EFFECTS OF A COOPERATIVE LEARNING MODULE ON STUDENTS' ACHIEVEMENT AND ATTITUDES TOWARDS CLASSIFICATION OF ORGANISMS IN BIOLOGY IN SELECTED SECONDARY SCHOOLS IN NAKURU DISTRICT, KENYA

By

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DECLARATION AND APPROVAL

This Thesis is my original work and has not been presented for a degree or diploma in any university.

.....

David Kimani Gitau

Date: 23/04/07

APPROVAL

This Thesis has been submitted for examination with our approval as university supervisors.

Signed ..... **Date** 25.04.07

Dr Joel K. Kiboss

Signed ..... **Date** 4/5/07

Dr. Fred N. Keraro

DEDICATION

This work dedicated to my beloved wife Joyce and dear sons Ian, Kevin and Jimmy.

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I would like to thank my supervisors Dr. Joel K. Kiboss and Dr. Fred N. Keraro for the support they accorded me through the preparation and writing of this study. They always had time and patience for discussion on various aspects of the study and they continually encouraged me.

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ABSTRACT

Biology is one of the Kenya Certificate of Secondary Education (K.C.S.E) subjects that registered a poor performance by learners between the years 1997 and 2000. Poor teaching methods are some of the reasons put forward to explain this poor performance. This study was designed to explore the effectiveness of a co-operative learning intervention on students' achievement and attitude towards the classification of organisms in school biology. The study was carried out in Nakuru district, Kenya, where a persistent low student's achievement in the subject has been registered. A quasi-experimental research design, the Solomon-Four-Group design was employed in the study. Four schools were purposively selected from the 140 secondary schools and randomly assigned to serve as the experimental group (E), control group I (C_1), control group II (C_2) and control group III (C_3). The co-operative learning method was used to teach classification of organisms to the experimental group and control group II (C_2). The true control groups, control group I and control group III were taught using the conventional methods. Data was collected from a sample of 165 form three students from four secondary schools in Nakuru district using two instruments namely, the Biology Achievement Test (BAT) and Students Attitude Questionnaire (SAQ). Two groups, the experimental group E and the true control group I (C_1), were pre-tested, while the second and third control groups (C_2 and C_3) were not. All groups were taught the same course content for a period of five weeks with the experimental groups receiving their instruction via the cooperative learning mode and the true control groups using the conventional methods of teaching. A post-test was administered to all groups after the completion of instruction on the biology topic on classification of organisms. Data was analysed using the Statistical Package for Social Sciences (SPSS) version 9. T-test and Analysis of Variance (ANOVA) were used to test hypotheses. The levels of significance were computed at α=0.05. The results of the study indicate that subjects in the experimental group outperformed the control group in the achievement and attitude tests. It can therefore be concluded that the cooperative leaning module used by the subjects in the experimental group led to a relatively higher achievement in the learning of biology as compared to the conventional learning used by subjects in the control group. The findings further indicate that students developed a positive attitude towards the subject. Science teachers, teacher educators and policy makers will benefit from the results and recommendations of the study in that they will provide them with an alternative teaching approach capable of fostering the learners' altitude towards biology, and thus improving their achievement in the subject.

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CHAPTER ONE

INTRODUCTION

1.0 Background to the Study

The importance of Biology in the science curriculum of most countries continues to grow. For instance, Fraser and Walberg (1995), note that Biology has increasingly become a mandatory subject, especially during the elementary years in school. Ross (2000) asserts that, it is becoming more and more important that all citizens understand the ways of science and how the actions of society affect living things. Understanding the nature of science and fundamental biological concepts is important for any person, regardless of his or her vocation. Taylor (2000) has defined Biology as the scientific study of life. It is an extension of our innate interests in life's diverse forms. According to Taylor, the scope of biology is immense, spanning from the sub microscopic realm of molecules to the complex web of ecosystems from the present, back through 4 billion years of evolutionary history. Biological organisation is based on a hierarchy of structural levels, ranging from atoms, through biological molecules, organelles, cells, tissues, organs, organ systems, organisms, populations, and communities to ecosystems. The study of biology includes understanding the various levels of biological organization and the link between these levels. As Taylor further notes, Biology is a demanding science partly because living systems are so complex and partly because Biology incorporates concepts from Chemistry, Physics and Mathematics. A study of the form of biological structure gives information on its functioning, and a study of function provides insight into structural organization.

In Kenya Biology education at the secondary school level is aimed at preparing learners to deal with the contemporary environmental challenges in society. The course consists of basic principles of biology and their application to real life situations. As a practical subject, it equips the learner with concepts and skills that come in hardy in solving the day to day problems in life. The subject also aims at providing the learner with the necessary knowledge with which to control or change the environment for the benefit of the community, (K.I.E 2001). As a science subject, it plays an important role and affects many aspects of human life. According to Ross (2000) young scientists from high school should not only 'know' but also 'understand' and be able to 'use' science. Biology is therefore, an objective study of the living universe that is geared towards equipping learners with knowledge, attitudes and skills needed for the various social and economic occupations in

society (Bennaars, Otiende & Boisvert, 1994; Maundu, Sambili & Muthwii, 1998). It is also a practical science subject that requires the active participation of learners in the construction of knowledge (Bell & Gilbert, 1996).

A Kenya National Examination Council (KNEC) report (2000) (Table 1) reveals that biology is poorly performed in both the Kenya Certificate of Secondary Education (KCSE) theory and practical papers. This has, among other reasons, been attributed to poor mastery of content by learners and the lack of the appropriate development of such skills as evaluation, application, interpretation and synthesis. Classification of organisms has been cited as one of the most difficult topics in secondary school biology because students find it difficult to learn and teachers find it difficult to teach (KNEC, 2000). The topic is one of the basic prerequisites for the other topics learnt by learners in the biology course. The conventional methods used in teaching the subject, do not enable learners comprehend other related concepts due to their (learners) inadequate understanding and negative attitude towards the topic.

Conventional biology teaching methods, which are basically expository in nature, emphasize practical or investigative learning. However, they do not usually offer the learners with varied experiences and the necessary exposure for an appropriate balance in the development of cognitive ability, psychomotor skills and affective behaviours (K.I.E, 1992). Moreover, the various constraints experienced in practical work, often make most teachers to rarely engage learners in authentic practical activities (K.I.E, 1992). According to Keraro (2002), the learning opportunities provided in science lessons are inadequate for effective learning of science as envisaged within the constructivist framework. The nature and quality of teacher-pupil interaction in science lessons, also fail to actively promote the acquisition of science concepts and process skills.

Research on science education indicates that most teachers expect learners to accumulate biological knowledge. As such, teachers engage them in limited activities that are in the form of illustrative and confirmatory practical sessions used to prove theories. The quality of teacher-pupil interaction in the science lessons does not encourage active and meaningful learning to take place (Keraro, 2002). In a majority of cases, lessons are teacher dominated, implying an emphasis on the transmission view of learning as opposed to construction of knowledge (Kiboss, 2000). The relevance of biology in society has not

been adequately addressed in the teaching of biology lessons in our schools. In the past science has been depicted in schools as a list of statements, rules and laws to be copied down and learnt by rote (Bell & Gilbert, 1996). Teachers have often ignored the personal side of science and the way in which individuals, with all their different strengths and weaknesses, have contributed to our present state of knowledge (Parkinson, 1998). Science is changing and expanding as we learn more about ourselves and the universe we live in. Thus, to achieve effective teaching and learning, it is necessary to combine practical activities with a more cognitive approach to the learning process.

According to Driver, Asoko, Leach, Mortimer and Scott (1994), knowledge is built up by learners through active involvement in the learning process. It is not simply transmitted from the teacher to the learners but constructed by learners. Learners actively attempt to make sense of the new content by relating it to experience and present knowledge. As such, learners need sufficient models of the external world as prerequisites in order for them to make valid predictions about what will happen, independently of their own actions and to act on the environment in a purposeful way (Kiboss,, 2004).

One proposed solution for improving the cognitive ability and developing the psychomotor skills of students is to prepare them to become adaptive learners. That is, students should be able to apply what they learn in school to the various and unpredictable situations that they might encounter over the course of their work lives. Obviously, the traditional teacher-as-information-giver, textbook guided classroom has failed to bring about the desired outcome of producing thinking students. A much-heralded alternative is to change the focus of the classroom from teacher dominated to student-centred using a constructivist approach (Baron & Goldman, 1992).One such constructivist approach is co-operative or collaborative learning. Co-operative learning is based on the Vygotskian perspective that takes the formation of the mind as an essentially and inescapably socio-cultural process (Williams, 1989). In such a learning process, learner involvement facilitates personal growth and skills development. By being involved, learners feel a measure of empowerment (Ngesa, 2002). As such they feel safe to take responsibility for their own learning. This according to Forman (1993) is a method by which the creation and transmission of knowledge can effectively be approached as a genuinely collective enterprise, inextricably embedded in the on-going system of shared activity that enhances

learning in two ways: first by generating individual and shared knowledge and secondly by accumulating and transmitting shared knowledge

Co-operative learning is beneficial as it emphasizes peer interaction in the context of collaborative goals as opposed to individualistic and competitive goals of the regular classroom environment (Johnson & Johnson, 2000). It is indeed appropriate in our large, heterogeneous classes in which individual attention cannot be accorded to learners (Kiboss, 1997). This study therefore, is intended to investigate the contribution of co-operative learning on students' achievement and attitudes towards classification of organisms in school biology. A co-operative learning module was designed and its effects on the students' achievement and attitudes towards the topic classification of organisms investigated.

1.1 Statement of the Problem

Despite the efforts made to improve the teaching and learning of biology by basing the course as much as possible on practical investigation and demonstration, students' performance and attitude towards the subject continue to be poor (KNEC, 2000). A major contributing factor to this is the lack of learners' active involvement in the learning process which results from the teaching approaches adopted by biology teachers as being mainly expository in nature. Lack in active student participation during the learning process make learners passive or limit their activities to a few practical demonstrations. This tends to affect pupils' motivation and lead to the development of negative attitudes towards the learning experience. Thus, it is necessary to combine practical activities that give learners more opportunities and the development of science process skills in a socially interactive environment. Although the co-operative learning approach has been found effective, its effectiveness in the teaching of biology, especially in the area of classification of organisms has not been fully explored. Therefore, this study was designed to investigate the effectiveness of co-operative learning on students' achievement and attitudes towards the classification of organisms in school biology.

1.2 Purpose of the Study

The purpose of this study was to investigate the effects of a co-operative learning module on students' achievement and attitude towards the topic classification of living organisms in school biology.

1.3 Objectives of the Study

The following objectives were used to guide the study:

(i) To determine the effects of a co-operative learning module on students' achievement in classification of organisms in school biology.

(ii) To determine the effects of a co-operative learning module on students' attitudes towards classification of organisms in school biology.

1.4 Hypotheses of the study

The following null hypotheses were tested:

Ho1: There is no statistically significant difference between the achievement of students using the co-operative learning module and those using the conventional methods to learn classification of organisms in school biology

Ho2: There is no statistically significant difference between the attitudes of the students using the cooperative learning module and those using the conventional methods to learn classification of organisms in school biology.

1.5 Significance of the study

The traditional teaching method of teacher as sole information-giver to passive students appears outdated. The role of learners is reduced to passive recipients of information. The method fails to encourage students to work together, to share ideas and information freely with each other, to extend their intellectual capabilities (Cheek, 1992). One proposed solution for this problem is to prepare students to become good adaptive learners. Learners need to actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation (Yager, 1991). Students should be able to apply what they learn in school to the various and unpredictable situations that they might encounter over the course of their lives. A much-heralded alternative is to change the focus of the classroom from teacher dominated to student-centred using a constructivist approach. It is expected that the findings of this study may be useful in resolving the appropriate roles

that learners and the teachers should play in the learning process. The findings may also provide biology (and other science) teachers with an alternative approach that may help them improve the learners' attitudes towards the learning of biology, and thereby improve their performance in the subject. Provide

1.6 Assumptions of the study

The following assumptions were made in this study:-

1. Subjects in the selected groups would cooperate during the study and also provide genuine and accurate data.
2. Teachers in the selected schools would execute the co-operative learning approach effectively.

1.7 Scope of the study

The study focused on form three students studying biology. Schools in Nakuru District were involved in the study because this is one of the districts where science subjects are poorly performed in the KCSE examination (KNEC, 2000). The concept of classification of organisms is taught in form three though a brief introduction is done in form one (KIE, 1992). The effect of the students' prior knowledge was determined through a pre-test administered to two of the four participating groups (Koul, 1984; Borg, 1987). A total of 165 students were involved in the study for a period of five weeks. Four biology teachers from the four schools also participated in the study. The cooperative learning approach and regular teaching methods were used in teaching the experimental groups (E and C_2) and control groups (C_1 and C_3) respectively in the 'classification of organisms' topic in form three biology. This topic has been repeatedly cited as difficult for teachers and learners (KNEC, 1998, 1999, 2000).

1.8 Limitations and Delimitations of the Study

Conducting research may violate the rights and welfare of research participants without intent. According to Frankfork-Nachmas and Nachmas (1997), ethical issues that arise from the kinds of problem investigated and the methods used may affect the validity and reliability of the data obtain. In this study, the research problem involved the determination of student's achievement and attitude towards biology prior to and after instruction using a cooperative learning module. A quasi experimental design called Solomon-Four group design was used. The research process had stages that involved

ethical or scientific considerations. The study had the following limitations and delimitations;

i). The use of formally constituted intact classes prevented the random assignment of research participants to experimental and control groups prior to the research operation. This could have the effect of using unequal groups with different characteristics. The Quasi-experimental design used allowed the researcher to randomly select samples from the population which did not require the random assignment of individual cases to comparison group. According to Frankfort-Nachmas *et al* (1997) this designs are superior because they usually involve the study of more than one sample, often over an extended period of time. In this study, matching and randomization were used as a way of equating the experimental and control groups with identical characteristics. Extrinsic factors were controlled by the use of matching and randomization which helped to offset the effects of age, gender and level of education. Matching groups also helped to control intrinsic factors like history, maturation and experimental mortality.

ii). Secondly, the methods of data collection involved the testing of participants as well as seeking personal information from them. To minimize the effects of the anticipated limitations, individuals in this study were required to participate in the research project on their on volition. Respect for the right of self-determination and voluntarism was taken into account and respected. The Competence and Comprehension Professional Code of Ethics and Regulations guiding social science was closely observed during the research study (FrankFort – Nachmas & Nachmas, 1997). Use of control groups enabled the researcher to rule out other factors as rival explanations of the observed association between the variables under investigation. Such a factor could have invalidated the inference that the variables are causally related. Cook and Campbell, (1979) has termed this issue, the problem of internal validity which answers the question whether changes in the independent variable caused the dependent variables to change.

iii). The research design required exposure of the experimental group to conditions that may have been totally new and could therefore have negative effects on the

participants. To minimize this limitation the Quasi experimental Solomon four-group design was used in this study involved the use of pre-test and post-tests in an experimental setting. Use of pre-tests had advantages as well as disadvantages. Although it provided an assessment of the time sequence as well as a basis of comparison, it could have severe reactive effects caused by the sensitizing of participants (Frankfort-Nachmas & Nachmas, 1997). The reactive effect of testing was directly measured by comparing the two experimental groups (E and C_2) and the two control groups (C_1 and C_3). This comparison indicated that the treatment had an independent effect on groups that were not sensitized by a pre-test.

1.9 Definition of terms

The following are operational meanings of the terms used in the study:

Achievement: The realization of scores in achievement tests. In this study it refers to student attainment scores in the Biology Achievement Test (BAT).

Attitude: Students' acquired feeling that influences their choice of learning or student disposition towards biology as a result of the instructional style adopted by the teacher. In this study it refers to students' scores in the Student Attitude Questionnaire (SAQ).

Biology Achievement Test (BAT): A test instrument based on form three biology course content, which was used to assess the students' achievement in the classification of organisms course.

Co-operative learning: Refers to an instructional procedure in which learners are encouraged or required to work together collaboratively on a given task.

Conventional approach: A traditional instruction method where the teacher normally has total control of the entire lesson and where learner-to-learner interaction is minimal or absent.

Form three: This is the third year in the Kenyan secondary school education system.

Kenya certificate of education (KCSE): The credential awarded to candidates who have successfully completed the Kenyan secondary education system.

Module: A standard format organized for use in instruction of learners in a section of their course. In this study it refers to work plan used in cooperative learning lessons on the topic classification of organisms in secondary biology.

Student Attitude Questionnaire (SAQ): A questionnaire that was adopted and used to assess student acquired feelings towards the teaching and learning of classification lessons in school biology.

CHAPTER TWO
REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter includes a review of literature that mainly focuses on the nature of science and science education worldwide. Particular consideration and attention has been paid to Kenyan secondary schools. It further looks at the biology curriculum in the Kenyan schools as well as the effects of the conventional teaching methods and co-operative learning in schools. In this review emphasis being laid on research findings of studies where co-operative learning has been effectively used in enhancing learners' achievement and attitudes towards science in general and Biology in particular. Finally the conceptual framework that guided the study has been discussed.

2.1 Science and Science Education

The word science is a noun derived from a Latin term *sciential*, meaning knowledge or knowing (Ross, 2000). According to Ross, science is a process or way of arriving at a solution to a problem or understanding an event in nature that involves testing possible solutions. Science is distinguished by how knowledge is acquired, rather than the act of accumulating facts. Ross therefore defines science as a particular way of investigating the world and notes that not all investigations are scientific. Science is devoted to discovering the general principles that govern the operation of the physical world. Scientists are observers and through their observations they determine the general principles that govern our physical world. The way of discovering general principles by careful examination of specific cases is called inductive reasoning. Inductive reasoning first became popular about 400 years ago, when Isaac Newton, Francis Bacon, among and others began to conduct experiments and from the results inferred general principles about how the world operates (Johnson, 2000). Their experiments were sometimes quite simple but they enabled them to draw the following conclusions:

i. Observation is essential in Science investigations.
ii. General principles should be inferred from the observations.
iii. These principles are the bases of hypotheses.

Science uses inductive reasoning to infer general principles from detailed observation. According to Johnson (2000), scientific investigations are carried out in six stages. These stages are:

(i) Observation - Careful observation is the key to any successful scientific investigation. It involves studies that enable one obtain details of a given phenomena. Records of observations should be carefully made.

(ii) Hypothesis - This is an intelligent guess to explain an observation. Alternative hypotheses are other guesses put forward for the explanation.

(iii) Predictions – These are the expected consequences which can be reasonably expected.

(iv) Testing – Tests are set out attempting to verify some of its predictions. Experiments are usually set out and their results studied.

(v) Controls – Many factors may influence set experiments. These factors are called variables. To evaluate alternative hypotheses about one variable, all other variables must be kept constant so that we do not get misled or confused by these other influences. This is done by carrying out two experiments in parallel. In the first experimental test, we alter one variable in a known way to test a particular hypothesis, in the second, the control experiment; we do no alter that variable. In all other respects the two experiments are the same.

