all questions in the space provided

1. a) What is the solar system? (1 mark)

b) Use the diagram below to answer the questions that follow.

i) What type of eclipse is represented by the diagram? (1 mark)

ii) Name the features marked L and M (2 marks)

2. (a) state the two types of movements of earth (2 marks)

d) Differentiate movements of earth from earth movements (2 marks)

3 .a) If the local time in Nairobi at longitude 37^{o} E is 10.00 a.m.

What will the time be at /Buchanan in Liberia at longitude 10^{o} W (2 marks)

b) What is the effect of the International Date Line on time? (2 marks)

4. What is latitude? (1 mark)

5. (a) Name two theories of the origin of the earth (2 marks)

(b) Name four layers of the earth's atmosphere (4 marks)

6. Give four proofs that the earth is spherical (4 marks)

7.(a) (i) Give the two dates in a year during which the number of hours of darkness Is equal in both the north and south poles. (2 marks)

(ii) Why do the lengths of days and nights vary from one part of the earth to another? (2 marks)

8. The diagram below shows the revolution of the earth around the sun. Use it to answer the questions that follow

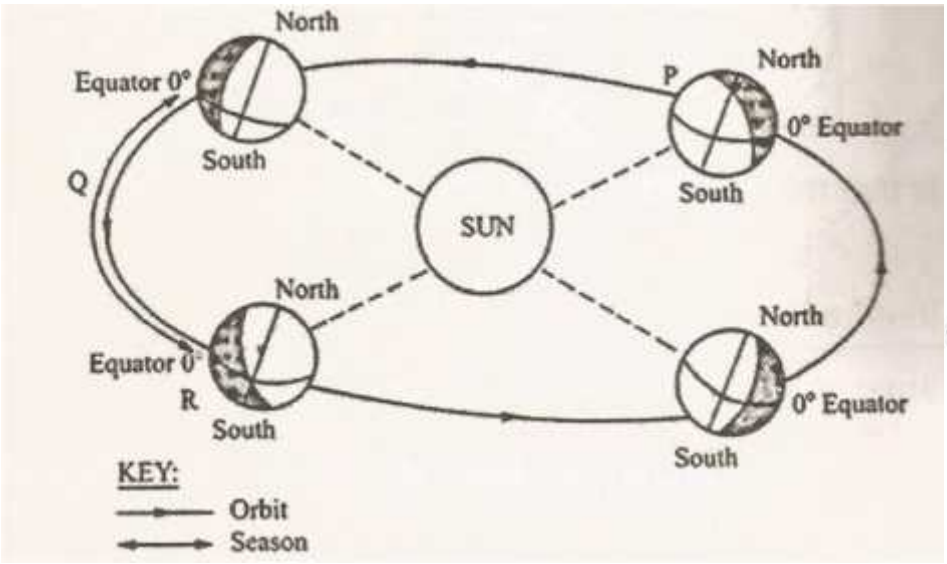
a)i)Give two effects of the movement represented by the diagram (2 marks)

(ii) If the earth takes 366 days to make a complete revolution during a leap year, how long will it take to move from position 1 to position 4? (1 mark)

(iii) What season is experienced in the southern hemisphere when the earth is in Position 1? (1 mark)

(b) State two effects of the rotation of the earth (2 marks)

9. The diagram below represents the revolution of the earth.

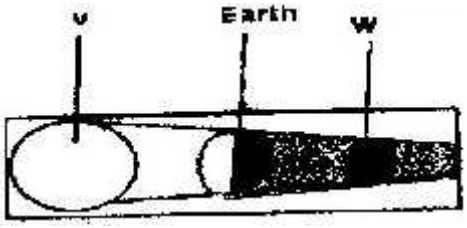


i) Name the solstice marked P (1 mark)

ii) Identify the season represented in the region marked Q (1 mark)

iii) Account for the shape of the earth (3 marks)

10. a) The diagram below shows an eclipse.

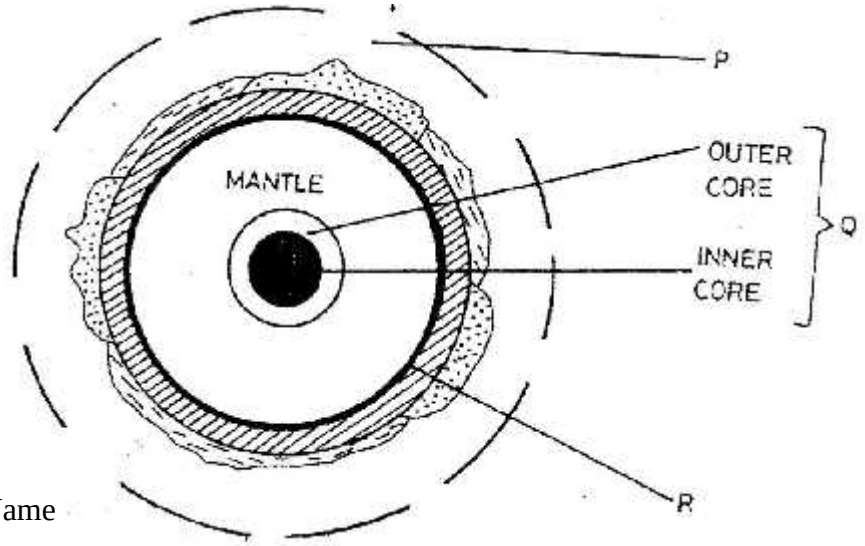


Name the features marked V and W. (2 marks)

11(a) What is a line of longitude? (2 marks)

14.(a) Differentiate between equinox and solstice. (2 marks)

12. The diagram below represents the structure of the earth. Use it to answer question



a)Name

(i) The parts marked P and Q (2marks)

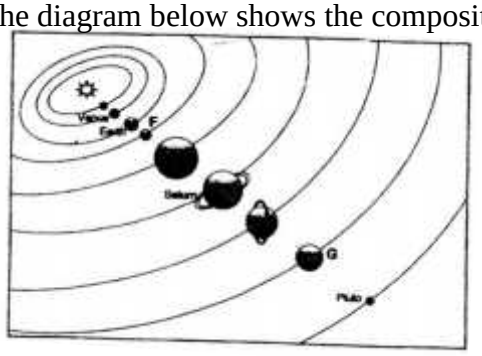
(ii) The discontinuity marked R (1 mark)

(b) State three characteristics of the mantle (3 marks)

c) Name the minerals that make up the inner core (2 marks)

d) Describe the composition of the crust (4 marks)

13. The diagram below shows the composition of the solar system



(a) Name the planets marked F and G (2 marks)

(b) State two reasons why Pluto was demoted from being a planet (2 marks)

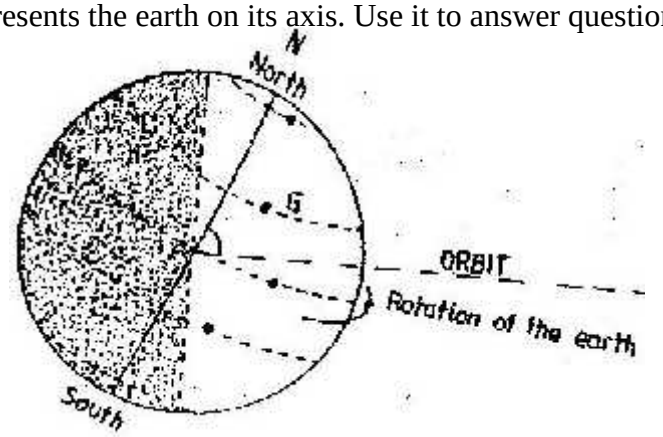
14.Give three components of the solar system. (3 marks)

15. (a) A)Name the two layers of discontinuity that are part of the interior structure of earth. (2 marks

(b) State three characteristics of the outer core in the interior structure of the earth

(c) Explain the origin of the earth according to the Nebula Cloud Theory. (3 marks)

16. The diagram below represents the earth on its axis. Use it to answer question (a)



(a) (i) Name the latitude marked G (1 mark)

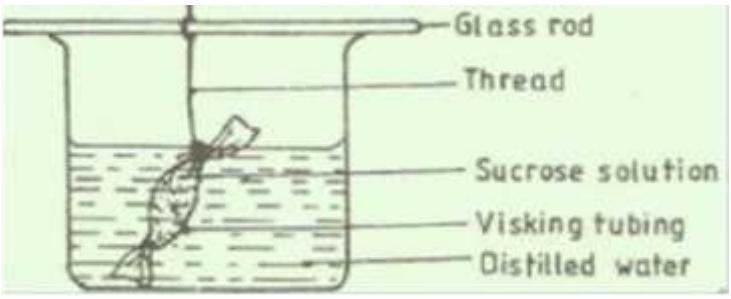
(ii) What is the angle of inclination of the earth's axis from it orbit? (1 mark)

(b) State two effects of the rotation of the earth (2 marks)

Biology Pre-Test Cell Physiology Time 1 Hour 40 Minutes

1. State the importance of osmosis in plants. 2 marks

2. An experiment was set up as shown below.



The set up was left for 30 minutes.

(a) State the expected results (1 mark)

(b) Explain your answer in (a) above (1 mark)

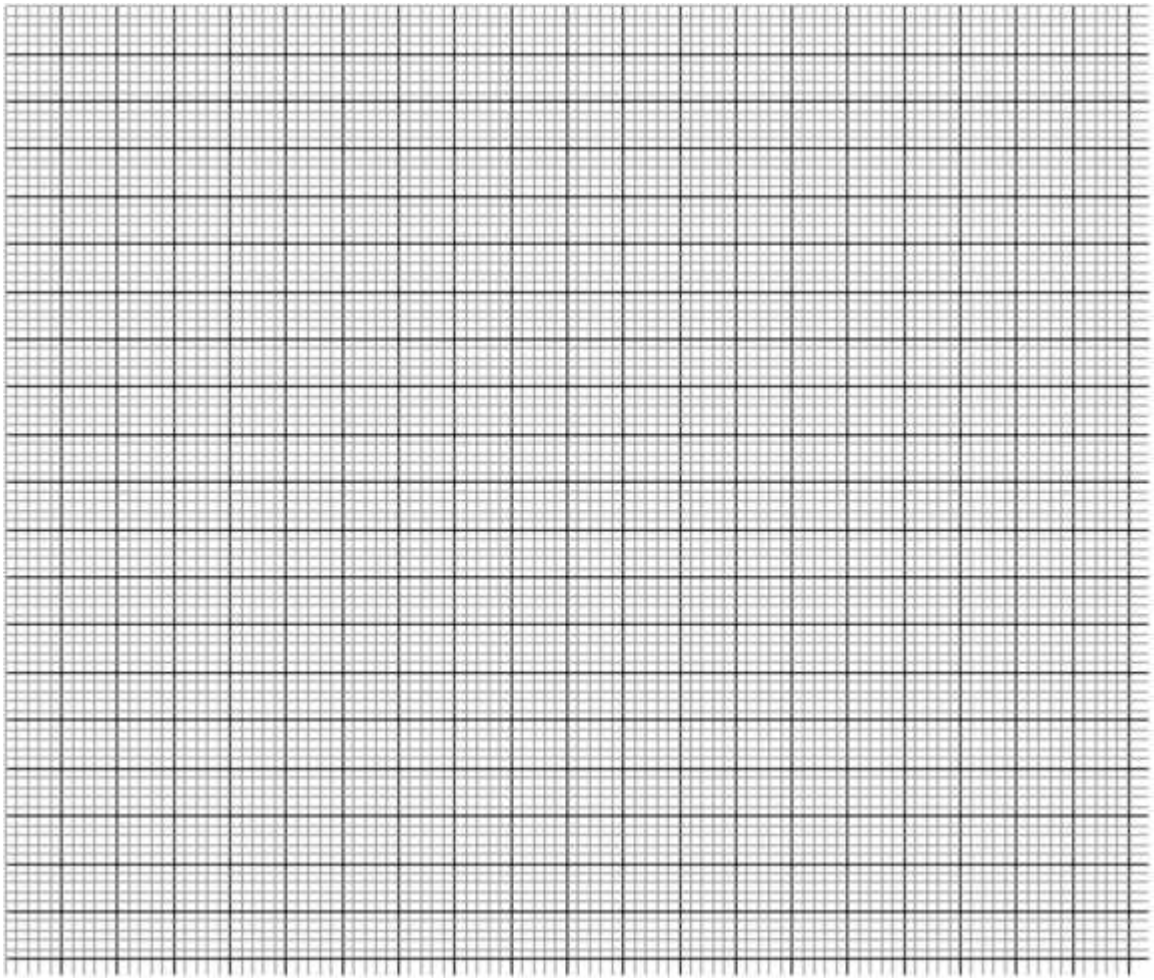
3. Explain what would happen to red blood cells if they are placed in a concentrated salt

Solution (2 marks)

4. An experiment was carried out to investigate haemolysis of human red blood cells. The red blood cells were placed in different concentrations of sodium chloride solution. The percentage of haemolysed cells was determined. The results were as shown in the table below.