(vi) Conclusion – A hypothesis that has been tested and not rejected is tentatively accepted. A collection of related hypotheses that have been tested many times is called a theory.

As can be seen, science progresses by systematically eliminating competing hypotheses that are not consistent with observation. In science, hypotheses that stand the test of time, their predictions often tested and never rejected, are sometimes combined into general statements called theories. A theory is a unifying explanation for a broad range of observations. Examples of theories include the theory of evolution, theory of speciation, the theory of bio-organic origin of life and the theory of gravity. (Alters, 1996).

Education, on the other hand, means the process of acquisition and development of knowledge, skills and attitudes (Oluoch 1982). It does not include training which in

most cases occur after one has received education. There is basic education in which knowledge, skills and attitudes gained are considered essential if one is to take charge of one's life in a society and be capable of learning higher education or further education. In Kenya basic education means primary education whereas it means pre-school or lower primary in other places. Oluoch identifies curriculum as all that is planned to enable the students acquire and develop the desired knowledge, skills and attitudes. He further asserts that a school curriculum is composed of specific elements. These elements can be summarized as:

(i) Objectives - the statement of objectives should be clear, precise, easy to understand and communicate and be in behavioural form.

(ii) Learning activities - Acquiring and developing desired knowledge, skill and attitudes, occurs as a result of the students carrying out learning activities.

(iii) Statement of learning activities through which desirable learning will be expected to take place.

(iv) Student assessment - Learning activities that are related to final assessment are undertaken enthusiastically by learners and are therefore a powerful learning tool which can be used with great advantage in the teaching and learning process. Assessment activities also help in the determination of the degree to which the learning objectives are being or have been met. Assessment can promote or thwart achievement of learning objectives.

From time immemorial all human societies have displayed a special interest in the education of their children. In most cases, during traditional times, societies tended to be small population–wise; being ethnic communities that often lived in relative isolation from each other (Bennaars, 1993). Education in these circumstances manifested, above all, a social function. It was primarily concerned with preparing the young for adulthood in their communities. Such induction into communal life served the purposes of guaranteeing social stability within the community in question. Traditional education in Africa, Europe, Asia and elsewhere was then strongly community oriented. According to Bennaars, education sought to integrate all members, young and old, by means of a collective orientation. At the same time such education was also highly particularized, restricted as it was to a single. In traditional times the African child was educated by the community for membership of a particular

community. Education in this broad sense was largely a matter of socialization, learning to be a member of a social group, be it the family group or the wide community.

Child upbringing was therefore a shared responsibility of all adults in the community. As the child went through the process of formation, he/she became socially integrated into the lineage and into the age-group. Throughout this process well defined rites and ceremonies reiterated the communal concern with the education of the young. According to Bennaars, Otiende & Boisvert (1994), the communal role of societies can be summarized as:-

(i) The collective or social nature of traditional education as well as the communal concern that accompanied it.

(ii) The close the between traditional education and social life in all its aspects; political, economic, religious, moral etc.

(iii) Its multivalent character, both in terms of the goals and the methods employed.

(iv) It conformity to the successive stages of child development; physical, emotions, social, moral and mental.

Elaborating on these, Bennars (1993) identified a number of educational objectives as being typical of African traditional education. Such education intended to develop the child's character, physical and intellectual skills, to provide vocational training and to promote a healthy attitude to work. It further sought to inculcate respect for elders and for those in authority, to foster a sense of socio- cultural belonging and participation. As Bennaars *et al* (1994) asserts the African indigenous education was rooted in the socio-cultural and geographical contexts of pre-colonial African societies. It was mainly informal and non-formal in structure. On the one hand, the informal education was participatory in nature and based on listening to stories, songs and poems or playing games and taking active roles in society on the other hand, the youth in non-formal education learnt through apprenticeships where learning was by participation, observation and imitation. All learning was therefore relevant to the contemporary society's aspirations, goals and needs.

Wanjohi (1981) adds that education also had a cultural function. Education was tailored to achieve the various cultural objectives. The first was the transmission of a heritage

from one generation to another. Education aimed at assuring continuity, at being the instrument by which civilizations perpetuated themselves. Through education, members of a society, who were also carriers of that culture, made sure that the behaviours necessary for the survival of the latter were learnt. In some ways education appeared like culture itself - transmitting, perpetuation, and actualizing itself in each new generation. It availed itself of everything – its organization, its resources, it genius – in order to ensure its perennial character. Secondly, the traditional education can be considered statistically. As such, it appeared as the heritage and the equipment that the individual received in order to be able to integrate himself into his community. It provided a language, a body of knowledge, a scale of values, a general framework of thought and reference, a sensibility, an "ethos", and a *savor – vivre.*

Finally, even in the most traditional and stable civilizations, education is seen as a factor of social change. The mental universe of a generation is never quite identical to that of preceding or future generation. Secondary institutions act upon primary institutions and especially so in the modes of socialization.

But on the contrary, the current science education is highly structured in that learning is expected to occur in specified places, timeframe and is systematic. In other words science education has concerned itself almost exclusively with processes and procedures rather than the ultimate product - the learner (Newton, 1988; Ndirangu, 1991). Therefore, there is a need to reform it to give greater relevance to life and to the societal needs.

The trend of science education in most developing countries seems to focus more on the learning of abstract scientific principles and theories that are not relevant to the countries' socio-economic potential or requirements and/or needs (Ogunniyi, 1998). According to Odhiambo (1999), Science education, at all levels, must be revamped, and with gender parity, so as to establish an atmosphere which well enhance Africa's capacity and capability to develop and sustain basic and applied sciences, towards meeting the needs and challenges of the 21st Century. Odhiambo asserts that African nations must nurture an environment which attracts talent towards the basic and applied science. The African community should also recognize and reward scientists, as part of

the long term deliberate efforts to promote and retain the continents human capital. Science must also be harnessed as a means for economic growth, in accordance with the acceptable moral and ethical obligations

According to the educational research by Maryland Teacher Preparation Organizations American children lag far behind in achievements tests, especially those in the math and science (Raizen & Michelsohn, 1994). Unfortunately, the situation is even worse in most African schools. Studies show that even students who score well on standardized tests often are unable to successfully integrate or contrast memorized facts and formulae with real-life applications outside the school room (Yager, 1991). Resnick (1987) has commented that practical knowledge (common sense) and school knowledge are becoming mutually exclusive; many students see little connection between what they learn in the classroom with real life.

Kenyan's achievement in education has been amongst the most dramatic and rewarding since independence on 12the December 1963 (Ministry of Education 1967). There has been a great surge of enthusiasm and interest which has resulted in the most substantial growth in the number of schools, students and teachers, in the development of entirely new institutions, and the launching of new ideas. The purposes of education go beyond those of developing individual talents, skills, knowledge and character. The education system has important social functions to perform. Out standing among these have been the tasks of forging National Unity and of producing the educated people to provide the country with indigenous leadership and skills. According to Ministry of Education, (1967), the secondary level of education is perhaps the one that has required the greatest attention from the government since independence. This is because Kenya was left in a highly unprepared state for independence from the point of view of the availability of indigenous skills and experience.

The main objective of secondary school education in Kenya is to prepare learners for self-reliance, training and further education (KIE, 1992; Bogonko, 1992). In order for all members of society to participate fully in nation building, knowledge of science is essential (Keraro, 2002; Wachanga, 2002). Learners who terminate formal education

after form four are expected to have the necessary practical knowledge and skills that they can utilise in life, while the rest should be well prepared for vocational training or further education. This is in line with the goal of education which focuses on laying a firm foundation for the development of self-discipline, integrity, adaptability, co-operation and patriotism and thereby prepares learners for their future (Newton, 1988; Okere, 1996). In other words science education should prepare learners in all aspects of life: mental, social and physical. This calls for varied experiences that facilitate the development of critical thinking and creative problem solving at an early stage of their formal education (D'Souza, 1987; Bogonko, 1992; Ogunniyi, 1998).

Several factors have been cited as being a hindrance to the successful teaching and learning of science in secondary school science (Changeiywo 2000; Ndirangu, 1991; Kiboss, 1997). The literature suggests that relatively few teachers routinely use computer-based technologies for instructional purposes. In addition there seems to be doubt about the pedagogical validity of using some of the newer technologies since the appearance of literature about these tools is relatively recent and scarce. They further note that there is lack of appropriate materials, particularly integrated media materials suitable for teacher education instruction; and clear programmatic goals for the teacher education program as a whole absent.

2.1.1 Limitations of Science.

Science is a way of thinking and seeking information to solve problem. Therefore, the scientific method can be applied only to questions that have factual bases (Ross, 2000). Questions concerning morals, value judgments, social issues, and attitudes cannot be answered using the scientific method. These include greatness in painting, good music, good wine, attractive colour among others. According to Johnson (2000), scientific study is limited to only organisms and processes we are able to observe and measure. Supernatural, religious, and unpredicted phenomena are beyond the realm of scientific analysis because they cannot be scientifically studied, analyzed, or explained. To some individuals, a non-scientific point of view may have a moral, religious or aesthetic value. However, scientists in their work are limited to objective interpretations of observable phenomena.

As Johnson (2000) asserts, science is also limited by the ability of people to pry understanding from the natural world. People are fallible and do not always come to the right conclusions because information is lacking or misinterpreted. But science is self-correcting, as new information is gathered; old incorrect ways of thinking must be changed and discarded. In summary, there are practical limits to what science can accomplish. While scientific study has and continues to revolutionize our world; it cannot be relied upon to solve all problems. For example if we pollute and squander our resources today, hoping that science will solve our problem in future, we may end with disappointment since science cannot solve problems like restoration of extinct species.

Theories are solid ground of science of which we are most certain. There is no absolute truth in science, however, only varying degrees of uncertainty. The possibility always remain that future evidence will cause a theory to be revised. A scientist's acceptance of a theory is, therefore, always provisional. For example, in another scientist's experiment, evidence that is inconsistent with a theory may be revealed. As information is shared through out the scientific community, previous hypotheses and theories maybe modified, and scientists may formulate new ideas. Very active areas of science are often alive with controversy, as scientists grope with new and challenging ideas.

Science may provide information about why populations grow and which actions will have the greatest effect to slow population growth. Science can also develop methods of conception control that would limit a person's ability to reproduce. The process has become known as the scientific method (Ross, 2000). The scientific method is a way of gaining information, or facts, about the world by forming possible solutions are valid by being meaningful, convincing, sound, and satisfactory and can be confirmed by others. Science endeavours to distinguish between situations that are merely related (happen together) and those that correlated and show a cause-and-effect relationship e.g. thunder and lighting.

2.2 The School Biology Curriculum

Biology as a scientific discipline, is broadly speaking, the study of living things. According to Ross, (2000), it draws on chemistry and physics for its foundation and applies these basic physical laws to living things. Due to the many kinds of living

things found on earth, there are many special areas of study in Biology. Practical biology; – such as medicine, crop science, plant breeding and wildlife management – is balanced by more theoretical biology, such as medical microbiological, physiology, photosynthesis biochemistry, plant taxonomy, and annual behaviour (ethology). Fun seeking individuals may practice insect collecting and bird watching. Specifically, biology is a science that deals with living things and how they interact with their surrounding.

2.2.1 The Nature and Value of Biology

To a great extent human beings owe their current high standards of living to advances biological inventions in two areas; food production and disease control. According to Johnson, (2000), plant and animal breeders have developed organisms that provide better sources of food than the original varieties. In food production the control of plants and animals that compete with or eat the organisms we use as food have been very successful. Control of insects and Fungi that weaken plants and reduce yields is as important as invention of new varieties of plants.

As Johnson (2000) note, there has been fantastic progress in the area of health and diseases such as polio, whooping cough, measles and mumps can be easily controlled by vaccination. The understanding of how the body works has led to treatments that can control such diseases as diabetes, high blood pressure, and even some kinds of cancer. The future will be influenced by issues on: electromagnetic radiation from electric power lines; computer monitors and microwave ovens; effects on living things; whether DNA testing is reliable enough to be admitted as evidence in court cases; whether the pill that can be used to control a person's weight can be made; whether genes can be manipulated to control diseases; the effect of the thinning ozone layer and skin cancer incidences and whether an AIDS vaccine will be developed in the next ten years.

Biological Science has aesthetic value in the learning and advancing of science. According to Taylor (2000), science emerges from our curiosity and drive to understand ourselves, the world, and the universe. As Alters (1996) notes, scientists study the natural world by using scientific methods, which most often include making observation, developing hypothesis to explain those observations, and then testing those

hypotheses. Scientific explanations that are supported by overwhelming evidence over time are called theories. These are powerful concepts that help scientists make dependable predictions about the world. Rising out of the abundance of scientific explanations are many themes regarding the natural world. An example of this is modern taxonomy, which is the classification of the diverse array of living things, categorizes organisms based on their common ancestry.

Asking questions about nature and believing that those questions are answerable provide the basis of Biological Science. Studies in biology usually include a control, an unaltered system or group of organisms that permits the testing of the effect of a single variable in the experimental group. Facts, in the form of observation and experimental results and conclusions, are prerequisites of Biological Science, but the new ways of organizing and relating those facts advance Science. Science is characterized as progressive and with self correction. Scientists build on the work done by others, refining or refuting their ideas, both cooperating and competing with each other.

As a component of school science, Biology makes an important contribution to the provision of breadth, balance and coherence to science. That contribution is possible because of the unique differences between the nature of biological experimental designs and those in other sciences (Shayer & Adey, 1981). Shayer *et al* argue that biological experimental designs are usually sophisticated and demanding hence concepts involved can only be understood at a number of different levels. This is made possible by the numerous inter-relationships that exist between topics at low, intermediate, and higher levels. According to Taylor (2000), Biological organisation is based on a hierarchy of structural levels, ranging from atoms, through biological molecules, organelles, cells, tissues, organs, organ systems, organisms, populations, and communities to ecosystems. The study of biology includes understanding these levels of biological organization and the connection between them. The levels also allow many different starting points and sequences making it possible for the subject to be divided into many areas of study.

Secondary school biology is divided into such areas in form of topics which are used as a guide for teaching. Here the teacher has opportunities to show personal initiative in the subject area. Practical activities suggested at the end of each topic are expected to

offer learners opportunities to develop science process skills. Brown (1995) identifies three reasons, why laboratory based work should be emphasized in science teaching. First is that science involves highly complex and abstract subject matter, which learners can only comprehend through the manipulation of concrete materials. Students' participation in actual investigation helps develop their inquiry and intellectual skills. Secondly, laboratories have been found to offer unique contexts for identification, diagnosis and solving students' misconceptions. Finally, students usually enjoy activities and practical work when offered a chance to experience meaningful experiences that may in turn make them interested in sciences.

In the current practice, however, practical work is mainly used to illustrate scientific work where learners are involved in a series of structured activities in specific knowledge or content. According to Newton (1988), teachers lay emphasis on routine, correct answers, and confirming what is taught. Keraro (2002) also asserts that the quality of teacher-pupil interaction in science lessons does not encourage active and meaningful learning to take place. Lessons are teacher dominated implying an emphasis on the transmission view of learning as opposed to the construction of knowledge. Furthermore, an analysis of the general teaching styles of science teachers by Alsop and Hicks (2001) showed that Biology teachers were more likely to adopt a fact oriented non-practical approach than their physics and chemistry colleagues. Such a situation is aggravated even more by the many problems faced in Kenyan secondary schools which range from lack of appropriate resources to inadequate number of qualified teaching personnel and lack of clear educational policy on science (Changeiywo, 2000). Due to these problems most teachers adopt the conventional methods of teaching in which over 85% of the instruction in our schools consist of lectures and competition in which students are isolated from one another and are not given the chance to interact (Johnson & Johnson, 1997).

2.2.2 The Relationship Between the Teaching and Learning of Biology

Factors which affect the status of the teaching profession in African countries include the fact that most teachers were initially the main sources of knowledge (Ogunniyi, 1996). The teachers had access to books and periodicals. They also knew how to convey knowledge professionally to those who went to their classes. But the newspaper, radio, television, books and professional experts can now provide the

knowledge which the teacher alone used to provide. Thus the unique role of the teacher has now been enhanced by these new communication media.

Brown and Atkins, (1991), have identified effective teaching as one of the preliqusites to learning. According to Brown *et al* (1991), teaching should have the following characteristics;

(i) Effective teaching is intellectually demanding in that it requires the teachers to know, in a deep sense, the subject being taught. To teach effectively you need to be able to think and problem solve, to analyse a topic, to reflect upon what is an appropriate approach, to select key strategies and materials and for organize and structure ideas, information and task for student.

(ii) Effective teaching is socially challenging in that it takes place in the context of a department and institution which may have unexamined traditions and conflicting goals and values. Most important of all effective teaching requires the teacher to consider what the students know, to communicate, and perhaps in their turn, to stimulate their teachers.

(iii) Effective teaching is not solely dependent upon teachers. Students too have responsibility to learn. A powerful way of improving teaching is to improve the ways in which students learn. The content of learning may be facts, procedures, skills and ideas and values. Goals of teaching and learning, therefore, may be gains in knowledge and skills, the deepening of understanding, the development of problems solving or charges in perception, attitudes, values, and behaviour. (Student's goals may, of course, be more pragmatic, like passing examinations).

2.3 The Topic "Classification of Organisms" in School Biology

In 1970 the biologists at the Smithsoman Institution, estimated that there are over thirty million species in the world (Johnson, 1971). Approximately 1.5 million of these have been named. Assigning of names to these species is important to enable Scientists all over the world to communicate and share information effectively. In the Scientific community, accuracy is essential; and therefore local names cannot be effectively used. Taxonomy is the Science of naming organisms and grouping them into logical categories. Various approaches have been used to classify organism ranging form the Greek philosopher Aristotle (384-322 B.C.) to the modern system of classification by

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Carolus Linnaeus (1907–1978). Linnaeus introduced the binomial system of nomenclature. In this system two Latin names, genus and specific epithet, is used for each species of organism. The unique name given to particular type of organism is called its scientific name. In addition to assigning a specific name to each species, Linnaeus recognized a need for placing organism into groups. This system divides all forms of live into Kingdom, the largest grouping used in the classification of organisms. Originally there were two Kingdoms, *plantae* and *animalia*. Today most biologists recognize five kingdoms of life. As Johnson notes, the classification of organism requires constant rethinking and reorganizing of new information. Classification of Organisms in School Biology is important to learners who study organisms throughout their course in biology. However learners find the science of naming organisms and grouping them to their respective taxa very exigent. The subject matter is divided into different aspects that learners amass and construct into a whole concept. The topic therefore requires that learners actively participate rather than teachers transferring their thoughts and meanings to the passive student.

2.4 The Concept of Learning and Learning Theories

Within the Science of Psychology, Learning has the status of a "Construct" (Johnson, 1971). Constructs are ideas or images that cannot be directly observed, such as electrons and genes. What we observe, however, are "dial readings" of one sort or another and, when certain patterns of reading appear (our measurement) we use these words to account for them. For our understanding of learning we depend on a relationship between time and performance. More precisely, learning is defined in psychology as a relatively permanent change in behavior as a result of practice (some would say reinforced practice). There is a distinction between learning and instruction. Learning is a term used to mean a situation in which a change in behavior has been described or explained. The term instruction means situations in which behavioral change is accomplished. This is accomplished according to specific criteria of efficiency. When instruction is successful, we have learning. The term learning is used when we intend to understand behavior while term instruction is used when we are trying to arrange conditions for effective learning. There are various forms of learning

2.4.1 Constructivist Theory of Learning and its Effects on Learning

Constructivism is not a new concept. It has its roots in philosophy and has been applied to sociology and anthropology, as well as cognitive psychology and education. Perhaps the first constructivist philosopher, Giambatista Vico, 1710, commented in a treatise in that "one only knows something if one can explain it" (Yager, 1991). Immanuel Kant further elaborated this idea by asserting that human beings are not passive recipients of information. Learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation (Cheek, 1992).

Focusing on a more educational description of constructivism, meaning is intimately connected with experience. Students come into classroom with their own experiences and a cognitive structure based on those experiences. These preconceived structures are valid, invalid or incomplete. The learner will reformulate his/her existing structures only if new information or experiences are connected to knowledge already in memory. Inferences, elaborations and relationships between old perceptions and new ideas must be personally drawn by the student in order for the new idea to become an integrated, useful part of his/her memory. Memorized facts or information that has not been connected with the learner's prior experiences will be quickly forgotten. In short, the learner must actively construct new information onto his/her existing mental framework for meaningful learning to occur.

According to Crowther (1997), it is important to understand the underpinnings for a constructivist learner setting and how do it differs from a classroom based on the traditional model (sometimes referred to as the objectivist model). Crowther notes that the current American classroom, whether grade school or college level, tends to resemble a one-person show with a captive but often comatose audience. Classes are usually driven by "teacher-talk" and depend heavily on textbooks for the structure of the course. There is the idea that there is a fixed world of knowledge that the student must come to know. Information is divided into parts and built into a whole concept. Teachers serve as pipelines and seek to transfer their thoughts and meanings to the passive student. There is little room for student-initiated questions, independent thought or interaction between students. The goal of the learner is to regurgitate the accepted explanation or methodology expostulated by the teacher (Caprio, 1994). The

situation is not any different in the Kenyan secondary schools (Changeiywo 2000, Kiboss 1997)

In a constructivist setting, knowledge is not objective; mathematics and science are viewed as systems with models that describe how the world might be rather than how it is (Lord, 1994). These models derive their validity not from their accuracy in describing the real world, but from the accuracy of any predictions which might be based on them (Postlewaite, 1993). The role of the teacher is to organize information around conceptual clusters of problems, questions and discrepant situations in order to engage the student's interest. Teachers assist the students in developing new insights and connecting them with their previous learning. Ideas are presented holistically as broad concepts and then broken down into parts. The activities are student centred and students are encouraged to ask their own questions, carry out their own experiments, make their own analogies and come to their own conclusions.

Clearly, a lesson based on constructivism differs greatly from the traditional "teacher-as-lecturer" class type. The effectiveness of the constructivist theory of learning has been evaluated and a few studies will be summarized. In one evaluation (Caprio, 1994), the constructivist approach was employed and compared to the traditional lecture-lab format for the second semester of a two-semester anatomy and physiology sequence in a community college. The two student groups were matched for academic ability and prerequisites. Both courses were night classes and most of the students were hoping to major in health-career programs. The testing instrument was the first exam. The same exam was given to both sets of students at midterm. A drawback to the study was that the two groups us re studied seven years apart. The results showed that better exam grades were obtained by students taught by the constructivist methodology. The average exam score for the constructivist group was 69.7% ($N = 44$) while that taught by the traditional lecture-lab method was 60.8 % ($N = 40$). A t-test showed that the grade difference was significant ($p > 0.99$).

Caprio (1994) also offered many personal insights on his perception of student learning. The students in the constructivist group seemed more confident of their learning and he gave them more material for independent learning. The investigator found that this was

necessary since constructive teaching methods are more time-consuming. This was done only with secondary topics. The students in the constructivist class seemed to like class better, had more energy and took more responsibility for their learning.

Another constructivist Carey (1981) probed the nature of student views on scientific inquiry. In this study grade 7 students were rated by interviews on a scale of 1 to 3 about their conception of how science is investigated before and after a constructivist style learning unit on the topic. Prior to the unit, most students fell in the Level 1 category. Level 1 students view science as a way of understanding facts about the world. After the learning unit, most of the students had moved to a Level 2 understanding; they saw scientific inquiry as being guided by questions and ideas. The also understood the difference between an idea and an experiment. Level 3 understanding was achieved only by a few students. At this level, the student understands the cyclic, cumulative nature of science and recognizes the goal of science as the construction of deeper explanations of the universe. Carey concluded that, despite instruction in the scientific method in the traditional mode, many students do not understand the nature or purpose of scientific inquiry. Science is seen as a random activity that has little meaning in real life.

In summary, constructivist teaching offers a bold departure from traditional objectivist classroom strategies. The goal is for the learner to play an active role in assimilating knowledge onto his/her existing mental framework. The ability of students to apply their school-learned knowledge to the real world is valued over memorizing bits and pieces of knowledge that may seem unrelated to them. The constructivist approach requires the teacher to relinquish his/her role as sole information-dispenser and instead to continually analyze his/her curriculum planning and instructional methodologies. Constructivists view learning as the result of mental construction. Students learn by fitting new information together with what they already know. People learn best when they actively construct their own understanding. In constructivist thinking learning is also affected by the context and the beliefs and attitudes of the learner. Learners are encouraged to invent their own solutions and to try out ideas and hypotheses. They are given the opportunity to build on prior knowledge. Today constructivist teaching is

based on recent research about the human brain and what is known about how learning occurs.

2.5 The Effects of Teaching and Learning of School Biology on Learners Achievement

The KIE has recommended the adoption of a biology teaching approach that emphasises a practical approach employed to make learning more meaningful to learners (KIE, 1988). As such, learners are expected to be involved in practical investigations, project designing, discussions and other problem-solving activities. This calls for heuristic teaching approaches that provide students with the opportunity of generating new information, organising it and presenting it in a logical order. However, Ndirangu (1991) and Ogunniyi (1998) have both observed that most African countries have failed to effect the appropriate teaching approaches in which the learners are actively involved in the learning process. Moreover, the prevailing conventional teaching methods, that are predominantly teacher-centred, have been variously cited as contributing to the dismal performance in science subjects (Tsuma, 1998; Changeiywo, 2000). Definitely such approaches to teaching contribute to the students' negative attitudes towards science. This is not unrelated to the continued poor students' performance at the Kenya certificate of Secondary Education (KCSE) in biology and other science subjects. Table 1 summarises the performance of both theory and practical papers between 1997 and 2000.

Table 1:

A Summary of the Performance of Candidates in Papers 1 and 2 of Biology between 1997 and 2000 in Kenya certificate of secondary education (KCSE)

Year	Paper	Candidature	Maximum score	Mean	SD
1997	231/1		100	36.39	14.19
	231/2	74,532	60	13.31	6.59
	Overall		160	49.35	19.49
1998	231/1	84,015	100	37.70	14.65
	231/2		60	10.68	5.16
	Overall		160	47.66	19.00
1999	231/1	93,361	100	33.01	14.20
	231/2		60	16.83	7.33
	Overall		160	49.93	19.93
2000	231/1	109,414	100	27.25	13.77
	231/2		60	17.66	6.99
	overall		160	44.50	18.80

Source: KNEC (2001)

From table 1, it can be inferred that the students' achievement in biology is poor. There has been poor performance for the last three years. The overall mean score range from 27.82% in 2000 and 31.21 % in 1990, yet biology is a key subject for learners aspiring for courses like medicine and pharmacy and other related fields. As noted earlier, conventional teaching methods continue to dominate our science instruction. These methods of teaching are instructional strategies in which the teacher controls the entire lesson and the learner-to-learner interaction is minimal or entirely missing (Cangelosi, 1997). Such teaching methods have been identified as contributing to reduced student participation and motivation in learning (Ogunniyi, 1998; Tsuma, 1998; Changeiywo, 2000). As noted earlier, these methods continue to dominate in biology lessons as teachers rush to cover the syllabus.

The common conventional methods used in biology include the question and answer method, lecture method, discussion method, demonstration method, field trips/excursions and assignments.

2.5.1 The Question and Answer Method

The question and answer method is perhaps the oldest and most common method used by teachers (Bennaars, Otiende & Boisvert, 1994). It is usually used to assess whether students have understood the facts and information presented to them during the lesson. This method has been cited as ideal for developing the process of thinking, guiding enquiry, judging the students understanding and discovering how much previous knowledge the students have learnt (Johnson, 2000). Good questions are those that encourage students to find links between ideas, draw differences, explain facts, and make judgements or generalizations, interpret, apply skills and understanding to the solving of problems and analyse situations. Although the questions often asked are suitable for developing learners' analytical and critical thinking, most teachers avoid asking probing questions (Keraro, 2002). They also do not encourage their pupils to ask any questions. Hohn (1995) attributes the shortfalls in the use of this method the system of education that gives too much importance to national examinations and not actual acquisition of concepts and development of skills.

2.5.2 Lecture Method

The term lecture was derived from the Medieval Latin word "Lecture" which means to read aloud (Brown, 1995). In the fifth century BC, the Greeks had lectures that consisted of oral reading of texts followed by a commentary. By the nineteenth century demonstrations, pictures and blackboards were used in lectures in science as well as medicine. Today it is still the lecturers in Science, Engineering and Medicine who are the more active users of audio–visual aids. In some situations the lecturers maybe the major source of information since they may be only ones who have access to texts and articles in the major languages of the world. These facts suggest that lectures are likely to be widely used well into the twenty–first century. Hence the importance of exploring ways of making lectures more effective as well as economical in the years ahead.

The weaknesses of lectures include:

(i) Inaudibility, incoherence, no emphasizing points, poor blackboard work

(ii) lecturers–saying too much too quickly, assuming too much knowledge, usually no summary, not indicating when making an aside or a main point, difficulty in timing the length of lecture.

This method is popularly used in high school, colleges and universities, especially with large groups. According to Bennaars, *et al* (1994), it is a process of delivering knowledge to students verbally, using a pre-organised outline. It is mostly a one-way communication approach. The lecture method is not recommended for high school though it may be used sparingly in upper forms to prepare learners for college and university entry (Race and Packard, 2000). Additionally, the traditional teaching method of teacher as sole information-giver to passive students appears outdated. In a study on undergraduates in a large lecture hall setting, Bell and Gilbert (1996), found that only 20 % of the students retained what the instructor discussed after the lecture. The students were too busy taking notes to internalize the information. They noted after a lecture has passed eight minutes, only 15 % of the students are paying attention. Furthermore, their Project 2061 charges that the "present curricula in science and mathematics are overstuffed and undernourished. They emphasize the learning of answers more than the exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understanding in context, recitation over argument, reading in lieu of doing. They fail to encourage students to work together, to share ideas and information freely with each other, or to use modern instruments to extend their intellectual capabilities."

Other limitations of Lectures include the following:

(i) Facts are retained as ends in themselves.

(ii) They cannot be used to teach certain concepts as those related to attitudes and psychomotor skills.

(iii) Social learning is minimized during oral presentations.

(iv) Compression by learners is usually minimal.

Lectures can be made more effective by:

(Being short to last between 5-10 minutes since attention span of student is short.

(i) Use of word within vocabulary of students.

(ii) Relate lectures to students' background, knowledge, skills and interests to ensure that students are kept attentive.

(iii) Supplement lecture with simple visual aids such as specimens, pictures and sketches.

Advantages of the lecture method include saving time and wide content coverage. However, it does not encourage learner participation and creativity.

2.5.3 Discussion Method

The discussion method is a valuable teaching technique that involves active student participation and provides a vehicle by which learners may develop social skills and effect attitudinal changes. This method differs from question and answer method in that learners can effectively engage themselves productively even in the absence of the teacher. Well organised discussions help learners to accumulate facts, which they can eventually use in solving different academic, social and economic problems (Kiboss, 1997). In large groups, however, there is no opportunity for all to participate in a discussion. Walkin (1982) notes that feelings of inhibition increase with group size and it becomes necessary to limit groups to 3, 4 or 5 members for fruitful discussions. In normal class discussions the groups should not exceed eight members to reduce such inhibition.

2.5.4 The Demonstration Method

The demonstration method mainly utilises real objects and audio-visual technology to enhance learners' ability to conceptualize facts. The teacher uses this approach to explain, emphasize or specify a topic or subject. In biology, demonstration is more prevalent in the laboratories where it is used to explain how machines and apparatus should be handled. It also enables teachers to illustrate experiments involving dangerous chemicals or where materials and equipment are inadequate. Though demonstration is economical in terms of time and money, it denies learners the opportunity to discover new experiences, to participate fully in the activity and to manipulate objects actively.

2.5.5 Field Trips/Excursions

Field trips or excursions are organised visits to specific places of interest outside the classroom. The teacher initiates the trips after consideration of the needs and interests of the students. Usually students are particularly keen on visiting places where they can see for themselves the things they have discussed in class. Trips enable learners to relate what they have learnt in class to what they can see in reality thus broadening their general knowledge and education. When carefully organised, trips can provide learning experience in particular subject areas as well as promote social contacts between students and teachers. However, study trips require a lot of time for planning and organising and are often expensive. They are therefore rarely used in schools.

2.5.6 Assignments

Sometimes, teachers give students work to do in particular subject areas after formal class hours. This may be in the form of homework or part of the unfinished classroom work to be done after school activities. According to Bennaars, Otiende and Boisvert (1994), this method is quite popular in schools and is often used as a form of assessment. The work to be done may be selected by the teacher or in some cases by the students with the teacher's approval. The time spent on assignments cannot be specified but students may be rewarded at the completion of assignment with a grade. Assignments have various advantages, which include providing students with an opportunity to develop skills for self-study, individualized learning and report writing. They also train students to become responsible and self-reliant. However, assignments may be disadvantageous to weak students who can develop negative attitudes towards the subject. Moreover, such students may end up copying from better students.

2.6 Modern Approaches to Teaching Science

A teaching approach refers to the strategy or technique the teacher applies in order to achieve the desired end or attain the desired objectives. According to Thornburg, (1992), many such techniques may be applied to any area of science; however the two approaches that are most applicable to the Biological Sciences are the inquiry and discovery approaches. The original Schwab's inquiry approach was developed in conjunction with his Biological Sciences Curriculum Study work (Parkinson, 1998).

2.6.1 Inquiry Approach

The essence of the inquiry approach is to teach pupils to handle situations which they encounter when dealing with the physical world by using techniques which are applied by research scientists (Tsuma 1998). Inquiry means that teachers design situations so that pupils are caused to employ procedures research scientists use to recognise problems, to ask questions, to apply investigational procedures, and to provide consistent descriptions, predictions, and explanations which are compatible with shared experience of the physical world. "Enquiry" is used to refer to all other questions, probes, surveys, or examinations of a general nature so that the terms are not be confused.

Inquiry tends to imply a constructionist approach to teaching science. Inquiry is open-ended and on-going. There are a number of teaching strategies which can be classified as inquiry. However, the approaches have a number of common aspects. The rationale for the inquiry approach has strong support from constructivist psychology. The teacher applies procedures so that:

(i) there is a primary emphasis on a hands-on, problem-centred approach;

(ii) the focus lies with learning and applying appropriate investigational or analytical strategies. This does not have anything to do with the use of the so-called "scientific method".

(iii) memorising the "facts" of science which may arise is not as important as development of an understanding of the manner of development of scientific constructs.

The approach is essentially reflective and judgemental with respect to investigations which have already been undertaken by research scientists. It is through the process of reflective criticism that the pupils learn the procedures and thought processes of research scientists and how to improve upon them. Some readers may recognise this as a means of facilitating metacognition.

A more classroom - oriented Inquiry Strategy has been developed by Suchman (Eggen, 1979). The Suchman inquiry model is often referred to as structured inquiry reasoning, while the Schwab approach is fundamentally laboratory or field centred to the extent

that research activities in the laboratory and the field are an important basis for the inquiry. Once the problem has been structured appropriately by the teacher, the Suchman model of inquiry teaching does not require the pupils to work in the field or laboratory. The approach depends upon the use of known conditions, known variables, and existing data as a basis for teaching and practising reasoning strategies which a research scientist might be expected to apply to the problem which the teacher has chosen as the focus. While the Schwab approach emphasizes reflective criticism, the Suchman model deals with the use of data, the formulation of questions, and the application of inference.

This approach to inquiry teaching shares some features of the "pupil centred model" to the extent that the teacher's role includes motivator, facilitator, and class manager. In a similar fashion, the teacher has no role as direct transmitter of factual information. At this point, however, the approaches diverge. The "pupil centred model" is almost entirely devoted to continuous hands-on investigation in the laboratory or field. The "creating knowledge" model begins with the class in a conventional class teaching/seating arrangement with the teacher at the front of the class. The approach has substantial support from constructivist psychology and should be studied carefully in conjunction with the lesson plan (Piaget 1964). Social transmission and personal experience are the two most important means by which teachers may influence cognitive development and knowledge growth. Both are used here. Conflicts and disagreements resulting from group discussions or class debate are an important means of establishing the disequilibration of inappropriate knowledge schemes in preparation for further knowledge growth.

The second set of assumptions is about the nature of pupils' learning. This includes the belief that pupils, who are encouraged to do so by the non-threatening and supportive nature of their school environment, will show natural exploratory and learning behaviour. This is a point which has been made by Jean Piaget and many other writers. A further belief is that pupils have both the competence and the right to make significant decisions concerning their own learning and that is a pupil has a choice, apart from exceptional circumstances, there will be full involvement and enjoyment

associated with any activity the pupil has chosen to do. As a result of the effect of self-motivation, more effective learning will take place.

2.6.2 The Discovery Approach

The discovery approach was first popularised by Jerome Bruner in a book "The Process of Education" which was written as a consequence of his involvement with a conference of science educators at Woods Hole in USA (Cheek, 1992). The stimulus for the conference was the perceived failure of the US to beat the USSR in the space race. The USSR won by putting "Sputnik" in orbit first on October 4, 1957.

The concept behind the discovery approach is that the motivation of pupils to learn science will be increased if they experience the feelings scientists obtain from "discovering" scientific knowledge. "Discovery" should not be confused with "Inquiry". The discovery approach assumes a realist or logical positivist approach to the world which is not necessarily present in inquiry approach. Further, the idea is supported by the notion that pupils would learn about the nature of science, and the formation of scientific knowledge through the process of "discovery". The discovery approach also concentrates upon closure on some important process, fact, principle, or law which is required by the science syllabus. It could be said that though Bruner's heart was in the right place, his rationale was faulty. Studies in the history and philosophy of science indicate that Bruner's idea poses some philosophical problems about the nature of science and the formation of scientific knowledge. The discovery approach is presented well by Schulman (Caprio 1994). His studies deal with the procedures of discovery learning and relevant issues and conflicting points of view.