Salt concentration *(g/I00cm3)* (%)	0.33	0.36	0.38	0.39	0.42	0.44	0.48
Red blood cells (Haemolysed) (%)	100	91	82	69	30	15	0

(a) (i) On the grid provided, plot a line graph of haemolysed red blood cells against salt concentration. (6 marks)



(ii) At what concentration of salt solution was the proportion of haemolysed cells equal to non-haemolysed cell (1 mark)

iii) State the percentage of cells haemolysed at salt concentration of 0.45% (1 mark)

(b) Account for the results obtained at:

(i) 0.33 percent salt concentration. (3 marks)

ii) 0.48 percent salt concertation. (3 marks)

c) What would happen to the red blood cells if they were placed in 0.50 percent salt solution?

(3 marks)

(d) Explain what would happen to onion epidermal cells if they were placed in distilled water. (3 marks)

5. Why is oxygen important in the process of active transport in cells? (1 marks)

6. Name the type of movement that occurs within a plant cell. (1 mark)

7. Distinguish between haemolysis and plasmolysis. (2 mark)

8. (a) What is diffusion? (2 marks)

(b) How do the following factors affect the rate of diffusion?

(i) Diffusion gradient (1 marks)

(ii) Surface area volume ratio (1 marks)

(iii) Temperature (1 marks)

(c) iii) Outline three roles of active transport in the human body (3 marks)

9. Distinguish between diffusion and osmosis. (2 marks)

10. (a) Distinguish between diffusion and active transport (2 marks)

b) State one role that is played by osmosis in

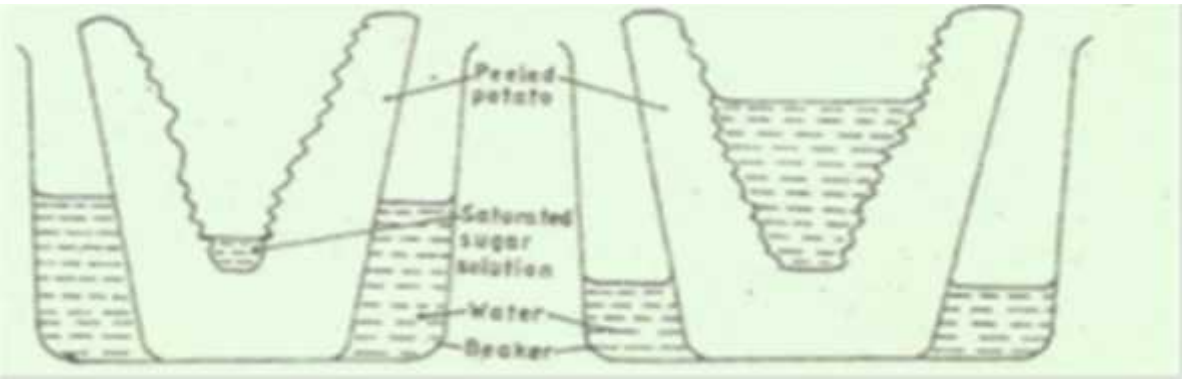
(i) Plants

(ii) Animals (2 marks)

11. Name the type of movement that occurs within a plant cell. (1 mark)

12. Distinguish between haemolysis and plasmolysis. (2 marks)

13. The diagrams below show an experimental set-up to investigate a certain process in a plant tissue.



Set-up at start of experiment. **Same set-up after 30 Minutes.**

Explain the results obtained after 30 minutes. **(4 marks)**

14. **In** an investigation, a student extracted three pairs of pawpaw cylinders using a cork borer. The cylinders were cut back to 50mm length and placed in a beaker containing a solution. The results after 40 minutes were as shown in the table below.

Feature	**Result**
Average length of cylinder (mm)	56mm
Stiffness of cylinders	Stiff

(a) Account for the results m the table above. (3 marks)

b) What would be a suitable control set-up for the investigation? (2 marks)

15. The diagram below shows red blood cell that was subjected to certain treatment

at start

at end of experiment

a) Account for the shape of the cell at the end of the experiment (2 marks)

b) Draw a diagram to illustrate how a plant cell would appear if subjected to the same treatment 1mark)

16. State three factors that affect the rate of diffusion. (3 marks)

17. The table provided shows the concentration of sodium and iodine in sea water and cell sap of a plant.

	Sodium ion concentration	**Iodide ion concentration**
Sea water	250	35
Cell sap	100	550

a) (i) Name the process through which the plant cells take up sodium ions. (1 mark)

(ii) Give a reason for your answer in (a) (i) above. (1 mark)

(b) If the plant was sprayed with a chemical that inhibits respiration:

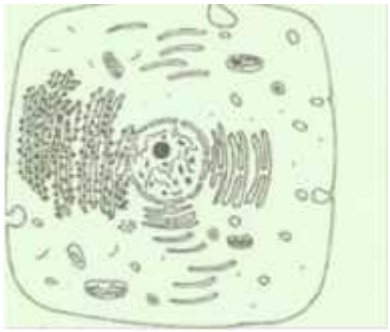
(i) Which of the two ions uptake will be affected? (1 mark)

(ii) Give a reason for your answer in (b) (i) above. (1 mark)

18. (a) What is meant by term wilting? (1 mark)

(b) Explain how an increase in temperature affects the rate of active transport. (2 marks)

19. The diagram below represents a cell as seen under an electron microscope.



Based on the diagram, state whether it represents an animal cell or a plant cel1.