In a discovery lesson, the teacher decides, in advance, the concept, process, law or piece of scientific knowledge which is to be "discovered" or un-covered by the pupils. The lesson proceeds through a hierarchy of stages which may be associated with Bruner's levels of thought.

In the enactive level Pupils perform "hands-on" activities which are directly related to what is to be discovered. This is where the pupil is able to think about the nature of the

physical world in terms of personal experience. The teacher directs the thinking of pupils to deal with the experiential situations in terms of mental images of the objects used in the activities upon which the "discovery" is to be based. The third stage is called the symbolic level. This is the stage where the pupils move to replace the mental images with symbols in a move to increased generality and abstraction which results in the "discovery" planned by the teacher in advance (Caprio 1994).

Naturally, there are serious problems at the symbolic level when teachers try to have concrete reasoning pupils "discover" relationships which are abstract and which require formal reasoning processes for invention, understanding or application. Teachers are generally driven to amazing verbal games in science classes to literally "put the words in the mouths" of the pupils so that the "discovery" process can be completed. What actually happens in science classes is usually a far cry from Bruner's hopes that pupils experience the positive feelings scientists obtain from "discovering" or un-covering scientific knowledge and that pupils are motivated to assimilate the "facts of science" through the process of "discovery" they actually experience in class.

2.7 Co-operative Learning Strategy

Cooperative learning provides a medium ground between the extremes of lecturing and private study. Cooperative learning may be highly structured and tightly controlled by the teacher or it may be free–flowing discussion in which the teacher prompts or facilitates occasionally (Brown, 1995). In a classroom using cooperative learning, students work on activities in small heterogeneous groups, and the often receive rewards or recognition based on the overall group performance. Although cooperative learning can be traced back to the 1920s, it seems startling or new because the typical classroom environment is frequently competitive (Sadler & Sadler,
2000). For example, when grading is done on a curve, one student's success is often detrimental to others. According to Sadler & Sadler, this competitive structure produces clear winners and losers, and only a limited number of each are possible. Sometimes classrooms are set up to be less competitive, incorporating independent study or learning contracts. In these cases, students work by themselves to reach individuals learning goals. But a cooperative learning structure differs from even these less competitive practices, because students depends on one another and work together to reach shared goals.

According to Hamachek (1995), learning should be an interactive mix of ideas, motivation, experience, psychological factors and brain chemistry. This calls for small classes, which should receive a practically oriented science curriculum. Currently, Kenyan schools have large classes, which are not adequately supported with learning facilities. In addition most schools lack science laboratories and for those that have, they are ill equipped and in most cases, the apparatus are poorly maintained (Kiboss, 1997; Changeiywo, 2000). Science is taught theoretically, which in turn make science irrelevant in life and therefore difficult to learn. Examination constraints and expectations of society, parents and head teachers are other problems that often lead teachers to adopt less effective teaching strategies (Ndirangu, 1991). In the end, learners leave schools not having understood scientific concepts and therefore not prepared for life after school.

According to researchers, cooperative learning groups work best when they meet the following criteria. Groups should be heterogeneous and, at least at the beginning, should be small, perhaps limited to two to six members (Johnson, 2000; Sadler & Sadler 2000; Hertz-Lazarowitz & Miller, 1998). Since face to Face interaction is important, the groups should be circular to permit easy conversation. Positive interdependence among group members can be fostered by a shared group goal, shared division of labour, and shared materials, all contributing to a sense that the group sink or swims together.

Slavin (1989), a pioneer in cooperative learning techniques, developed student team learning methods in which a team's work is not completed until all students on the team understand the material being studied. Rewards are earned only when the entire team achieves the goals set by the teacher. Students tutor one another, so that everyone can succeed on individual quizzes, and each member of the group is accountable for learning. Since students contribute to their teams by improving prior scores, it does not matter whether the students is a high, average, or low achiever. Increased achievement by an individual student at any level contributes to the overall performance of the group, resulting in equal opportunity for success. Research shows that:

(i) Cooperative learning promotes both intellectual and emotional growth:

(ii) Students make higher achievements gains; this is especially true for math in elementary grades.

(iii) Students have higher levels of self-esteem and greeter motivation to learn.

(iv) Students have a stronger sense that classmates have positive regard for one another.

(v) Understanding and cooperation among students from different racial and ethnic background are enhanced. (Johnson, 2000; Slavin, 1989, Hertz-Lazarowitz and Miller, 1998)

As ability of grouping becomes more controversial, educators are growing increasingly interested in cooperative learning as a strategy for working successfully with mixed – ability groups and diverse classrooms populations. Finally school learning should be structured to encourage processes in which the mechanisms of learning operate within the bounds set by the phenomenon of schooling to accomplish the goals of education. School learning is a process in which mechanisms of learning are engaged or brought into play by the environmental context of schooling. The major independent variable of school learning is the curriculum and the major dependent variable of school learning is achievement. In order to describe ways in which these variables are related to one another we must come to groups with learning as it arises as a concept in experimental psychology, and as it is related to concepts of teaching and knowledge in educational psychology.

2.7.1 Advantages of Cooperative Learning

Cooperative learning has been cited as an effective learning method due its advantages. These advantages include;

(i) Teachers are able to see all students at all times.

(ii) Teaching materials and supplies are readily available.

(iii) Arrangement in cooperative learning groups should minimize congestion.

(iv) Students are able to see instruments and materials more easily.

(v) Procedures and routines are actively taught in the same way that academic content is taught (Slavin, 1989, Hertz-Lazarowitz &Miller, 1998).

2.7.2 The Use of Co-operative Learning in a Science Classroom

Co-operative learning and other kinds of peer-based small-group instruction are flourishing in classrooms around the world (Hertz-Lazarowitz & Miller, 1998).

Cooperative interdependence in classroom setting is the basis of many interventions designed to improve both academic achievement and social relations in schools and as such has been a primary focus in educational and social psychological literature for more than two decades. The researchers have recognized that it is the natural tendency of children to grow and learn through social interaction and share the beliefs that understanding cooperative interaction, within school contexts will not only help children achieve educational goals but also create more long term benefits or human kind.

School activities that employ collaborative problem solving have the potential for teaching children how to deal with complex tasks and to work with and learn from each other. One would expect that exposure to a rich array of collaborative problem–solving activities in school would help children become effective problem solvers as adults. The Vygotskian theory argues for the analysis of problem solving as a culturally and historically situated activity (Forman, 1993). That is, we need to understand the ways in which a particular problem–solving activity is embedded in a set of cultural practices and institutions at a specific point in their historical evolution. Thus the physical and institutional context of an activity, the social roles and status of the individuals involved the cultural mediators available, and the prevalent cultural values and beliefs about the activity support and constrain the participants' attitudes, goals, understanding, and actions.

Also cognitive development is inherently integrated with social and emotional development. This view implies that fundament changes in thinking must be accompanied by a reorganization of children's attitudes, goals, and mediational means. This aspect of the theory implies that an analysis of the potential benefits of peer collaboration must include information about changes in children's communication, goals, and social interactions over time as well as changes in their ability to solve a particular problem.

Slavin (1989), argued that extrinsic rewards create different types of interpersonal goal structure (Cooperative, competitive and individualistic), which in turn affect how the group responds to each other's task–related efforts. This children who receive rewards

for their group products tend to create a cooperative goal structure " in which group members will give or withhold social rein forcers in response to their group-mates' task-related efforts in addition, if individual accountability is coupled with group rewards, students are motivated to learn from the group effort.

According to Slavin (1989), this combination of group rewards and individual accountability is most frequent associated with academic achievement gains as a result of exposure to cooperative learning activities. In summary, Slavin argued that students' motivation to engage in cooperative interactions and to learn from those interactions must be taken into account when designing effective cooperative learning activities. He proposed that teachers manipulate group goal structures by providing extrinsic rewards for group products. He also suggested that individual achievement motivations be maintained by evaluating learning outcomes through individual testing.

Forman (1993) agreed with slavin and proposed that the goal of all learning activities (both cooperative and individual) should be the achievement of genuine insight, not merely the production of correct solutions. Thus the teacher's role in fostering collaborative activities is to provide tasks that are intrinsically interesting and to encourage social interactions that can foster comprehension activity.

As a social constructivist view of learning, cooperative learning has its philosophical roots in the work of philosophers like Harre and Kuhn (Heertz-LazaroWitz and Miller, 1998). According to Heertz-LazaroWitz *et al,* (1998) this has been further articulated in the work of Wittgenstein and mead, who share the conceptualization of knowledge as a social artefact. Knowledge, then, is not based on an objective reality that can be measured and quantified but rather is consensually formed trough social int-eraction. The connections between social constructivism and writing can be clearly linked. Social constructivism incorporates discourse with learning, and this learning is internalized. If an individual's thoughts are internalized conversations, writing can be perceived as the re-emergence of this internalized interaction.

In classrooms studied by Feldman (1986) students had opportunities to work in groups to respond to our author's texts. However, students, worked at completing teacher –

given tasks rather than responding to one another's writing in one of the classrooms. Feldman hypothesized that the teacher never relinquished control but gave the students specific assignment to complete and directions on how to assess one another's work. In another classroom, freedman found that students initiated talk about content and encouraged and questioned one another. The differences between these classrooms suggest that classroom structure affect peer interactions, the degree of control that student will have over their interactions, and thus what students can learn from one another This method of instruction is based on the idea that education is essentially a social process. It is therefore designed to encourage students to work together collaboratively in given tasks. Students working in groups have been found to benefit more than those working individually on a similar task (Johnson & Johnson, 2000; Kiboss, 1997; Chemwei, 2003; Wekesa, 2003). Students working in collaborative groups show a high level of ability to seek help and utilize obtained information on problem solving.

In a school situation, individual learners, schoolmates and teachers constitute the social context for learning. The teachers in this social arrangement are viewed as more competent than learners, and are therefore capable of assisting learners to attain higher planes of cognitive development than they would on their own (Driver, Squires, Rushworth, and Wood-Robinson, 2000). The individual learners, also through cooperative interactions with peers, raise their levels of cognitive development above what they are capable of individually (Ngesa, 2002). This suggests that co-operative learning is especially suitable in developing student skills as well as providing them with immediate means of monitoring and evaluating their progress.

In science classrooms, practical activities that are predominantly student-centred require that learners effectively participate in order to learn. However, large classes and lack of adequate facilities, make it difficult for students to access apparatus and materials whenever they need them. As Malamah-Thomas (1997) asserts, co-operative learning provides learners with an interactive environment and demands no additional resources in terms of equipment and materials. This is because as learners interact, they share the available resources in their discussion groups. Smaller, less formal groups, improves social development in learners and provides them with an opportunity to express themselves than in the large classroom.

2.7.3 Co-operative Learning Techniques

Effective cooperative learning is a much more challenging task than often realized. According to Brown and Atkins (1991), it is relatively easy to have a vague meandering discussion and much more difficult for learners to discuss coherently, to question, and to think. Small groups can be used for tutorials, seminars, or problems-solving sessions. Tutorials contain up to five students, seminars as many as twenty and problem solving up to ten. The size of a group affects the intimacy of members and their interaction. Put simply the immediate of cooperative learning are to get students to talk and think. The long-term goals are personal growth and competence.

These goals may be expressed in the form:-

(i) Development of communication skills.

(ii) Development of intellectual and professional competencies.

(iii) Personal growth of students.

(iv) Facilitating small group learning

(i) **Development of Communication skills** - This include listening, explaining, questioning and responding are crucial for the development of intellectual skills. Communications also improve language, socialization and discipline.

(ii) **Development of Intellectual skills** - The value and precise nature of thinking vary from subject to subject. Cooperative learning is one way in which intellectual and professional competencies may be developed. Cooperative learning encourages students to think which may develop proficiency with data and evidence handling. Thinking occur as learners analyse, logically reason, evaluate evidence or data, appraise and judge perceptively, critique, see new relationships, synthesize, speculate creatively, design, argue rationally, transfer skills to new contexts and problem- solve.

(iii) **Personal growth** - This includes the development of communication skills and thinking. It also includes the notions of developing self-confidence, managing own learning, working with others and insight into oneself and others. This encourage students to talk and think in the short term while in the long term, it assist the students to develop professionally as well as personally.

(iv) **Facilitating small group learning** - There are four simple, but effective, strategies which increase the chances of students talking and thinking while working in

small groups. They will all help the group to feel safe enough to take and share thoughts. These strategies are:-

a) Seating arrangements.

b) Expectations and ground rules.

c) Safety.

d) Making the small group smaller.

a) Seating arrangements - It affects interaction patterns (Argyle, 1983) and should not be neglected. According to Argyle there are 3 main seating arrangements. The tutor dominated arrangements where tutor sits in front and most interactions are tutor-student. In this arrangement the central row of students make most of the interactions. The semi- circle arrangement increase probability of sub-groups interaction while each group interact with the teacher. The circular arrangement increases the probability of students talking to each other as well as the tutor. In all case, distance between tutors and students and type of furniture can influence interaction.

b) **Expectations and ground rules** - Students often do not know what is expected of them in small group session, so it is worth while outlining and discussing your expectation and theirs so that you can arrive at an understanding or even an informal contract. One important feature of the contract is that students have permission to ask questions, no matter how trivial, and to try out ideas which may be wrong. In return the tutor should agree to tackle questions asked and to provide, in a matter of fact way, his or her view. This allays anxieties and clarifies goals but also provide a reference point for analysing later sessions. There are four phases of that groups tend to go through. These are forming, storming, norming and performing. The first phase is where the group are getting to appraise and know each other. The second phase is when the members of the group are struggling to establish their roles. In the third phase the group have arrived at an understanding of how to behave and in the forth they are working together on the task.

c) **Safety** - Members in a group must feel safe enough to contribute. Member in groups are usually plagued by fear. Fear is usually tackled in two main ways –rewards risk reduction. Rewards involved the approval of all good points, valid references or the adoption of a creative approach to a problem it helps to show that helpful contributions are valued. Risks reduction includes making clear what is expected from the students

since uncertainty increase fear. Secondly, the setting of tasks or problems which are with students' capabilities and resources can also minimise fear. Finally the teacher should facilitate the sessions towards goal achievement.

d) **Making the small group smaller** - Students should be provided with the opportunity to talk in groups of two or three without the teacher listening. This enables the students to check their views and approaches without fear of being appraised by the teacher. Three variations on this theme are:-

I. Buzz groups – students are asked to discuss or solve a problem in twos or threes and then asked to give their views.

II. Brainstorming – Each student scribble down thoughts, ideas or questions then compare them with those of his group mates.

III. Snowballing – Each student spends a little time noting and thinking, and then compares his views with other students in the group. The pair then compare with another pair in the group.

Co-operative learning is based on task interdependence and shared outcomes for students within work groups. This learning approach has been achieved through group organization strategies (Johnson & Johnson, 1989; Slavin, 1989). These include:

1) **Jigsaw Method**

In this method the teacher assigns learning tasks that are divided into partial sections of the whole. Each group member is responsible for one section. All the members then combine the sections to make one whole product. This method enhances individual attention for the co-operative process since in the process students must listen attentively and take turns in participation. However students have limited exposure to materials other than what they have studied themselves.

2) **Students Team Achievement Divisions (STAD)**

In STAD Students are grouped into four or five members who are heterogeneous in performance level, sex and ethnicity. After working in these groups to a mastery level on the task, they are then reorganised and assigned to new teams according to the same criteria. This has the effect of enhancing learning in groups as well as between groups. Collective group incentives can be used to ensure maximum co-operation of members.

3) Group Investigation

In the group investigation method, each group take on a topic within a unit studied by the whole class and then subdivide each topic into tasks distributed among members of the group. Each student investigates his/her subtopic individually and ultimately presents their findings to the whole class. This method has been found to significantly increase student achievement and understanding of content (Slavin, 1989).

4) Learning Together

Learning together involves assigning groups of four or five mixed ability students to a task in the form of an assignment. Members of a group, work together towards a common final product. This method may often encourage able group members to do all work or give answers to team mates. It can however be improved by use of individual report writing on the groups' common task.

5) Co-operative Integrated Reading and Composition (CIRC)

In CIRC, students work in peer response groups or form partnerships to help one another draft, revise and edit compositions. This approach is particularly effective in improving creative writing and student writing achievement.

In this study the Students Team Achievement Divisions (STAD) group organizational strategy was adopted due to its ability to enhance learning in groups. In all cases, the teacher introduced the lesson and the allowed the learners to work in their cooperative groups before reporting their finding to the rest of the class. The teacher then concluded the lesson by leading the class to collate all group findings.

2.8 Effects of the Co-operative Learning Approach on Students' Achievement

Existing evidence demonstrating the relative effectiveness of co-operative learning is quite strong (Carin, Bass and Constant, 2001). In a review of studies conducted to determine the effects of co-operation on performance and achievement, Hertz-Lazorowitz and Miller (1998) concluded that interaction among students on learning tasks led to improved students achievement. This is because students learn from each other in their discussions of the content. However, cognitive conflicts may arise leading to inadequate reasoning being exposed. The disequilibration that may occur, often end up in higher quality understanding emerging. In a similar study Johnson & Johnson (2000) conducted a program of research that resulted in over 80 published studies.

They also reviewed published and unpublished research conducted over the past 90 years comparing co-operative, competitive and individualistic efforts. These studies were conducted in different historical periods, with subjects of various ages, with numerous types of tasks, and vastly different subject populations. They were also in different settings, with different operationalizations of the independent variables, and with a variety of measures of the dependent variables. From the overall results, which had considerable power and generalizability, they concluded that under a broad range of conditions, co-operative efforts resulted in higher achievement and great productivity than did competitive or individualistic efforts. Race and Parkard (2000) in their studies on motivation also concluded that there is evidence that active involvement of learners in the learning process help them to understand new situations. Aronson (2002) found that co-operative incentives led to peer-norm favouring the performance of tasks that help the group to be rewarded. Parkinson (1998) concluded that co-operation is more effective in increasing performance when co-ordination of efforts is vital to effective functioning and that competition is at least as effective as co-operation when co-ordination of efforts is not so important. He further noted that over longer periods, growth of social pressures favouring performance in co-operative groups makes co-operation more effective.

Forman (1993) while investigating performance and masterly of rules by children in London schools found out that, younger learners quickly mastered rules for playing games when placed in groups with older students learning similar rules. Fraser and Walberg (1995) while comparing performance between homogenous and heterogeneous groups found out that co-operative learning enhanced the performance of a mixed ability group of learners. This suggests that co-operative learning greatly enhance learning in students especially in large classes where individual learner attention is lacking. Chemwei (2003) designed a cooperative learning module and studied its effects on the learning of poetry. He concluded that students learning poetry in cooperative groups in Baringo secondary schools in Kenya achieved higher and developed positive attitude compared to those taught the same course content using conventional methods. A study by Wachanga (2002) using a Co-operative Class Experiment (CCE) in the learning of chemistry in Nakuru district secondary schools, concluded that this method facilitates student learning than the regular teaching

methods. He further asserts that students taught using CCE have higher motivation to learn chemistry than those taught through regular methods. A similar study by Kiboss (1997) using a Computer Based Instruction (CBI) environment in the learning of physics in the same district, found that the co-operative groups outperformed the individual groups across gender and ability grouping.

Monk (2000) while comparing different modes of instruction in the performance of assorted tasks in American schools found out that co-operative learning enhances academic achievement, individual mastery and maintenance of on-task behaviour in Biology over time. Wekesa (2003) also compared the achievement and attitude change between students learning in a Computer-Based Instruction (CBI) environment in groups and those working individually on similar tasks in Biology and concluded that students working in groups achieved higher than those working individually on similar tasks. Moreover, the students working in groups were highly motivated and perceived the subject positively. However, a study by Johnson and Johnson (2000) suggested that co-operative learning does not always work, but this may be due to poor planning on the part of the teacher/instructor. This instructional method is still not fully exploited in our Kenyan schools. There is no documented study that has been done to establish its effectiveness in biology in Kenyan high schools.

2.9 Effectiveness of Co-operative Learning on Students' Attitude.

Due to factors like rapid increase in student population, shortage of funds for adequate laboratory facilities, shortage of well trained science teachers and negative influence of external examinations, teaching in most African schools is essentially expository in nature (Ogunniyi, 1996). Thus learners tend to remain inactive, inattentive and often uninterested in science lessons. There is evidence, which suggests that active involvement of learners in the learning process help learners to understand new situations more easily (Alsop and Hicks, 2001). As noted earlier, learner involvement is found to facilitate personal growth and instil in them a measure of empowerment. Learners develop responsibility for their learning. Hertz-Lazarowitz and Miller (1998) found that students who worked in co-operative learning groups were significantly more likely than control students to agree that their classmates wanted them to do their best. This means that group support contribute to a positive attitude towards

achievement of learners. Working in groups help make students feel accepted as well as feeling that their work is beneficial to others. As Okere (1996) note, group discussion tends to make pupils more tolerant and broad minded, encourages listening and provides a co-operative means of bringing together the facts and opinions of members of the groups so that conclusion may be drawn.

2.9.1 Attitude as Performance Indicators

The systematic measurement of pupil attitude to school goes back to Tenenbaun, who devised a test in 1940 to measure a child's attitude towards schools, teacher, and classmates. He devised a questionnaire with 20 items and came to the conclusion that almost 60% liked school in 1976. In a survey of 2000 fourth year pupils conducted as part of evaluation, 59% indicated that they found lessons not interesting.

Pupil attitudes can constitute valuable performance indicators if used comparatively and over time. This is especially true because in the present climate, pupils are less passive in their acceptance of school. They are more likely to questions authority than they were in 1940 and for this reasons the school is more likely to influence attitudes which can tentatively be regarded at out comes; non- cognitive results achieved by the school. The extent to which we should hold a school responsible for the attitudes of its pupils remain open to question. However, like other indicators, some corrections can be made for ability and attitudes on entry to school and changes in attitude may be of value. Attitude indication can be used as signposts and as an outgoing process of monitoring primarily for the purpose of internal development and management. The systematic attitude measurement in schools is, therefore, feasible, acceptable and important.

2.10 Theoretical Framework

This study was guided by the integrative theory of co-operative learning and achievement developed by Slavin (1989). This theory is based on six complementary theoretical perspectives. According to Slavin, all the six theoretical perspectives have well-established rationales which have supporting evidence. These perspectives are

1) Motivational,
2) Social cohesion,
3) Cognitive developmental,

4) Cognitive elaboration,

5) Practice and

6) Classroom organisation.

1) Motivational perspective - The motivational perspective focuses primarily on the reward or goal structures under which students operate (Slavin, 1996). According to Johnson and Johnson (1997), rewarding a whole group creates an interpersonal reward structure in which group members will give or withhold social reinforcers like praise and encouragement.

2) Social cohesion perspective - The social cohesion perspective holds that the effects of co-operative learning on achievement are strongly mediated by the cohesiveness of the group (Hertz-Lazarowitz & Miller, 1998). Students help each other because they would like the others to succeed. A hallmark of the social cohesion perspective is an emphasis on team–building activities in preparation for co-operative learning and on the process or group self-evaluation during and after group activities. The cognitive perspectives however, contend that interactions among students increase student achievement through mental processing of information rather than with motivation or the social cohesion of the group.

3) Cognitive development perspective - The developmental perspectives' fundamental assumption is that interaction among children while performing appropriate tasks facilitates learning of critical concepts. According to Vygotsky (1978), collaborating activities among children promotes growth because children of similar ages are likely to be operating within one another's proximal zones of development.

4) Cognitive elaboration perspective - The cognitive elaboration perspective holds that for information to be retained in memory and to be related to information already in memory, the learner must engage in some sort of cognitive restructuring, or elaboration of the material (Wiltrock 1979 in Hertz-Lazarowitz & Miller 1992). In other words, as students explain to each other, the material is elaborated in their mind.

5) **Practice perspective** - The practice perspective is based on the idea that co-operative learning increases opportunities to practice or rehearse the materials to proficiency (Hertz-Lazarowitz & Miller, 1998). The opportunity to take turns, quizzing one another is simply more effective than trying to study alone, and no incentives are needed.

6) **Classroom organisation** - The classroom organisation perspective focuses on the ability of students to take responsibility for managing themselves in co-operative groups, freeing the teacher to attend to more essential tasks (Hertz- Lazarowitz & Miller, 1998). Students can work in mixed-ability learning teams while the teacher calls up groups of students at the same performance level for lessons. Back at their desks, the remaining students work together on activities that advance them in the subject.

The diagrammatic representation of the relationships among the six perspectives on co-operative learning is shown in the figure 1 below:

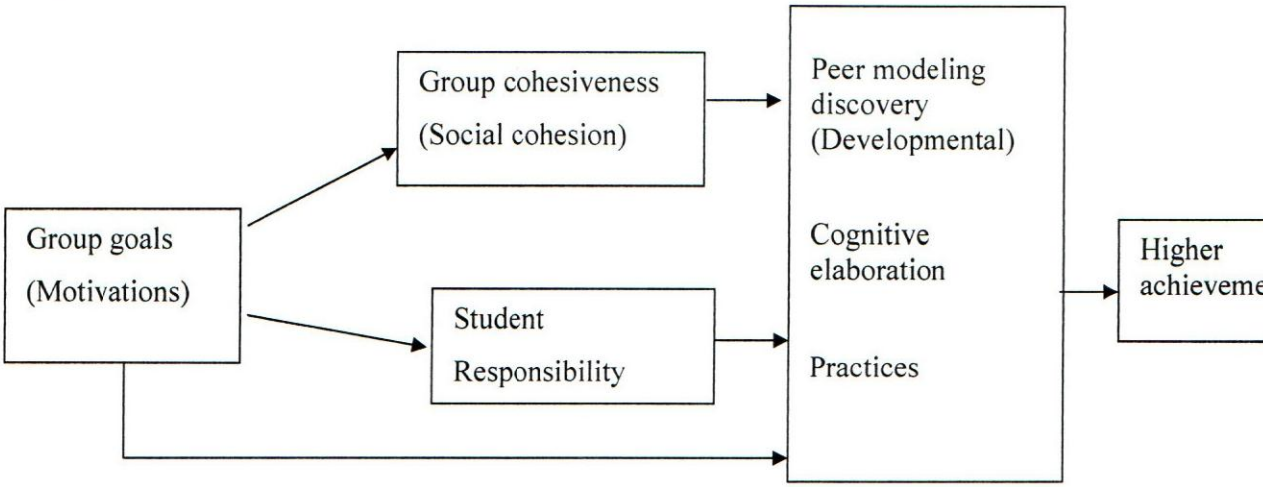


Figure 1: Relationships among six perspectives on co-operative learning
(Adopted from Slavin, 1989)

Figure 1 shows the process by which group goals might enhance the learning outcomes of co-operative learning. According to Slavin, group goals based on the individual

learning of all group members might affect cognitive processes directly by motivating students to engage in peer modelling, cognitive elaboration, and practice with one another. Group goals may also lead to group cohesiveness, increase care and concern among students and make them feel responsible for one another's achievement. This may encourage students to engage in cognitive processes that enhance learning. Finally, group goals may make students to take responsibility for one another independently of the teacher, thereby solving classroom organisation problems by providing increased opportunities for cognitively appropriate learning activities.

In this study the integrative theory of cooperative learning and achievement was used to develop collaborative group structures in which group members shared responsibilities in a socially interactive environment. The value of grouping learners to enhance their achievement and attitude towards biology comes from the environment that provides them with opportunities to interact and learn from each other. In addition, using cooperative teams facilitate class management by providing for sharing of limited science resources giving students responsibility to manage materials, and involving students in helping team members with assignments and problems. In this setup the teacher plays a role in planning and facilitation of learning to achieve the lesson objectives. The teacher determines the group composition, the learning activity and the gradual student assessment.

The framework developed for cooperative learning can be summarized diagrammatically as follows.

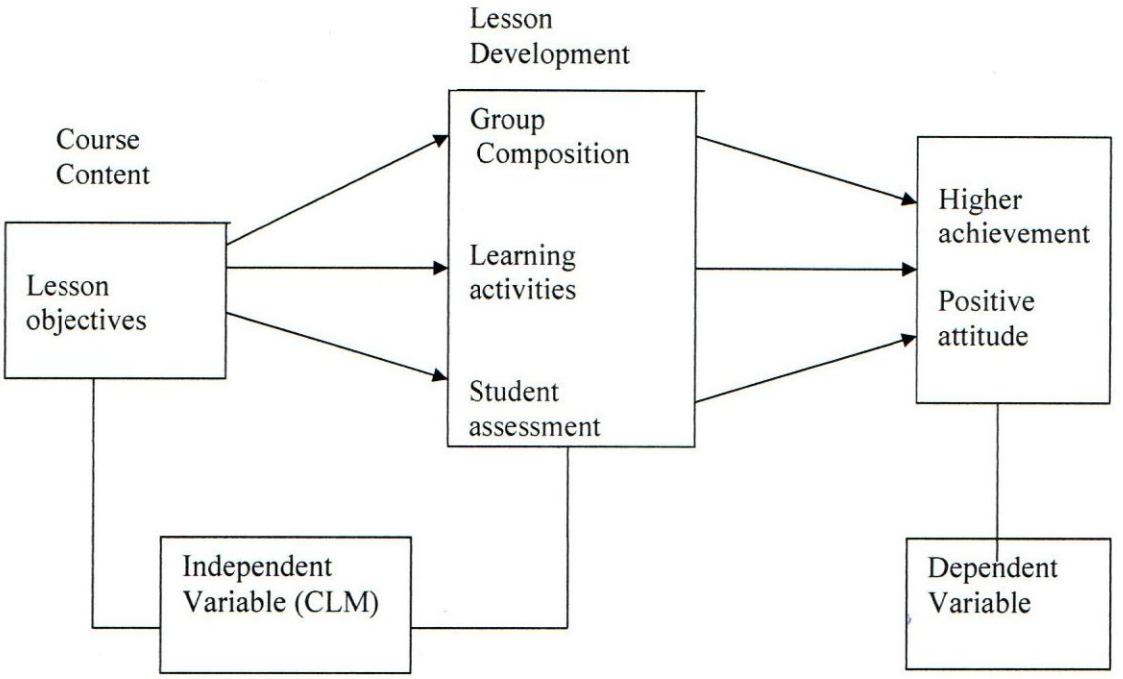


Figure 2: Conceptual framework to determine the effects of cooperative learning on students' achievements and attitudes in biology lessons.

CHAPTER THREE
RESEARCH METHODOLOGY

3.0 Introduction

In this chapter, the research methodology applied in the study is discussed. This includes the research design, population, sampling procedures, instrumentation and the data collection and analysis procedures.

3.1 Research Design

In this study a quasi experimental research design called the Solomon Four-Group design was adopted. This was found to be appropriate because it takes care of external and internal validity problems by providing controls for the effects due to treatment, pre-testing, history and maturation (Cook & Campbell, 1979; Borg & Gall, 1989; Borg, 1987). The design requires that subjects be randomly assigned to four groups; one experimental group and three control groups. The groups used in this study were, however, already been constituted and therefore random assignment was not possible. Nevertheless a quasi-experimental approach was adopted. Quasi- experimental designs allow researchers to randomly select samples from the population, without requiring the random assignment of individual cases to comparison group (Borg & Gall, 89; Koul, 1984; Cook & Campbell, 1979; Borg, 1987 FrankFort–Nachmias & Nachmias, 1996). These designs are superior to cross – sectional designs because they usually involve the study of more than one sample, often over an extended period of time.

The researcher had to obtain similar schools in terms of ability and facilities to control the extrinsic factors. Matching and randomization of intact classes with similar characteristics were used to attain homogeneity of groups.

(i) Matching

Matching is a way of equating the experimental and control groups on extrinsic factors that are known to the research hypotheses. In matching two methods can be used to control factors known to the researcher prior to the study (Borg & Gall, 1989). Precision matching or pair wise matching-for each case in the experimental group, another case with identical characteristics is selected for the control group. This may be base on age, gender, race and level of education. This however, has the drawback of difficulty and when there are many characteristics that need to be controlled. Frequency

Distribution-The experimental and control groups are made similar for each of the relevant variables separately, then in combination. Thus instead of one to one matching, the two groups are matched on central characteristics (e.g. age, gender, proportion and academic achievement). Although somewhat less precise, frequency distribution matching is much easier to execute than precision matching and enables the investigator to control for several factors without having to discard a large number of cases. Randomization helps to offset the effect of unforeseen factors. In this study precision matching was used since the subjects in the study groups had already been constituted.

(ii) Randomization

Johnson (2000) has developed a Framework for description in which he defines the term "design" to refer to the way in which the researcher arranges the independent variables in relation to the dependent variables. According to Johnson, the researcher must arrange the independent variables so that they have proper experimental controls and so that one thing varies at a time. He also must arrange the independent variables so that they are not confounded. This means that he should make sure that the change in value of one independent variable does not change the value of one independent variable. This can be achieved in two ways;

a) Using two Randomized Groups- here the first task is to select an independent variable that varies in at least two respects so that we can assign it two values. These two values are called treatments, conditions, or methods. Their intention is to determine whether these two treatments differently affect the value of the dependent variable. It is essential to identify a population of individuals whose behaviour we wish to describe. A number of individuals are sampled at random from this population and randomly assigned to the two groups in experimental situation. Sampling randomly from the population leaves it to chance which individuals are used. Random assignment leaves it to chance which individuals are put into which group. This makes the average score of subjects on the dependent variable to be the same in the two groups at the start of the experiment. The independent treatments are administered to the groups to measure their achievement and attitude.

b) Using two matched groups. To reduce the chances of the two groups being different before the treatment, a procedure called matched group design used. By matching groups the subjects are given a pre-test before they are assigned to experimental groups. Ideally, the pre-test should be exactly the same test administer after the independent variable, but if this might affect the results of the experiment, re-tests that are related to the values of the independent variable measure are chosen

In this study two matched groups were used. The experimental group (E) and first control group (C_1) received a pre-test and a post test while the second and third control groups (C_2 and C_3) received a post test only. The experimental and second control groups were taught using the cooperative learning module (treatment) while the first and third control group were taught using regular methods (Borg and Gall, 1989; Koul, 1984; Cook & Campbell, 1979; Borg, 1987).

In the Solomon Four-Group design the pre-test in an experimental setting has advantages as well as disadvantages. Although pre-testing provides an assessment of the time sequence as well as a basis of comparison, it can have severe reactive effects. By sensitizing the sampled population, a pre-test might in and of itself affect post-test scores. However, since the design also consisted of an additional set of control and experimental groups that were not pre-tested, the reactive effect of testing was directly measured by comparing the two experimental groups (E and C_2) and the two control groups (C_1 and C_3). This comparison would indicated whether the treatment had an independent effect on groups that were not sensitized by a pre-test. If the comparison showed that the independent variable had an effect even with the absence of the pre-test, the results can be generalized to populations that were not measured prior to exposure to the treatment.

Solomon Four-Group design is considered rigorous enough for experimental and quasi–experimental studies (Borg & Gall 1989). The design helps the researcher to achieve following four purposes;

(i) To asses the effect of the experimental treatment relative to the control conditions.

(ii) To asses the interaction between pre-test and treatment conditions.

(iii) To asses the effect of the pre-test relative to no pre-test and

(iv) To asses the homogeneity of the groups before administration of treatment (Borg & Gall, 1989)

The control groups enable the researcher to rule out other factors as rival explanations of the observed association between the variables under investigation. Such factors could invalidate the inference that the variables are causally related. Cook and Campbell (1979) has termed this issue the problem of internal validity which answers the question whether changes in the independent variable did, in fact, cause the dependent variables to change.

Finally the Solomon four-group Design also takes care of intrinsic factors that may have affected the study. These include history, maturation, experimental mortality, instrumentation, testing, regression artefacts, and interaction with selection close–ended questions, where respondents are offered a set of answers and asked to choose the one that most closely represents their views. The quasi-experimental approach was adopted in this study, is illustrated below.

Table 2:

The Randomised Solomon-Four group Design

Group	Pre-test	Independent variable	Post test
Experimental group (E)	T_1 O_1	Co-operative learning	T_2O_2
Control group C_1)	T_1O_3	Conventional methods	T_2O_4
Control group C_2)	No pre-test	Co-operative learning	T_2O_5
Control group C_3)	No pre-test	Conventional methods	T_2O_6

Adopted from Borg and Gall, 1996

Key

T_1 - Pre-test

T_2 - Post-test

O_{1-6}. Observation of dependent variables

3.2 Population of the Study

The population of the study consisted of all form three secondary schools students in Nakuru district. The form three students were used in this study because the topic on classification of organisms is mainly taught at this level in secondary school biology in Kenya (KIE, 1992). There are 140 secondary schools in Nakuru district, 2 of which are national, 15 provincial, 71 district schools and the other 52 private. There are 112 mixed district schools in the District. They make the largest proportion of schools and a majority of the students in these schools have been cited as performing poorly in the Kenya Certificate of Education (KCSE) examination (KNEC, 2000). The mixed district schools were therefore used in this study.

3.3 Sample Size and Sampling Procedures

The research design required that four groups be used in the study. A purposive sampling method was used to select four mixed district secondary schools in Nakuru District. Schools that were equivalent in terms of facilities were first identified and listed to make the sampling frame. From the 68 listed schools the researcher purposively selected four schools that were included in the study. This as to enable the researcher to obtain equivalent schools terms of ability and facilities. Balloting was used to select one random stream from each school to be used for data collection and analysis (Borg, 1987) although all streams in each selected school were taught using the same teaching method due ethical considerations. The four selected streams were then randomly assigned to serve as either the experimental group or control groups. The four groups selected constituted a sample of 165 subjects that formed the sample for the study. The number of subjects in the four groups were as follows; 39 in experimental group (E), 45 in control group I (C_1)) 41 in control group II (C_2) and 40 in control group III (C_3)

3.4 Instrumentation

The necessary data was collected using four instruments;

(i) Biology Achievement Test (BAT),

(ii) Student Attitude Questionnaire (SAQ),

(iii) Teacher Interview Guides (TIG) and

(iv) Student Interview Schedules (SIS).