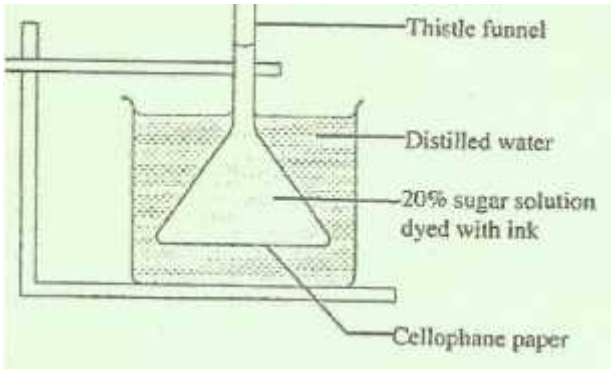
(1 mark)

(b) Give two reasons for your answer in 17(a) above. (1 mark)

(c) Why is the palisade layer a tissue? (1 mark)

20. State **two** ways in which osmosis is significant to plants. (2 marks)

21. The diagram below shows a set up for an experiment to demonstrate a certain physiological process.



a) What nature of solution is represented by 20% sugar solution? (1 mark)

(b) Explain the observation made on the set up after one hour. (2 marks)

22. (a) Explain two roles of diffusion in human beings. (4 marks)

(b) What is meant by each of the following terms?

(i) Crenated cell. (1 mark)

(ii) Flaccid cell. (1 mark)

Biology Post-Test Cell Physiology Time I Hour 40 Minutes

Answer all the question in the space provided

1. Explain what would happen to red blood cells if they are placed in a concentrated salt Solution (2 marks)

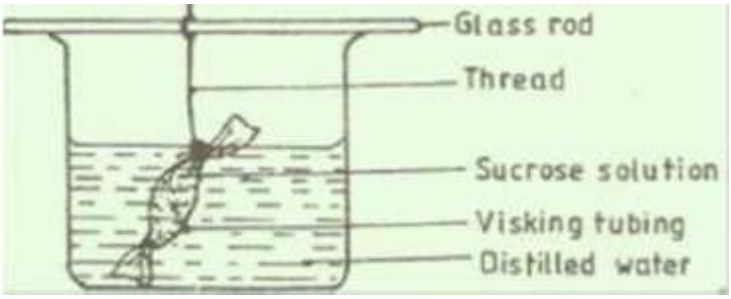
2. Why is oxygen important in the process of active transport in cells (1 marks)

3. (a) What is diffusion? (2 marks)

4. State the importance of osmosis in plants. (2 marks)

5. Distinguish between diffusion and osmosis. (2 marks)

6. An experiment was set up as shown below.



The set up was left for 30 minutes.

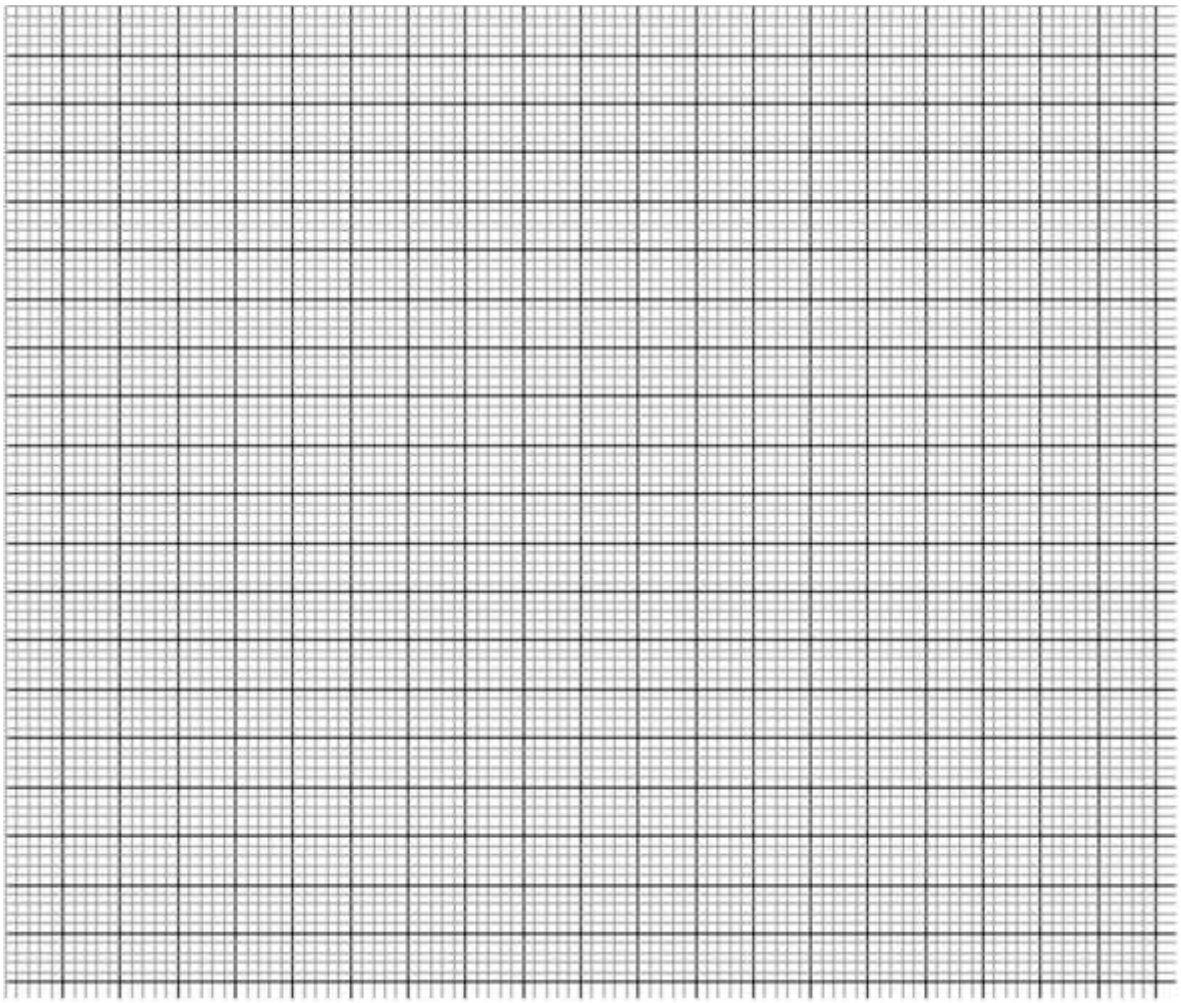
(a) State the expected results (1 mark)

(b) Explain your answer in (a) above (1 mark)

7. An experiment was carried out to investigate haemolysis of human red blood cells. The red blood cells were placed in different concentrations of sodium chloride solution. The percentage of haemolysed cells was determined. The results were as shown in the table below.

Salt concentration *(g/I00cm3)* (%)	0.33	0.36	0.38	0.39	0.42	0.44	0.48
Red blood cells (Haemolysed) (%)	100	91	82	69	30	15	0

(a) (i) On the grid provided, plot a line graph of haemolysed red blood cells against salt concentration. (6 marks)



(ii) At what concentration of salt solution was the proportion of haemolysed cells equal to non-haemolysed cells? (1 mark)

iii) State the percentage of cells haemolysed at salt concentration of 0.45% (1 mark)

(b) Account for the results obtained at:

(i) 0.33 percent salt concentration. (3 marks)

ii) 0.48 percent salt concertation. (3 marks)

c) What would happen to the red blood cells if they were placed in 0.50 percent salt solution? (3 marks)

(d) Explain what would happen to onion epidermal cells if they were placed in distilled water. (3 marks)

(b) How do the following factors affect the rate of diffusion?

(i) Diffusion gradient (1 marks)

(ii) Surface area volume ratio (1 marks)

(iii) Temperature (1 marks)

(c) iii) Outline three roles of active transport in the human body (3 marks)

8. The diagram below shows red blood cell that was subjected to certain treatment

at start

at end of experiment

a) Account for the shape of the cell at the end of the experiment (2 marks)

b) Draw a diagram to illustrate how a plant cell would appear if subjected to the same treatment (1 mark)

9. A freshly obtained dandelion stem measuring 5 cm long was split lengthwise to obtain two similar pieces. The pieces were placed in solutions of different concentrations in Petri dishes for 20 minutes. The appearance after 20 minutes is as shown

(a) Account for the appearance of the pieces in solutions LJ and L2 (6 marks)

b). State the significance of the biological process involved in the experiment (2 marks)

10. (a) Distinguish between diffusion and active transport (2 marks)

b) State one role that is played by osmosis in

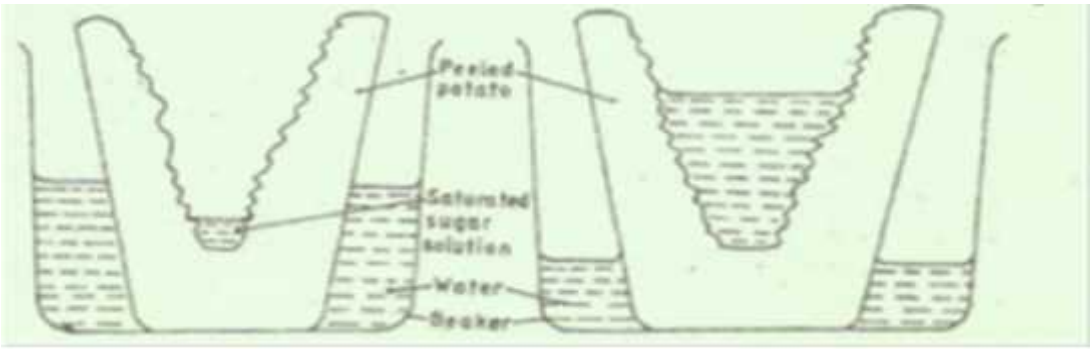
(i) Plants

(ii) Animals (2 marks)

11. Name the type of movement that occurs within a plant cell. (1 mark)

12. Distinguish between haemolysis and plasmolysis. (2 marks)

13. The diagrams below show an experimental set-up to investigate a certain process in a plant tissue.



Set-up at start of experiment. Same set-up after 30 Minutes.

Explain the results obtained after 30 minutes. (4 marks)

14. In an investigation, a student extracted three pairs of pawpaw cylinders using a cork borer. The cylinders were cut back to 50mm length and placed in a beaker containing a solution. The results after 40 minutes were as shown in the table below.

Feature	**Result**
Average length of cylinder (mm)	56mm
Stiffness of cylinders	Stiff

(a) Account for the results m the table above. (3 marks)

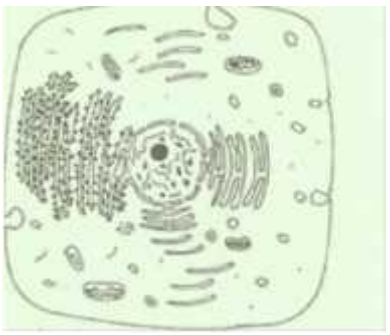
b) What would be a suitable control set-up for the investigation? (2 marks)

15. State three factors that affect the rate of diffusion. (3 marks)

16. (a) What is meant by term wilting? (1 mark)

(b) Explain how an increase in temperature affects the rate of active transport. (2 marks)

17. The diagram below represents a cell as seen under an electron microscope.



(a) Based on the diagram, state whether it represents an animal cell or a plant cel1. (1 mark

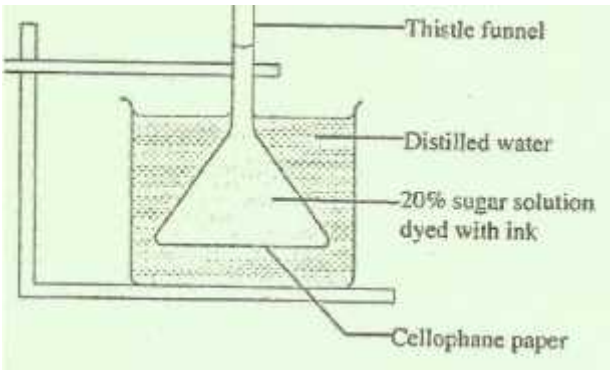
(b) Give two reasons for your answer in 17(a) above. (1 mark)

(c) Why is the palisade layer a tissue? (1 mark)

18. Describe how turgor pressure builds up. (3 marks)

19. State **two** ways in which osmosis is significant to plants. (2 marks)

20. The diagram below shows a set up for an experiment to demonstrate a certain physiological process.



a) What nature of solution is represented by 20% sugar solution? (1 mark)

(b) Explain the observation made on the set up after one hour. (2 marks)

21. (a) Explain **two** roles of diffusion in human beings. (4 marks)

(b) What is meant by each of the following terms?