The BAT was used to measure students' achievement before and after the course of study. The SAQ was used to assess the students' attitude towards school biology and the use of the co-operative learning approach. The interview schedules (TIG and SIS) were used to obtain teachers' and students' views on the new teaching and learning approach. Co-operative learning was the treatment used on the experimental groups.

3.4.1 Biology Achievement Test (BAT)

The Biology Achievement Test (BAT) was based on the course covered during the study. It covered the content in the topic "classification of organisms", in secondary Biology. According to Lindvall (1995), tests must be carefully planed, developed and used as intended. To achieve these, the following factors were considered when preparing the BAT; validity, reliability, objectivity, comprehensiveness, economical use of class time and simplicity in uses. BAT contained thirty completion or supply –type items that needed the students to supply answers with one word or sentence. These type of items were deemed appropriate because they provided little likely hood of correct guessing, (Lindvall. 1995). Moreover the supply of own correct response by the testee almost certainly represents actual knowledge unlike lucky choice among alternatives. This made the BAT instrument more reliable. It also had the advantage of being relatively easy to construct and score. Scoring was done using a standard marking scheme and the scores used in data analysis. The researcher used the following phases described by Lindvall (1995) as follows;

1) **Planning.**

The researcher first put down the objectives included in the topic on classification of organisms in school biology. Using a planning list of objectives based on the six major categories of Blooms, 1956, taxonomy of learning, a matrix, or table of content categories on one axis and ability categories on the other was drawn.

2) Writing the initial version

Using this table of content one hundred items were developed out of which thirty were included in BAT. The items were aimed at testing the ability of learners to recall, recognize principles, rules, procedures and specific factors, comprehensive

relationships, apply facts. Explain, describe, translate or interpret. BAT was then given to Biology teachers for validation and objectivity and comprehensiveness check.

3) Assembling of test items

The items were then assembled into a complete test form. This included providing instructions for the study examinees on what they were expected to do. Items of similar type were grouped together and arranged in order of difficulty with easier items near the begging of the test and therefore not having time to attempt later, easier items for which they know the answers – Adequate spaces were provided on the test sheet for student to write their answers. After test administration the test sheets were then scored against a moderate marking scheme and scores recorded. Ranking was carried out to give information regarding the degree of importance or the priorities that people give to a set of attitudes or objects.

The BAT was therefore a teacher–made test consisting of thirty items based on the 'classification of organisms' topic of biology. Marks for the items ranged from 1-4 marks. Four experts in biology education who included a senior lecturer in a university and three biology teachers from secondary schools validated the instrument. Before it was used BAT was pilot-tested in two schools in Koibatek District schools not included in the study. Reliability was estimated using the Cronbachs coefficient alpha that is apt for structured test items of varying difficulty (Leed, 1989). A reliability of 0.70 is the normal acceptable coefficient for research purposes. The instrument had a reliability co-efficient of 0.864 which was therefore accepted. The BAT was administered to the experimental group (E) and the true control group (C_1) before the commencement of the classification course and to all the groups after the course. The BAT was then scored using a standardized marking scheme and the obtained scores recorded and used during data analysis.

3.4.2 Student Attitude Questionnaire (SAQ)

The Student Attitude Questionnaire (SAQ) consisted of 20 items that were used to collect data on students' attitude towards the cooperative learning used in classification of organisms in school biology. The SAQ, which had a reliability coefficient of 0.79 using the KR–21 formula, was adopted from Kiboss (1997). However the SAQ was

modified to suit this study. It was then pilot-tested before using it in this study and it yielded a reliability coefficient of 0.771 that was acceptable for use in the study.

3.5 Teacher Interview Guides and Student Interview Schedules

Qualitative data was collected from the teachers and students taking part in the study through interview schedules. The teacher and a sample of ten students from each of the four participating groups were interviewed by the researcher during the course of study. In total four teachers and forty students were interviewed. Both the Teacher Interview Guides (TIG) and the Student Interview Schedules (SIS) were adopted from Kiboss (1997) and modified to suit the study. These Interview schedules were used to provide the researcher with the teachers' and students' views about co-operative learning.

3.6 Implementation of the Cooperative Learning Module

Before visiting the school, official permission was sought from the Ministry of Education. The researcher then visited each of the schools and sought permission from the gatekeepers to gain entry into the school compound. The researcher then obtained permission from the head teachers of the institutions and explained to the Biology teachers the nature of the study and the role they were expected to play. The researcher then inducted the biology teachers participating in the study on the co-operative learning strategy for five days. In this induction, the teachers were trained on how to use the co-operative learning approach in teaching. A pre-test was then administered to the experimental group (E) and first control group (C_1) by the biology teachers participating in the study. In this study, the experimental group (E) and control group (C_1) were taught classification of organisms using the co-operative approach. The first and third control groups were taught the same course content using conventional or regular teaching methods. At the end of the topic on classification of organisms, a post-test was administered to the four groups.

3.7 Data Collection Procedure

In this study data was collected from the sample of 165 form three students from the four selected secondary schools in Nakuru district using the BAT and SAQ. The four student groups were matched for equivalence in academic achievement and attitude towards secondary Biology. The BAT was used to collect data on achievement before

and after the subjects' exposure to biology course on classification of organisms. Similarly, the SAQ was used to collect data on students' attitudes before and after the biology course. After obtaining official permission from the Ministry of Education the researcher then visited the schools. He then sought permission from the gatekeepers to gain entry into the school compound. The head teachers of the institutions allowed the researcher to explain to the Biology teachers the nature of the study and the role they were expected to play. The researcher then inducted the biology teachers participating in the study on the co-operative learning strategy for five days. Before the commencement of the study, the pre-test was administered to the experimental (E) and first control group (C_1). Similar instruments were given to both groups of students. The students were then taught using the designated teaching approaches for five weeks. A post-test was later administered to all groups at the completion of the topic on classification of organisms in biology. Teachers and students' interview schedules were used to get additional data on the students' and teachers' views on the new learning method..

3.8 Data Analysis

After obtaining data using the BAT and SAQ, students' responses were scored against moderated marking schemes and the resulting total scores (X) used for analysis. Data analysis was done using both descriptive and inferential statistics. The qualitative data from the interviews was analysed and summarised in form of means, frequencies, percentages, standard deviations and ratios, while the quantitative data was analysed using Analysis of Variance (ANOVA) for all four groups and the t-test for the true experimental (E) and true control (C_2) groups. The computer program Statistical Package for Social Sciences (SPSS) version 9 was used to analyse data. Tests of significance were done at the α=0.05 level. Information obtained from was analysed and presented in form of frequencies and percentages. Excerpts from interviews were also presented in verbatim.

Table 3:

Summary of Data Analysis Procedures

Hypothesis	Independent variable	Dependent variable	Statistical test
Ho1: There is no statistically significant difference on students' achievement in the learning of classification of organisms in school biology between learners exposed to co-operative learning and those not so exposed	Co-operative learning	Students' Achievement in biology	t-test ANOVA
Ho2: There is no statistically significant difference on students' attitudes towards the learning of classification of organisms in school biology between learners exposed to co-operative learning and those not so exposed	Co-operative learning	Students' attitudes towards biology	t-test ANOVA

CHAPTER FOUR
RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents the results obtained and their interpretation. The analysis of pre-tests to check on the equivalence and therefore suitability of the four groups selected for the study is presented. Quantitative data has been analysed using t- test where two groups, Experimental group (E) and control group 1 (C_1) are compared and Analysis of Variance (ANOVA) when comparing the four groups. The qualitative data on the other hand has been summarized and presented as means, frequencies, percentages or in verbatim form.

This study was designed to determine the effects of a co-operative learning module in classification of organisms in school biology on students' achievement and students' attitudes towards the topic classification of organisms in school biology. The study comprised of four groups. Two groups, the experimental group (E) taught using a cooperative learning module which undertook a pre-test and a post-test and the true control group (C_1) that also took a pre-test and a post-test but was taught using conventional methods. The other two groups, control group II (C_2) that was taught using the cooperative learning module and the control group III (C_3) taught using conventional methods which took only a post-test.

Based on the objectives the following null hypotheses were put forward for testing:

Ho1: There is no statistically significant difference between the achievement of students using the co-operative learning module and those using the conventional methods to learn classification of organisms in school biology

Ho2: There is no statistically significant difference between the attitudes of the students using the cooperative learning module and those using the conventional methods to learn classification of organisms in school biology.

4.1 Analysis of Pre-tests

Two instruments, the Biology Achievement Test (BAT) and Student Attitude Questionnaire (SAQ), were used to obtain the students' level of achievement and

attitudes towards biology before the start of the study. As required by the Solomon Four-Group design, the pre-tests of BAT and SAQ were administered to one experimental group (E) and the true control group (C_1) before the onset of the study. This was to enable the researcher to compare the results of the subjects and to determine whether the groups were similar before the commencement of the biology topic on classification. Table 4 shows the results of the pre-test scores of student's attitude and achievement for the two groups prior to intervention.

Table 4

A Comparison of Mean Pre-test Scores and Standard Deviation (S.D) of Subjects on BAT and SAQ

Test	Group	N	Mean	S.D
Achievement Pre-test	Experimental Group(E)	41	26.97	11.03
	Control Group (C_1)	45	27.09	9.85
Attitude Pre-test	Experimental Group(E)	39	73.59	8.08
	Control Group (C_1)	45	72.13	9. 06

A look at the results in table 4 shows that the mean scores and standard deviation (S.D) of the pre-tested experimental and control groups are slightly different. A t-test was undertaken to determine whether the difference was statistically significant or not at the 0.05 level of significance. The results are presented in Table 5

Table 5:

Independent Sample T-test of the Pre-test Scores on BAT and SAQ

Test	Group	Mean	S.D.	t-value	p-value
BAT	Experimental (E)	26.97	11.03	1.49	0.405
	Control Group (C_1)	27.09	9.85		
SAQ	Experimental (E)	73.59	8.03	2.91	0.633
	Control Group (C_1)	72.67	9.60		

Results in table 5 revealed that the difference in the students scores in the achievement test and the scores of SAQ between the experimental and control group groups were not significant. This is because the p-values of 0.405 and 0.633 tabulated for both the BAT and SAQ respectively are greater than the respective levels ($p>0.05$). This indicates that the students in both the experimental and control groups were at the same achievement level and had similar attitudes. They were, therefore, suitable for the study.

4.2 Effect of the Cooperative Learning Module on Students' Achievement on Classification of Organisms in School Biology

The first hypothesis (Ho_1) sought to determine whether or not, the use of cooperative learning module would have any effect on the students' achievement in classification of organisms in secondary school biology. The mean scores and standard deviations of the pre-test and post-test of BAT were therefore compared for both the experimental (E) and control group 1 (C_1) presented in the Table 6.

Table 6:

Comparison of Pre-test, Post-test and Standard Deviation (S.D) of the Experimental and Control Groups on BAT

Scale	Overall	E	C_1	C_2	C_3
Achievement Pre-test scores	23.85	26.97	27.09	-	-
S.D	10.44	11.03	9.85	-	-
Achievement Post-test scores	42.48	48.45	42.86	43.56	41.99
S.D	16.21	19.55	12.86	14.65	13.31
Mean Gain	18.63	21.48	15.77	-	-

Results shown in table 6 indicate that the experimental group achieved higher scores in the post-test as is evident from the mean gain (21.48). The control group had a low mean gain (15.77) which was lower than the overall mean gain (18.63).

An analysis of variance (ANOVA) carried out to establish whether the subjects' mean scores on the BAT were significantly different are presented in table 7.

Table 7:

ANOVA of Subjects' Post-test Scores on BAT

Test	Source	SS	Df	Ms	F	P-Value
BAT	Between groups	6067.466	3	2022.489	9.032	0.000*
	Within groups	35157.652	157	223.934		
	Total	41225.118	160			

**The mean difference is significant at the 0.5 level.*

The results shown in table 7 indicate that a statistically significant difference exists between the mean scores of the subjects, $F(3,157) = 9.032$, $p<0.05$. However these findings do not indicate which groups are similar and which ones are different. To establish in which of the groups these differences occurred, it was necessary to carry out the Least Significance Difference (LSD) post hoc comparisons that indicates which group are statistically significant different. The results are shown in table 8.

Table 8:

Post Hoc Comparison of the BAT Means for the Four Groups

	(I)Group	(J)group	Mean difference(I-J)	p-value
LSD	Experimental	Control 1	12.129*	.000
		Control 2	3.6303	.286
		Control 3	15.2516*	.000
	Control 1	Experimental	12.1291*	.000
		Control 2	-8.4988*	.011
		Control 3	3.1225	.343
		Experimental	-3.6303	.286
	Control 2	Control 1	8.4988*	.011
		Control 3	11.6213*	.001
		Experimental	15.2516*	.000
	Control 3	Control 1	-3.1225	.343
		Control 2	11.6213*	.001

**The difference is significant at 0.05 level*

Results of the post hoc comparison using the Least Significant Difference (LSD) shown in table 8 indicate the following findings:

a) The mean scores of both experimental group (E) and the other control experimental group (C_2) which received the cooperative learning treatment were not statistically different from each other but were statistically significantly different than those of the groups (C_1 and C_3) that did not receive the treatment.

b) The mean scores of the subjects in the control experimental group (C_2) that was not pre-tested were not statistically different from those of the experimental group (E) that was pre-tested and received the cooperative learning treatment. This is a strong indication that the cooperative learning program had similar effect on the two groups.

c) The subjects in the experimental condition outperformed the students that were taught using the regular methods.

d) The mean scores of the subjects in the true control groups (C_1 and C_3) were similar but significantly lower than those of the subjects in the experimental condition (groups E and C_2).

On the overall, these results indicate that the experimental group outperformed the control group in the achievement test. It can therefore be concluded that the cooperative learning module used by the subjects in the experimental group led to a relatively higher achievement in the learning of biology as compared to the conventional learning

used by subjects in the control group. Therefore the null hypothesis saying that the cooperative learning program would have no significant effect was therefore rejected.

4.3 Effects of Cooperative Learning on Students' Attitude towards Classification of Organisms in Secondary School Biology.

The second null hypothesis Ho_2 sought to determine whether cooperative learning had a significant difference on students' attitude compared to conventional methods. In this study, a Student Attitude Questionnaire (SAQ) was used to determine the students' attitude before and after learning classification of organisms. Two groups, the experimental (E) and group control group1 (C1) were used for comparison since they took part in both the pre-test and post-test. Table 9 summarizes the results of pre-test and post-test on SAQ.

Table 9
A Comparison of Pre-tests and Post-tests Scores and Standard Deviations (S.D.) from the Subjects in both Experimental and Control Groups on the SAQ

Scale	Overall	E	C_1	C_2	C_3
SAQ pre-test	74.10	73.59	72.13	-	-
S.D.	8.82	8.08	9.60	-	-
SAQ post-test	75.93	80.54	72.69	76.62	73.88
S.D.	9.52	9.24	10.13	9.02	9.69
Mean Gain	2.88	6.95	0.56	-	-

Before the commencement of the study, the two pre-tested groups (E and $C_{1)}$ recorded similar scores in the SAQ test as shown in the analysis of pre-tests (table 9). However, as the results in the Table indicate, the experimental group registered a much higher mean gain in attitude (6.95) while the control group1 recorded a much lower mean gain (0.56), which is much lower than the overall mean gain (3.49). However, it is not clear whether this mean gains imply any statistically significant differences. To determine whether the mean scores from the four groups were statistically different, a t-test was performed and the results are presented in table 10.

Table 10:
Results of T-test on Pre-test and Post-test Mean Scores of the Subjects on the SAQ

Variable	Group	Mean Gain	S.D.	t-value	p-value
SAQ	Experimental (E)	6.95	4.17	0.22	0.018
	Control (C_1)	0.56	0.09		

An examination of the results in table 10 indicate that the observed t-value of 0.22 has a p-value of 0.018 which is less than the critical level ($p<0.05$). This implies that the attitude change observed was statistically significantly different in favour of the experimental group. Therefore, it can be concluded that the cooperative learning program enhanced the students' attitude. Therefore, the hypothesis suggesting that the cooperative learning program would have no significant effect on the subjects' attitude towards classification of organisms topic in school biology was therefore rejected.

4.4 Qualitative Descriptions of the Effect of Cooperative Learning on the Subjects Attitudes towards the Learning of Classification of Organisms in School Biology

Student Interview Guides were used to obtain additional data on students' views on the use of cooperative learning strategy in the teaching of school biology. The students in the Experimental group (E) and true control group (C_1) provided the following information about their attitude towards the cooperative learning.

Table 11:

Students' Learning Experiences in Biology Lessons

Variable	Frequency (% in parenthesis)	
	Experimental group	Control group I
Found Learning exciting	16 (65.8)	8 (17.8)
Found Learning depressing	5 (13.1)	21 (46.7)
Experienced fun in Learning	5 (13.2)	7 (15.6)
Felt confused during Lessons	3 (7.9)	10 (22.2)
Total	39 (100.0)	45 (100.0)

The data shown in table 11 illustrate the experiences expressed by students during the course of learning biology. From the results, it can be concluded that apart from finding biology lessons fun the following additional observations were noted:

a) Most students (65.88 %) learning biology using the cooperative module found learning exciting as compared to those (17.8 %)using conventional methods.

b) Fewer students (13.1 %) found cooperative learning depressing as compared to those (46.7 %) using conventional methods.

c) Learners who felt confused by the new method were few (7.9 %) compared to those using conventional methods (22.2 %).

From the foregoing it appears that most students using the cooperative learning program to learn biology developed a positive learning experience towards the topic compared to those using conventional learning method.

In the Student Interview Guides the students were required to provide information about what they

felt the teacher should do during cooperative learning lessons. The data shown in table 12 presents the students' feeling on the role of the teacher during cooperative learning lessons.

Table 12:

Students Perception of the Teachers' Role in Cooperative Learning

Variable	Frequency	Percentage
The teacher should leave them alone and only come in when help is required.	11	26.3
The teacher should tell them what to do.	3	7.9
The teacher should discuss with learners their work.	16	42.1
The teacher to supervise their work.	9	23.7
Total	39	100.0

A look at the results indicates that:

a) A good number (26.3 %) of the learners felt that the teacher should allow more freedom in the groups and only come in to assist when the group is discussing their work.

b) Few learners (23.7 %) suggested that the teacher's role should supervise their work throughout the lesson.

c) The majority of learners (42.1 %) felt that the teacher should come in when the group is discussing their work when other form of help is required.

d) Very few learners (7.9 %) suggested that the teacher should direct all the work done by learners throughout the lesson.

e) They all seem concur that the teacher's role should mainly be facultative and learners should be left to manage their work.