(i) Crenated cell. (1 mark)

(ii) Flaccid cell. (1 mark)

22. The table provided shows the concentration of sodium and iodine in sea water and cell sap of a plant.

	Sodium ion concentration	**Iodide ion concentration**
Sea water	250	35
Cell sap	100	550

a) (i) Name the process through which the plant cells take up sodium ions. (1 mark)

(ii) Give a reason for your answer in (a) (i) above. (1 mark)

(b) If the plant was sprayed with a chemical that inhibits respiration:

(i) Which of the two ions uptake will be affected? (1 mark)

(ii) Give a reason for your answer in (b) (i) above. (1 mark)

APPENDIX IV: SCHOOLS WHICH HAD DONE KCSE BY 2014

PUBLIC SCHOOLS IN NAIROBI COUNTY

	CODE	SCHOOL NAME	GENDER
1	20401001	Aquinas High School	Boys'
2	20401002	Highway Secondary School	Boys'
3	20401003	Huruma Girls' High School	Girls'
4	20401004	Our Lady of Mercy Secondary School	Girls'
5	20401005	Ofafa Jericho High School	Boys'
6	20401006	Nileroad Secondary	Girls'
7	20401007	Buruburu Girls' Sec	Girls'
8	20401008	Makongeni High School	Mixed
9	20401020	St Anne's Girls' Sec School	Girls'
10	20402001	Eastleigh High School	Boys'
11	20402002	St. Teresa's Boys'	Boys'
12	20402003	Maina Wanjigi Secondary School	Mixed
13	20402004	Uhuru Secondary School	Boys'
14	20402005	Kamukunji Secondary School	Mixed
15	20402006	O.L.M Shauri Moyo Girls Sec. School	Girls'
16	20403001	Jamhuri High School	Boys'
17	20403002	Parklands Secondary School	Boys'
18	20403003	Pumwani Secondary School	Boys'
19	20403004	Ngara Girls' High School	Girls'
20	20403005	St Teresa's Girls Secondary School	Girls'
21	20403019	Ndururuno Secondary School	Mixed
22	20403024	Murang'a Road Mixed Day Secondary School	Mixed
23	20403025	C.G.H.U. Mixed Secondary School	Mixed
24	20403026	Pumwani Girls' Secondary School	Girls'
25	20404001	Lang'ata High School	Mixed
26	20404008	St. Hanna's Girls'	Girls'
27	20404013	Nairobi Muslim Academy	Girls'
28	20404022	Karen ' C ' Secondary School.	Mixed
29	20404024	Olympic High School	Mixed
30	20404025	Raila Educational Centre	Mixed
31	20404030	St. Nicholas Senior Sch	Mixed

32	20404031	The Visionary Academic Centre	Mixed
33	20405001	Dagoretti High School	Boys’
34	20405002	Upper Hill School	Boys’
35	20405003	Moi Girls’ School Nairobi	Girls’
36	20405004	Precious Blood Riruta	Girls’
37	20405005	Mutuini High School	Boys’
38	20405006	Ruthimitu Secondary School	Mixed
39	20405007	Nembu Girls High School	Girls’
40	20405008	Ruthimitu Girls Sec School	Girls’
41	20405009	Dagoretti Mixed Sec School	Mixed
42	20405031	Brooklynn High	Mixed
43	20406001	Parklands Arya Girls High School	Girls’
44	20406002	Statehouse Girls H. Sch	Girls’
45	20406007	Kangemi High School	Boys’
46	20406009	Hospital Hill High School	Boys’
47	20406011	St. George’s Girls’ Secondary School	Girls’
48	20406012	Nairobi Milimani Secondary School	Boys’
49	20406018	Lavington Mixed Secondary School	Mixed
50	20406019	Highridge Mixed Secondary School	Mixed
51	20407001	Our Lady Of Fatima Secondary School	Mixed
52	20407002	Kahawa Garrison Secondary School	Mixed
53	20407003	Ruaraka High School	Mixed
54	20407004	Kamiti Secondary School	Mixed
55	20407005	Baba Dogo Sec	Mixed
56	20408001	The Komarock Sec. School	Mixed
57	20408007	Embakasi Girls Secondary School	Girls’
58	20408014	Peter Kibukosya Secondary School	Mixed
59	20408015	Kayole South Secondary School	Mixed
60	20408020	Mwangaza Secondary school	Mixed
61	20409001	Dandora Secondary School	Mixed
62	20409002	Muhuri Muchiri Boys High School	Boys’
63	20409003	Hon. Dr. Mwenje Secondary School	Mixed
64	20409004	Ushirika Secondary School	Mixed
65	20409005	Jehova Jire Secondary School	Mixed

66	20409006	Drumvale Secondary School	Mixed
67	20409007	St. George Athi Secondary School	Mixed
68	20409024	Ruai Girls' Sec	Girls'
69	20409025	Ruai Boys' Sec School	Boys'
70	20401021	St Patrick Nairobi Mixed Sec Sch	Mixed
71	20427037	North Girls Sec School	Girls'
72	20407040	Annointed High School	Mixed
73	20408029	Embakasi Garrison Sec School	Mixed
74	200400009	Starehe Girls	Girls'
75	20400008	Moi Forces Academy	Boys'
76	20400004	Starehe Boys	Boys'
77	20400002	Nairobi School	Boys'
78	20400001	Lenana School	Boys'