During the interview, learners were asked to give their feelings on how biology lessons should be presented to make them more appealing and easier to understand. Table 13 presents the information provided.

Table 13:

Students' Feelings on Biology Lessons Presentation

Variable	Frequency (% in parenthesis)	
	Experiential group	Control group I
The lessons easy to understand	14 (35.9)	5 (11.1)
The lessons were confusing and not easy to follow.	5 (12.8)	12 (26.7)
The lessons made them learn more Biology.	9 (48.7)	11 (24.4)
The lessons made them hate Biology	1 (2.6)	17 (37.8)
Total	39 (100.0)	46 (100.0)

A summary of the data shown in table 13 reveal that:

a) Few students (12.8 %) saw the method as a source of confusion compared to many students (26.7 %) learning biology using conventional methods.

b) More than a third (35.9%) of the learners felt that the cooperative learning method enabled them to learn and understand more about biology compared to 11.1 % sing conventional learning methods.

c) Most students (48.7 %) felt that the method made them learn more compared to (24.4 %) who indicated that using conventional methods made them learn more about biology.

d) More students (37.8 %) developed a negative attitude towards the conventional methods as compared to the few (2.6) using the cooperative learning program.

The participating learners were required to give general comments on the use of cooperative learning method. The information provided is summarized in table 14.

Table 14:

Students' General Comments on the Use of Cooperative Learning Method.

Variable	Frequency	Percentage
The method a source of anxiety	8	21.1
The method was something to look forward to	21	52.6
The method not exciting or not motivating	10	26.3
Total	39	100.0

The summary of data in table 14 indicates that:

a) more than half (52.6 %) of the students interviewed said they looked forward to learning using the new method.

b) few students (21 %) found the method as source of anxiety while.

c) few students (26.3 %) did not find it exciting or not motivating.

From the foregoing, it can be inferred that the majority of learners showed a positive inclination towards learning biology in cooperative groups.

The students were further required to indicate whether the cooperative learning method encouraged a free learning environment where they could participate freely or if they found it frustrating and discouraging. Table 15 gives a summary of the information obtained.

Table 15:

Students' Perception of Cooperative Learning Method and Ability to Receive and Respond to Questions and Answers

Variable	Frequency	Percentage
Found the method motivating and errors can be corrected without making the learner embarrassed	32	81.6
Said the method was frustrating and discouraging	5	13.1
Had a negative attitude towards the method	2	5.3
Total	39	100.0

The data presented in table 15 show that:

a) Most learners (81.6 %) of the learners found the new method motivating and suitable in the correction of errors without causing embarrassment to the affected learners. This is due to the use of peers in smaller discussion groups as opposed to full class where the learners shy off in fear of ridicule.

b) Only a small number of learners said the method was frustrating (13.1%).

c) A negligible number had a negative attitude towards the method (5.3 %)

The learners were also required to suggest the aspects of learning where cooperative learning method could be applied to improve the learning of biology. Their suggestions were summarized in table 16.

Table 16:

Students' Suggestions on Learning Aspects where Cooperative Learning should be Employed.

Variable	Frequency	Percentage
Where encouraging the sharing of resources with teachers' supervision is needed.	30	75.7
Found the method inappropriate in the introduction of new topics.	3	8.1
Said the method is good for revision only.	6	16.2
Total	39	100.0

The summary of data in table 16 shows that:

a) A majority (75.7 %) of suggested that cooperative learning motivating allowed the sharing of resources with teacher's supervision.

b) Only a few learners (8.1 %) found the method inappropriate in the introduction of new topics.

c) A few learners (16.2 %) suggested that the method was good for revision only.

The interview further sought the experiences of learners who participated in the cooperative learning groups. The obtained results are summarized the in table 17.

Table 17:

Students' Reactions about Working in Groups.

Variable	Frequency	Percentage
Liked working in groups	34	86.8
Did not like working in groups	5	13.2
Total	39	100.0

From the table, it can be concluded that:

a) Most of the learners interviewed (86.8 %) liked working in groups while;

b) Only a few (13.2 %) did not.

The interviews sought the inclination of students on working in cooperative groups in future. The students provided the information on table 18.

Table 18:

Students' Reactions about Working in Cooperative Groups in Future.

Variable	Frequency	Percentage
Would like to work in cooperative groups again.	29	73.7
Would not like to work in cooperative groups again	10	26.3
Total	39	100.0

The data summarized in table 18 show that:

a) A Majority of learners (73.7 %) registered their desire to work in group in future while;

b) Only a few (26.3 %) indicated that they would not like working in groups in again.

4.5 Teachers' Views on the Merits and Demerits of the Cooperative Learning Strategy

The Biology teachers using cooperative learning method to teach Biology were interviewed and provided the following information on the cooperative learning method.

1. First Experience of Having to Use the New Method to Teach Biology

On their first experience of having to use the new method to teach biology, one of the two teachers agreed that it caused some tension and apprehension among the students at first due to its sudden introduction. The other teacher indicated that he had earlier on used group work and therefore was used to it. The teachers noted that most learners adjusted fairly fast due to the contribution made by their colleagues. The following are excerpts from the interview carried out with the participating teachers.

Excerpt 1

Researcher: What was your experience of having to use the method to teach biology?

Teacher 1 (Experimental group): Introducing the new method was a bit difficult especially the grouping of students. Putting students in a group was not as easy as I

anticipated. You see, you have to consider the students who can work together and benefit from the group. Some students can be tense and never contribute in the group discussions. (Excerpt 1, Teacher Interview, Group E, 5 March 2004).

Teacher 2 (Experimental group): Using groups for discussion was not a new experience for me. I have used informal groups in experimental work before. I think it makes the work easier since the better students assist their classmates when need arises. (Excerpt 1, Teacher Interview, Group E, 5 March 2004).

Teacher 3 (Control group 2): It is all right although biology is not an easy subject. I use this form of teaching in biology and I am used to it now. We have to teach this way though it is difficult to enable us cover the syllabus. (Excerpt 2, Teacher Interview, Group C_1, 10 March 2004).

Teacher 4 (Control group 2): I use various methods depending on the content and type of students. This enables me to pass the message across to all types of learners. (Excerpt 2, Teacher Interview, Group C_1, 10 March 2004).

2. Role of Teacher When Teaching the Biology Course Using this New Method

All the teachers interviewed suggested that the teacher's role should be guiding the learners towards achieving the set objectives. The teacher should always be there to facilitate the discussions by supplying the necessary reference material, and ensure learners stick to the relevant aspects of a discussion. Moreover the teachers noted that when left on their own learners can easily digress into unrelated issues in their discussions. Excerpts of the interview with some of the interviewed teachers are presented below.

Excerpt 2:

Researcher: What do you feel should be your role in a lesson?

Teacher 1 (Experimental group): Guiding the learners to ensure that the discussion remains focused on the goals of the lesson. (Excerpt 1, Teacher Interview, Group E, 5 March 2004).

Teacher 2 (Experimental group): A teacher should supply all the requirements of the learners to facilitate the leaning process. He should also be around to make sure that students do not digress to unrelated issues in their discussion. (Excerpt 1, Teacher Interview, Group E, 5 March 2004).

Teacher 3 (Control group 2): A teacher should guide the students especially at the beginning of the lesson. (Excerpt 2, Teacher Interview, Group C_1, 10 March 2004).

Teacher 4 (Control group 2): A teacher should be present at all times to facilitate the learners' discussions. When left on their own learners can digress from the objectives of the lesson. (Excerpt 2, Teacher Interview, Group C_1, 10 March 2004).

4.6 Effectiveness of Cooperative Learning in the Teaching of Biology.

The two teachers who used the cooperative learning method to teach experimental group E and second control group C_2, asserted that learning in groups was quite successful. They noted that the majority of learners were more relaxed in smaller groups than in the full class. The learners who were active in the groups were able to master the concepts more easily than the less active members. The teachers found the teaching method suitable in the teaching of biology and therefore had a positive effect on their teaching of biology. The teachers also noted that group work enhanced learning and were quick to agree that they would not hesitate to use the cooperative learning method in other topics of biology. They however cautioned that this method should be introduced with care since learners take time to get used to new ideas. Below are some of the excerpts from the teachers' interview.

Excerpt 3:

Researcher: Do you think that the new learning method affected the learning of biology?

Teacher 1 (Experimental group): Yes! The students' discussions were very productive. Students were able to discuss with their colleagues at the same level and language. Grouping of learners enhanced their participation since there was enough time for all to contribute (Excerpt 1, Teacher Interview, Group E, 5 March 2004).

Teacher 2 (Control group 2): I think the effect was positive; Students were more active in the smaller groups than they are in the whole class. The group discussions was actually beneficial to both the bright and weak students because all were more relaxed in the groups that in normal class situations. (Excerpt 2, Teacher Interview, Group C_1, 10 March 2004).

4.7 Discussion of the Results

This study was designed to determine the effects of cooperative learning on students' achievement and attitude towards classification of organisms in school Biology. To achieve this, two groups of students were taught using cooperative learning while two other groups were taught using conventional methods. From each category, one group was pre-tested while the other received a post-test only.

From the results of this study it was observed that;

a) Learners in The experimental group outperformed those in the control group. The results of the study indicate that students who learnt classification of organisms through cooperative learning achieved higher than those taught using conventional methods.

b) Learners using the cooperative learning program to learn classification in school biology developed a comparatively better attitude towards biology as compared to those using regular methods. Learners using the cooperative learning program expressed a desire to learn more than those in the control programs.

These findings indicate that cooperative learning is highly effective in enhancing students' achievement as well as fostering appositive attitude towards school biology. Qualitative findings from interviews also clarified that students learning cooperatively developed better social interactions and found the new method helpful in the understanding of content.

These observations are in agreement with findings of similar studies carried out earlier. While studying the effects of cooperative learning in Chemistry Class Experiments (CCE), Wachanga (2000) found that students in cooperative class experiment groups in Nakuru District secondary schools in Kenya achieved higher than in control groups. In a similar study, Chemwei (2002) designed a cooperative learning module and studied

its effects on the learning of poetry. He concluded that students learning poetry using a co-operative learning approach in Baringo secondary schools in Kenya achieved higher and developed positive attitude compared to those taught the same course content using conventional methods. Johnson and Johnson (1991) also documented that students working in groups benefit more than those working individually on a similar task. Research also indicates that students in large classes benefit more than when working in groups than in conventional classes (Kiboss, 1997).

The findings indicate that when students interact during the learning process, both the weak and bright students benefit. In addition interpersonal interaction increases productivity (Johnson & Johnson, 1998). The bright students explain to their weaker peers in a language level that they can understand. Therefore students act as resource to their peers. This method is therefore highly recommended for Biology teachers at the secondary school level.

The findings of this study further indicate that students developed a positive attitude towards the subject. A positive attitude enhances achievement through motivation. The findings indicate that, a majority of students (86.8 %) indicated, they found working in groups desirable. Furthermore most of the students (73.7 %) showed a desire to work in groups in other topics.

In a conventional learning set up the teacher is the centre of interest as he controls the whole class. Wachanga (2000) note that such a setup denies the learners a chance to interact between themselves. Only one learner can interact with the teacher at a time and the rest of the students remain passive during that particular time. In a cooperative learning interaction, learners can benefit from the student–student interaction that also enhances students' motivation and achievement. In addition students' attention and confidence improve as they work in groups.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the conclusion and recommendations drawn from the results of the study. In the chapter, the implications of the study have also been discussed and suggestions made for further research based on the results from the study.

5.1 Summary and Conclusions

5.1.1 Summary of the findings

In summary the findings of the study indicate at:

1. Cooperative learning offers a bold departure from traditional objectivist classroom strategies.

2. The goal is for the learner to play an active role in assimilating knowledge onto his/her existing mental framework.

3. The ability of students to apply their school-learned knowledge to the real world is valued over memorizing bits and pieces of knowledge that may seem unrelated to them.

4. The cooperative learning approach requires the teacher to relinquish his/her role as sole information-dispenser and instead to continually analyze his/her curriculum planning and instructional methodologies. Perhaps the best quality for a cooperative learning teacher to have is the "instantaneous and intuitive vision of the pupil's mind as it gropes and fumble to grasp a new idea.

5. Cooperative learning opens new avenues for learning as well as challenges for the teacher trying to implement it.

6. Cooperative learning encourages students to challenge each other's conceptualizations and ideas.

5.1.1 Conclusions

From the results of this study, it can be concluded that:

1. Students learning biology through cooperative groups achieved higher than those learning the same course content through the conventional methods. This is evident

from the significant gain in BAT by students learning cooperatively as compared to those learning through conventional teaching methods. Cooperative learning is therefore a more effective learning method than the conventional methods currently in use.

2. Cooperative learning method is enhances a positive attitude towards Biology than when the conventional methods are used. More students expressed desire to work with their classmates in other topics in future.

3. Learning biology in cooperative groups enables students to interact more in a social environment that enabled them to learn from each other. Learners expressed themselves better in smaller group unlike in the whole class. They were also able to identify their colleagues as a source of ideas instead of competitors.

4. Students learning through cooperative groups develop more confidence than those learning through conventional methods. Cooperative groups provide learners with opportunities to express themselves as they ask or answer questions in group discussions. In addition the learners develop their cognitive and affective domains and improve manipulative skills.

5. In cooperative learning the teachers' role should be mainly facilitative. This promotes the constructivists' approach to teaching where the learners' contributions are regarded useful to their learning and understanding.

6. When teaching using cooperative groups the teacher has adequate time to give the much needed remedial attention to weaker learners as well evaluate progress from one group to the other.

From the foregoing, it may be concluded that the statistically significant difference observed in favour of the experimental groups (E and C_2) is not unrelated to the cooperative learning program in which they were exposed. In other words, the cooperative learning program had a relative effect on the students learning of classification in school biology.

5.2 Implications of the Study

In the current classroom practice use of conventional methods like lectures and writing notes cannot adequately achieve meaningful learning. The classroom learning used mainly benefits the higher achievers. Weaker students learning the subject are disadvantaged since

they are unable to comprehend and master concepts mainly taught in lectures. The results of this study indicate that cooperative learning enhances student achievement in Biology at secondary school level. They also indicate that students taught through this method develop a favourably attitude towards the subject leading to a higher interest in learning. From the foregoing indications important implications merit special attention:

(i) The method raises enthusiasm in biology lessons thus enhancing learning but teachers must initiate learner interaction in order to promote a socially active environment. Learners in groups whose members interact freely and share information in a relatively free environment effectively share experience and thereby relate learning to real life.

(ii) Though cooperative learning encourage the use of alternative sources of information both from written materials and experts, teachers require to be sensitized on the importance of new teaching methods. Therefore science teacher colleges and universities should emphasize cooperative learning in preparation of similar application in our secondary schools.

(iii) Weak students should be encouraged not to hold back in fear of ridicule since groups are made up of peers.

5.3 Recommendations

Based on the results of this study, the cooperative learning method leads to high student achievement and a positive attitude towards Biology in secondary school Biology. It is therefore recommended that:

1. Teachers incorporate it in teaching Biology at the secondary school level, especially in topics where group work is particularly desirable. However as Wachanga (2000) notes, it is essential that teacher training programmes prepare the teachers as effectively as possible by providing them with the knowledge and skills necessary to achieve the educational goals and objectives. It is thus recommended that the teacher educational institutions such as universities make cooperative learning method of teaching part of the content covered during training. This would ensure that the method is effectively used in school to achieve better results in school science teaching.
2. Teachers' guides and other reference books should also incorporate learner-centred activities that will enhance cooperative learning. It is therefore recommended that the Ministry of education science and technology (MOEST) give the relevant guide lines in the writing of biology books and foresee the inclusion of cooperative learning in

secondary schools biology curriculum. It is also recommended that teacher education curriculum developers incorporate cooperative learning method in their training syllabus to make it port of the biology education curriculum.

3. The education regulation bodies like the Kenya Institute of Education (K.I.E.) should encourage teachers to use cooperative learning method in their teaching since it enables the sharing of the few facilities available.

4. Lastly the content of cooperative learning should be included in the regular in-service courses organized by the Ministry of Education e.g. strengthening mathematics and secondary science education (SMASSE) for practicing teachers.

5.4 Areas for Further Research

Though this study has found cooperative learning to lead to higher achievement and positive attitude towards Biology, the following areas need further investigation:

1. A study should be carried out to determine the duration of retention of knowledge acquired through cooperative learning to establish its long term effect.

2. A study should be carried out to investigate the effects of cooperative learning on student acquisition of science process skills.

3. A study should be carried out to determine the effects of students' age on cooperative learning, whether or not age affects interaction between students and the effects of such a hindrance.

4. A study should be carried out to investigate the effects of teacher qualification and experience on the effectiveness of cooperative leaning in secondary school biology.

5. A study should be carried out to determine the effects and role of gender and group composition on the effectiveness of cooperative learning in biology.

REFERENCES

Alsop, S. and Hicks, K. (2001). *Teaching Science. A Handbook for Primary and Secondary School Teachers:* London. Kogan Page Ltd.

Alters, S. (1996) *Biology Understudy Life*: New York. Mosby–year Book, Inc.

American Association for the Advancement of Science, Project 2061. (1990). Science *for All Americans* New York: Oxford University Press.

American Association of Colleges for Teacher Education. (1987). Teaching teachers: Facts and figures. Washington, DC: Author. ED 292 774.

Argyle, M (1983) *The Psychology of Interpersonal Behaviour*: Harmondsworth. Penguin.

Aronson, J. (2002). *Improving Academic Achievement. Impact of Psychological Factors on Education.* USA: Elsevier Science.

Ary, D., Jacobs, L.C, Razavich, A., (1972*). Introduction to Research in Education*: New York: Rinehart and Winston. Inc.

Bajah, S. T. (1981) Preparation of the Secondary School Teacher of the Physical Sciences for the African Environment, *West African Journal of Education*, XIX, 85-86.

Baron, L. C., & Goldman, E. S. (1994). Integrating technology with teacher preparation. In B. Means (Ed.), *Technology and Education Reform*. San Francisco: Jossey- Bass Publishers. 81-110.

Bell, B. and Gilbert, J. (1996).*Teacher Development. A Model from Science Education.* Great Britain: The Falmer Press.

Bennaars, G.A. (1993) *Ethics, Education and Development East African*: Nairobi. Educational Publishers, Ltd.

Bennaars, G. A; Otiende, J.E. and Boisvert, B.R. (1994). *Theory and Practice of Education.* Nairobi: East African Educational Publishers Ltd.

Bloom, J.R. and Schunke, G.M. (1979). *The journal of Experimental Education* 48, (1), 84-90.

Bogonko, S.N. (1992). *A History of Modern Education in Kenya (1995-91* Nairobi: ACME press (Kenya) Ltd.

Bogonko, S.N. (1992). *Reflections on Education in East Africa.* Nairobi: Oxford University Press.

Borg, R.W. (1987). *Applying Education Researches. A Practical Guide for Teachers.* New York: Macmillan.