PRIVATE SECONDARY SCHOOLS IN NAIROBI COUNTY

1.	Aga Khan High School, Nairobi	Mixed
2.	Malezi High School	Mixed
3.	Al Maktoum Foundation	Mixed
4.	Apostolic Carmel Secondary Sch.	Mixed
5.	Mugumo-Ini Girls Secondary School	Girls'
6.	Authentic Academy	Mixed
7.	Munadhamat Al Dawa Al Islamia	Mixed
8.	Batian Christian School	Mixed
9.	Mwiki Mixed Secondary School	Mixed
10.	Bright Star High School	Mixed
11.	Brookfield Secondary School	Mixed
12.	Brookshine School, Nairobi	Mixed
13.	Nairobi Queens Educational Centre	Girls'
14.	C.G.H.U. Girls Secondary School	Girls'
15.	Ngei P.A.G Secondary School	Mixed
16.	Pan African High School	Mixed
17.	Consolata School	Mixed
18.	Corner Brook School	Mixed
19.	Prince Johns Mixed Day & Boarding School	Mixed
20.	Cresent Girls Secondary	Girls'

21.	Don Bosco Secondary School	Mixed
22.	Riara Springs Girls High School	Girls’
23.	E.M.F Excellent Education Centre	Mixed
24.	Elgonridge Schools Ltd (Allumini Academy)	Mixed
25.	Riruta Central Secondary School	Mixed
26.	Embakasi High School	Mixed
27.	Sharda High School	Mixed
28.	Shauri Moyo M.H. Secondary Sch	Mixed
29.	Shilce Secondary School	Mixed
30.	Gateway High School	Mixed
31.	SSD Secondary School	Mixed
32.	Gladys Girls High School	Girls’
33.	St. Bernard Secondary School	Mixed
34.	Global Vision Secondary School	Mixed
35.	St. Christopher School	Mixed
36.	Good Samaritan High School	Mixed
37.	St. Deborah School	Mixed
38.	Good Shepherd High School	Mixed
39.	St. Dominic Savio’s Secondary School	Mixed
40.	Guru Nanak (GN) Secondary School	Mixed
41.	St. Edward’s High School	Mixed
42.	St. Elizabeth Secondary School	Girls’
43.	High Link Secondary School	Mixed
44.	St. Florence Girls Secondary School	Girls’
45.	Imprezza Secondary School	Mixed
46.	St. Hannah’s Boy’s School	Boys
47.	St. Hannah’s Girls School	Girls’
48.	Jucky Secondary School	Mixed
49.	Kahawa Secondary School	Mixed
50.	St. John’s High School	Boys’
51.	Kariobangi South Secondary School	Mixed
52.	St. Lucie Kiriri Girls Secondary School	Mixed
53.	St. Lukes Sec. School, Sigona	Mixed
54.	Karura S.D.A. Secondary School	Mixed

55.	Kayole Girls High School	Girls’
56.	Kenya Muslim Academy	Mixed
57.	St. Mary’s Ruaraka School	Mixed
58.	Khalsa Girls Secondary School	Girls’
59.	St. Tito High School	Mixed
60.	Kitisuru High School	Mixed
61.	Stanmore High School	Mixed
62.	Strathmore School	Boys’
63.	Sunflower Secondary School	Mixed
64.	Lili Vision High School	Mixed
65.	Sunshine Secondary School	Boys’
66.	Loreto Convent, Msongari	Mixed
67.	Temple Road High School	Mixed
68.	Loreto Convent, Valley Road	Boys’
69.	Vinespring Girls Secondary School	Girls’
70.	Makina High School	Mixed
71.	Wakulima Secondary School	Mixed
72.	Welkim Senior Academy	Mixed
73.	Wamy High School	Mixed
74.	Silverbrigde School	Mixed

APPENDIX V: DATA ON PILOT STUDY

i) Pilot Group Preferred Learning Styles

Name	**gender**	**Pre-Test**				**Post-Test**				**Pre-test** scores	**Post-test** scores
		ar	**vvr**	**si**	**sqg**	**ar**	**vvr**	**si**	**sqg**		
Jack	M	3r	7v	1s	5sq	3r	7v	1s	5sq	16.00	16.00
Muthee	M	3a	7v	1i	7g	3a	7v	1i	5g	18.00	16.00
Glain	F	9a	11v	3i	3sq	9a	11v	1i	3sq	26.00	24.00
Alex	M	1r	11v	1i	5sq	3r	11v	5s	9sq	18.00	22.00
Leon	M	7r	1v	1i	11sq	7r	1v	3s	11sq	20.00	22.00
Leah	F	1a	7vr	7s	3sq	1a	7vr	7s	5sq	18.00	20.00
James	M	5r	7v	1i	7sq	3r	7v	1i	3sq	20.00	14.00
Samuel	M	1a	9v	3s	7sq	3a	9v	5s	7sq	20.00	24.00
Edinah	F	5a	1vr	3i	1g	1a	1vr	3i	1g	10.00	6.00
Sabina	F	9r	1v	5s	3g	9r	1v	5s	3g	18.00	18.00
Chenjo	M	5r	1v	3s	5sq	5r	1v	3s	7sq	14.00	16.00
Stephen	M	11a	9vr	3s	5sq	11a	5vr	5s	5sq	28.00	26.00
George	M	1a	11v	3s	5sq	1a	9v	5s	5sq	20.00	20.00
Winny	M	7a	5v	1i	1sq	7a	3v	1i	1sq	14.00	12.00
1an	M	5a	7v	7i	3sq	3a	9v	3i	1sq	22.00	16.00
Obure	F	3a	5v	5s	1g	5a	5v	5s	1g	14.00	16.00
Cynthia	F	3r	1vr	5s	11sq	3r	1vr	7s	9sq	20.00	20.00
Irene	F	1a	3v	7s	3sq	1a	3v	7s	3sq	14.00	14.00
Everline	F	5r	9v	5s	3sq	7r	9v	1s	1sq	22.00	18.00
Bosire	M	5a	7v	3s	5g	3a	5v	3s	5g	20.00	16.00
Sebe	F	5a	9v	1s	5sq	7a	9v	3s	7sq	22.00	26.00
Cather	F	5r	3v	3s	1sq	5r	3v	3s	3sq	12.00	14.00
Annie	F	1r	7v	1s	5sq	1r	7v	3s	7sq	14.00	18.00
Fridah	F	5a	9v	7s	7sq	5a	9v	9s	7sq	28.00	30.00
Wendy	F	7r	1vr	1s	5sq	7r	1vr	1s	3sq	14.00	12.00
Waina	M	1a	11v	1s	1g	5a	11v	3s	7g	14.00	26.00
Florenc	F	1a	7v	7s	7sq	1a	11v	7s	7sq	22.00	26.00

e											
Roy	M	7a	1vr	3i	3sq	7a	3vr	3i	7sq	14.00	18.00
Kiogera	M	1r	1v	1s	5g	1r	1v	5s	5g	8.00	12.00
Feny	F	3a	7v	3s	5g	3a	5v	3s	5g	18.00	16.00
Dan	M	3a	5v	1i	7g	3a	3v	1i	5g	16.00	12.00
Sarah	F	3a	3v	7s	1sq	5a	5v	5s	5sq	14.00	20.00

a = active r = reflective v = visual vr = verbal s = sensing sq = sequencing g = global

Pearson Correlation of Preferred Learning Styles

Type of Test		N	Mean	Std. Deviation	Pearson Correlation	
Preferred Learning Styles	Pre-test	32	17.75	4.759	.710**	
					Sig. (2-tailed)	.000
	Post-test	32	18.31	5.3306		

**. Correlation is significant at the 0.01 level (2-tailed

vii) Pilot Group Performance in Sciences (Geography and Biology)

Pre-Test Geography	Post-Test Geography	Pre-test Biology	Post-Test biology
64.00	60.00	58.00	55.00
39.00	42.00	45.00	46.00
29.00	30.00	38.00	45.00
36.00	34.00	37.00	38.00
42.00	41.00	40.00	43.00
57.00	58.00	58.00	57.00
78.00	78.00	73.00	69.00
60.00	62.00	59.00	60.00
59.00	56.00	46.00	59.00
44.00	43.00	40.00	44.00
48.00	44.00	46.00	48.00

33.00	34.00	34.00	36.00
56.00	50.00	50.00	56.00
49.00	47.00	51.00	59.00
65.00	65.00	49.00	55.00
60.00	59.00	59.00	60.00
68.00	67.00	61.00	68.00
70.00	71.00	72.00	70.00
37.00	40.00	43.00	39.00
40.00	44.00	42.00	40.00
69.00	60.00	65.00	69.00
39.00	38.00	38.00	39.00
63.00	61.00	56.00	63.00
35.00	36.00	37.00	40.00
49.00	50.00	45.00	49.00
71.00	67.00	57.00	60.00
45.00	49.00	43.00	45.00
63.00	64.00	61.00	63.00
51.00	55.00	54.00	61.00
43.00	48.00	52.00	60.00
24.00	30.00	34.00	38.00
37.00	36.00	39.00	44.00

Pearson Correlation of Preferred Achievement Test Science (Biology and Geography)

Type of Test		N	Mean	Std. Deviation	Pearson Correlation	
Achievement Test	Pre-test	64	50.0781	12.41006	.950**	
					Sig. (2-tailed)	.000
	Post-test	64	51.5156	11.74868		

**. Correlation is significant at the 0.01 level (2-tailed)

APPENDIX VI: MAP OF NAIROBI COUNTY

APPENDIX VII: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. SIMON SILA KAITHO
of KABARAK UNIVERSITY, 0-100 nairobi gpo,has been permitted to conduct research in *Nairobi County*

on the topic: *RELATIONSHIP BETWEEN MISMATCH OF TEACHING STYLES TO PREFERRED LEARNING STYLES AND PERFORMANCE OF STUDENTS IN SCIENCES IN SECONDARY SCHOOLS OF NAIROBI COUNTY, KENYA*

for the period ending:
31st August,2016

.....
Applicant's Signature

Permit No : NACOSTI/P/15/1138/7159
Date Of Issue : 14th August,2015
Fee Recieved :Ksh 2,000

.....
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 6181

CONDITIONS: see back page

APPENDIX VIII: RESEARCH AUTHORIZATION

INSTITUTE OF POST GRADUATE STUDIES AND RESEARCH

Private Bag - 20157
KABARAK, KENYA
E-mail: directorpostgraduate@kabarak.ac.ke

Tel: 0773265999
Fax: 254-51-343012
www.kabarak.ac.ke

29th June, 2015

Ministry of Education, Science and Technology,
National Commission for Science, Technology and Innovation,
9th Floor, Utalii House,
P.O. Box 30623 – 00100,
NAIROBI.

Dear Sir/Madam,

RE: RESEARCH BY GDE/M/0938/09/10–KAITHO SIMON SILA

The above named is a Doctoral student at Kabarak University in the School of Education, Theology and Arts. He is carrying out research entitled "Relationship between Mismatch of Teaching Styles to Preferred Learning Styles and Performance of Students in Sciences in Secondary Schools of Nairobi County, Kenya"

The information obtained in the course of this research will be used for academic purposes only and will be treated with utmost confidentiality.

Please provide the necessary assistance.

Thank you.

Yours faithfully,

KABARAK UNIVERSITY
POSTGRADUATE STUDIES & RESEARCH DEPT.
29 JUN 2015
PRIVATE BAG - 20157, KABARAK

Dr. Betty Tikoko
DIRECTOR POST GRADUATE STUDIES & RESEARCH

Kabarak University Moral Code

As members of Kabarak University family, we purpose at all times and in all places, to set apart in one's heart, Jesus as Lord. (1 Peter 3:15)

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:

14th August, 2015

NACOSTI/P/15/1138/7159

Simon Sila Kaitho
Kabarak University
Private Bag - 20157
KABARAK.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Relationship between mismatch of teaching styles to preferred learning styles and performance of students in sciences in secondary schools of Nairobi County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for a period ending **31st August, 2016.**

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

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

SAID HUSSEIN
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nairobi County.

COUNTY COMMISSIONER
NAIROBI COUNTY
P. O. Box 30124-00100, NBI
TEL: 341666

The County Director of Education
Nairobi County.

COUNTY DIRECTOR OF EDU...
14 AUG 2015
MINISTRY OF EDUCATION
P. O. Box 74629, NAIROBI