Borg, W.R and Gall, M.D. (1989*). Educational Research. An Introduction. 4th Ed.* New York: Longman INC.

Bosch, K. A., & Cardinale, L. (1993). Preservice teachers' perceptions of computer use during a field experience. *Journal of Computing in Teacher Education,* 10(1), 23-27. EJ 492 121.

Bracey, G. W. (1993). Research: *Exemplary computer use.* Phi Delta Kappan75 (3), 270-273

Brooks, J.G. and Brooks, M.G. (1993):*Association for Supervision and Curriculum Development.* Alexandria, VA.

Brown, C.R. (1995). *The Effective Teaching of Biology*. London: Longman.

Brown, G. and Atkins, M. (1991). *Effective teaching in Higher Education*: London. Rout edge.

Bruner, J.S. 1960: *The Process of Education.* Cambridge, Mass.: Belknap Press.

Campoy, R. (1992). The role of technology in the school reform movement. *Educational Technology,* 32(8), 17-22.

Cangelosi, J.S. (1997). *Classroom Management Strategies: Gaining and Maintaining Students Cooperative.* Longman: New York.

Caprio, M.W. (1994). Easing into constructivism, connecting meaningful learning with student experience. *Journal of College Science Teaching,* 23 (4), 210-212.

Carey, S., Evans, R., Honda, M., Jay, E., & Unger, C. (1981). 'An experiment is when you try it and see if it works': a study of grade 7 students' understanding of the construction of scientific knowledge. *International Journal of Science Education,* 11, 514-529.

Carin, A.A., Bass, J.E. and Constant, T.E. (2001). Methods for Teaching Science as Inquiry. USA: Pearson Merrill Prentice Hall.

Castle, E. B. (1979). *Principals of Education for Teachers in Africa.* Oxford: Oxford university press.

Cheek, D.W. (1992). Thinking *Constructively About Science, Technology and Society Education.* Albany, NY: State University of New York Press.

Chemwei, B. (2003). *Effects of Cooperative learning on students AchievementAnd Attitude towards the learning of Poetry in selected secondary schools in Baringo District, Kenya.* Unpublished M.Ed. Thesis. Egerton University.

Changeiywo, J.M (2000*). Students' Image of Science in Kenya: A Comparison by Gender Difference, Level of Schooling and Regional Disparities.* PhD Thesis, Egerton University: Njoro.

Cook T.D. and Campbell, D.T. (1979). *Quasi-experimentation.* Boston: Houghton Mifflin.

Crowther , D. T. (1997). The Constructivist Zone. *Journal of Science Education,* Vol. 2, No. 2

D'Souza, H. (1987). *Kenyan Education in Its African Context (vol. 2)*. New York: Vantage press.

Daudel, R. (1986). *Life Science and Society*. Oxford: Elsevier.

Delamont, S. (1976). *Interaction in the Classroom.* London: Routledge.

Driver, R., Asoko, H., Leach. J., Mortimer, E. and Scott, P. (1994). 'Constructing Scientific Knowledge in the Classroom', *Educational,* 23, 7, 5-12.

Driver, R., Squires, A., Rushworth, P. and Wood-Robinson, C. (2000*). Making Sense of Secondary Science. Research Into Children's Ideas* London: Routlege Falmer.

Eggen, P.D. (1979): *Strategies for Teachers. Englewood Cliffs*: Prentice-Hall Inc.

Eggleston, J.F. Galton, M and Jones, M.E (1976). *Process and Products of Science Teaching.* London: Macmillan Education.

Feifer, N. (1971): "The Teacher's Role in the Discovery Approach: Lessons from the History of Science." *The Science Teacher*, 38, Nov., 27-29.

Feldman, R. S. (1986). *The social Psychology of Education Current Research and Theory*.New York: Cambridge University Press.

Forman, E.A. (1993). *Contents for Learning: Socio-Cultural Dynamics in Children's Development*. New York: Oxford University Press.

Frankfork-Nachmas, C. and Nachmias, D. (1997) *Research methods in the social science:* New York. Martin's Press Inc.

Fraser, B.J. and Walberg, H.J. (1995). *Improving Science Education.* USA: The International Academy of Education.

Goodlad, S.D. (1989). *Peer Tutoring: A Guide to Learning by Teaching.* New York: Nichols publishing.

Gruber, H.E. & Voneche J.J. (1977): *The Essential Piaget: An Interpretative Reference and Guide.* New York: Basic Books.

Hamacheck, D. (1995). *Psychology in Teaching, Learning and Growth.* Boston; Allyn and Bacon publishers.

Hawes, H. (1988). *Child to Child: Another Path to Learning.* Hamburg: UNESCO institute of Education.

Hertz – Lazarowitz, R.H. and Miller, N. (1998). *Interaction in Co-operative Groups. The Theoretical Anatomy of Group Learning.* New York: Cambridge University Press.

Hohn, R.L. (1995). *Classroom Learning and Teaching.* U.S.A: Longman.

Hunt, N. P., & Bohlin, R. M. (1995). Events and practices that promote positive attitudes and emotions in computing courses. *Journal of Computing in Teacher Education,* 11(3), 21-23. SP 524 325.

Indagasi, H. Motoro, H. and Manna, M. (1993). *American Studies in East Africa.* Nairobi: Nairobi university press.

Ishumi, A.G.M. (1994*) 30 Years of Learning Education Development in Eastern and Southern Africa from Independence to 1990*: Canada. International Development Research Centre.

Johnson, D.W. Johnson, R.T. and Holubec, E. (1993). *Cooperation in the Classroom.* New York: Teachers College Press.

Johnson, D.W. and Johnson, R.T. (1997). *Learning Together and Alone.* Englewood Cliffs: Prenticehall.

Johnson, D.W. and Johnson R.T. (2000). *Cooperation and Competition*: Theory and Research Interaction Books. Edna MN.

Johnson, E.P. (1971) *Psychology of School Learning*: U.S.A. John Wiley & Sons Inc.

Johnson, G.B. (2000). *The Living World*: U.S.A. The McGraw –Hills Companies, Inc.

Joyce, B. & Weil, M. (1980). *Models of Teaching*. Englewood Cliffs: Prentice-Hall Inc.,

Kennedy, I. M. (1995). 'Cooperative Learning and Computers: Understanding the partnership'. In P.M. Alexander *Computer Assisted Instruction and Training in Developing Countries.* Pretoria: University of South Africa.

Kenya Institute of Education (K.I.E.) (1988). *Biological Sciences Syllabus for KenyaCertificate of Secondary Education.* Nairobi: Kenya Literature Bureau.

Kenya Institute of Education (KIE) (1992). *The Secondary School Syllabus Vol. 7.* Nairobi: Jomo Kenyatta Foundation.

Kenya Institute of Education (KIE) (2001). *Secondary Biology: Form Three Students Book.* Nairobi: Kenya Literature Bureau.

Kenya National Examination council (KNEC 1998) *Examination Report* Vol. 1

Kenya National Examination Council (KNEC 1999) *Examination Report* Vol. 1

Kenya National Examination Council (KNEC 2000). *Examination Report Vol.1*

Keraro, F.N. (2002) *Acquisition of Science Concepts and Skills by Kenyan Primary School Pupils: The influence of Culture and Learning Opportunities.* Unpublished Ph.D. Thesis. Egerton University

Kiboss, J.K. (1997) *Relative Effects of Computer Based Instruction in Physics on Students' Attitudes, Motivation, and understanding about Measurement and Perception of the Classroom Environment.* Unpublished D. Ed. Thesis, University of Western Cape.

Kiboss, J. K. (2000). Teacher/Pupil Perspective of Computer Augmented Physics Lessons on Measurement in Kenya Secondary schools. *Journal for Information Technology for Teacher Education (9) 3,* 119-213

Koul, L. (1984). *Methodology of Education Research.* Delhi: Vikas publishing house Ltd.

Lazarowitz, R., Hertz- Lazarowitz, R., Baird, J.H. and Bowlden, V. (1988). Academic Achievement and on Task Behaviour of High School Biology Students Instructed in Cooperative Investigative Small Group. *Science Education Journal, 72, (4),* 475-487.

Leed, P.D. *(1989). Practical Research. Planning and Design. 4th ed.* New York, Macmillan Publishing Company.

Lindvall, O.M (1995) *Measuring Pupil Achievement and Aptitude:* U.S.A. Harcourt Brace Taranovich, Inc

Lord, T.R. (1994). Using constructivism to enhance student learning in college biology. *Journal of College Science Teaching,* 23 (6), 346-348.

Madden, N.A, and Slavin, R.E (1983) Effects of Co-operative Learning on the Social Acceptance of Mainstreamed Academically Handicapped Students. *Journal of SpecialEducation,* 17, 171 –182.

Madden, N.A., and Slavin, R.E. (1983). Effects of Co-Operative Learning on the Social Acceptance of Mainstreamed Academically Handicapped Students. *Journal ofEducational Psychology,* 60, 75-78.

Malamah-Thomas, A. (1997*). Classroom Interaction.* Oxford: Oxford University press

Maundu, J.N., Sambili, H.J. and Muthwii, S, M, (1998). *Biology Education: A Methodological Approach.* Nairobi: Latern publishing.

Means, B. (Ed.). (1994). *Technology and education reform.* San Francisco: Jossey-Bass Publishers.

Ministry of Education (1967) Triennial Survey 1964-66 and Annual Report for 1966.

Monk, M. (2000). A critique of the QCE Specimen of Work for Stage 3 Science, *School Science Review* 81, 297.

Ndirangu, M. (1991). *Designing Active ways of learning for cooperative education in Kenya.* Unpublished M.Ed Thesis: University of Wales Aberystwyth.

National Research Council (1990). *Fulfilling the promise: Biology Education in the Nation'sschools.* Washington D.C.: National Academy Press.

Newton, D (1988). *Making Science Education Relevant.* Worcester: Billing and sons Ltd.

Ngesa, F. U. (2002). *Impact of Experiential and Mastery Learning Programme on Academic Achievement in Secondary School Agriculture.* Unpublished PhD Thesis. Egerton University.

Odhiambo, T.R. (1999) Vision on Science for the New Millennium: *Discovery and Innovation Journal* 11, 314 122-124.

Office of Technology Assessment. U.S. Congress. (1995*). Teachers & technology: Making the connection. Washington,* DC: U.S. Government Printing Office.

Ogunniyi M. B. (1998) *Effects of Science and Technology on Traditional Beliefs and Cultures.* Bellville: University of Cape.

Ogunniyi, M.B. (1996). Two Decades of Science Education in Africa *Journal of Science Education, 70 (2)* 111-122.

Okere M. (1996*) Physics Education.* EMC and Lectern Publishers LTD. Njoro: Kenya.

Oluoch, G.P. (1982), *Essentials of curriculum development*: Nairobi. Birds Printers, office stationary and equipment ltd.

Otiende, J.E., Wamahiu, S.P. and Karugu, A. M. (1992). *Education and Development inKenya.* Nairobi: Oxford university press.

Parkinson, J. (1998). *The Effective Teaching of Secondary Science.* London: Longman

Piaget, J. (1964). "Development and Learning." *Journal of Research in Science Teaching.* 2, 2, 176-186.

Popper, K. (1961). *The Logic of Scientific Discovery.* U.S.A.: New York Science Editions.

Postlethwaite, K. (1993). *Differentiated Science Teaching.* Philadelphia: Open University Press.

Race, P. and Packard, N. (2000). 2000 *Tips for Teachers.* London: RoutledgeFalmer.

Raizen, S.A. and Michelsohn, A.M. (1994). *The Future of Science in Elementary Schools.* San Fransico: Jossey-Bass.

Ramirez, R., & Bell, R. (1994). Recent legislative initiatives expected to affect educational technology. In NCREL policy briefs, Report 3 (pp. 26-31). Oak Brook, IL: *North CentralRegional Educational Laboratory.* ED 374 -786.

Renner, J.W. & Wick S. W. (1976*). Research, Teaching and Learning with the Piaget Model.* Norman: University of Oklahoma Press

Resnick, L.B. (1987). Learning in school and out. *Educational Researcher,* 16, 13-20.

Ross, B. (2000). *Modern Trends in Education.* London: The Macmillan press Ltd.

Ross, E. (2000) *Concepts in Biology McGraw: U.S.A.* Hull Companies Inc.

Sadler, M.P. and Sadler, D.M. (2000) *Teachers, Schools, Society.* U.S.A. McGraw- Hill High Education.

Schulman, L.S. (1972): *"Psychological Controversies in the Teaching of Science and Mathematics" in R.G. Good, Science <--> Children: Readings in Elementary Science Education.* Dubuque: Wm. C. Brown Co., Publishers,

Shayer, M and Adey, P. (1981). *Towards a Science of Science Teaching.* London: Heinemann Educational Books.

Sheingold, K. (1991). *Restructuring for learning with technology.* Phi Delta Kappan, 73 (1), 17-27.

Slavin, R. (1989*). Co-operative Learning.* New York: Longman.

Slavin, R.E, (1986). Research on Co-Operative Learning: An International Perspective. Scandinavian, Journal *of Educational Research, 33 (4)* 35-55.

Smasse (2004). Trends in Teaching Approaches and Methods in Science and Mathematics Education. A Paper Presented in 1st Circle National Inset of Smasse Project.

Solomon, J. (1986). Motivation for Learning Science. *The School and Science Review 67 (240)* 436-442.

Strike, K.A. 1975: "The Logic of Learning by Discovery". *Review of Education*

Taylor, M.R. (2000) *Student's Study Guide for Campbell's Biology*: U.S.A. The Benjamin/Cummings publishing Company, Inc.

Thomas, L. (1994). NCATE releases new unit accreditation guidelines: Standards for technology are included. *Journal of Computing in Teacher Education*, 11(3), 5-7' SP 523 918.

Thornburg, D. D. (1992). *Learning alternatives: Technology in support of lifelong education. In Council of Chief State School Officers, Learning technologies essential for educational change).* Washington, DC: Council of Chief State School Officers.

Tiberondwa, A.K. (1981). The status of African Teachers in Independent Africa. Education: Eastern Africa Journal 161-166.

Topp, N. W., Mortensen, R., & Grandgenett, N. (1995). Building a technology-using faculty to facilitate technology-using teachers. *Journal of Computing in Teacher Education,* 11(3), 11-14. SP 524 325. *Research,* 45, 3, 461-483.

Tsuma, O.G.K. (1998). *Science Education in the African Context.* Nairobi: The Jomo Kenyatta Foundations.

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological processes.* Cambridge: MIT Press.

Wachanga, S.W. (2002). *Effects of Co-operative Class Experiment Teaching Method on Secondary School Students' Motivation and Achievement in Chemistry.* Unpublished PhD. Thesis, Egerton University, Kenya.

Walkin, L. (1982). *Instructional Technique and Practice.* United Kingdom: Stanley Thornes (publishers) Ltd.

Walters, J. T. (1992, June). *Technology in the curriculum: The inclusion solution. Paper presented at the National Forum of the Association of Independent Liberal Arts Colleges for Teacher Education;* Louisville, KY.

Wanjohi, G.T. (1981). *The child and his environment in black Africa. An essay on traditional education*: New York. Oxford University Press.

Weibe, J. (1995). The need to teach people about computers. *Journal of Computing in Teacher Education,* 11(3), 2-3.

Wekesa, W.E. (2003) *Effect of a Computer Based Instruction Module On Students' Achievement, Perception Of Classroom Environment And Attitude Towards Secondary School Biology in Nakuru District, Kenya.* Unpublished masters of Education Thesis: Egerton University, Kenya.

Widmer, C. C., & Amburgey, V. (1994). *Meeting technology guidelines for teacher reparation.* Journal of Computing in Teacher Education, 10(2), 12-16. SP 523 575.

Williams, M. (1989) Vygotsky's Social Theory of Mind. *Harvard Educational Review, 59(10),* 108 –126.

Yager, R. (1991). The constructivist learning model, towards real reform in science education. *The Science Teacher*, 58 (6), 52-57.

APPENDICES

APPENDIX 1

BIOLOGY ACHIEVEMENT TEST (BAT)

ADMISSION NUMBER---------- CLASS--------- AGE-------- SEX----------

INSTRUCTIONS TIME: 2 HOURS

1. Please try to answer all the questions.
2. Take your TIME BUT DO NOT spend TOO MUCH TIME on one question
3. Read the question carefully and try to understand before answering.
4. If you do not understand something, please ASK FOR HELP from the teacher.

Questions

1. Identify the shapes of the leaves marked A and B



A



B

(a) A----------

(b) B----------

2. Identify the type of margins in leaves C and D.



C



D

C----------

D----------

3. Define the following terms as used in scientific classification of organisms

(a) Taxonomy

(b) Species

4. What is Binomial nomenclature?

5. State three differences between plants and animals

(i).

(ii).

(iii).

6. Explain the importance of biological classification

7. What name is given to plants found in dry (arid) areas?.....

8. State four diagnostic features of the phylum platyhelminthes

i)

ii)

iii)

iv)

9. What are the five classes of the phylum arthropoda?

i)

ii)

iii)

iv)

v)

10. What is a dichotomous Key?

11. Name the taxonomic units in order from the largest to the smallest.

12. Name the largest living mammal. .....

13. What is a habitat?

14. Differentiate between common names and scientific names of living organisms

15. An organism has the following observable features: unicellular, has chloroplasts, has one or two flagella and contractile vacuole

(a) Give the following taxa of the organisms

(i) Kingdom.....

(ii) Division.....

(b) Give an example of an organism in this group.....

16. State five characteristics common to all living organisms

(i) ----------

(ii) ----------

(iii) ----------

(iv) ----------

(v) ----------

17. What are the main characteristics of organisms in Division Spermatophyta?

18. State any three differences between dicotyledons and monocotyledons.

(i)

(ii)

(iii)

19. What are the reproductive cells in Bryophytes called? .....

20. What are the main characteristics of organisms in Division Pteridophyta?

21. Use the key below to identify the plant diagrams S, T, and U.

Key

1. (a) Plant with simple leaves----------2
   (b) Plant with compound leaves----------3
2. (a) Flower has fused petal----------4
   (b) Flower has separate petals----------5
3. (a) Leaf has five leaflets----------**Gynadropsis**
   (b) Leaf has three leaflets---------- **Vigna**
4. (a) Plant has climbing stem---------- **Ipomoea**
   (b)Plant has erect stem---------- **Mirabilis**
5. (a) Flower has five petals---------- **Pavonia**
   (b)Flower has four petals----------**Farsetia**

Diagrams







S **T** **U**

Identification Steps followed

S---------- ----------

T---------- ----------

U---------- ----------

(b) List two observable differences between T and U which have not been mentioned in the key

(i)

(ii)

22) What are main characteristics of the phylum coelenterata?

23) How are reptiles adapted to their habitat?

24) In what phylum and class are birds classified?

Phylum..... Class.....

25) State four main functions of a plant leaf

i)

ii)

iii)

iv)

26) Why are mycophytes neither completely classified as neither animals nor as complete plants?

27) Name three characteristics of a mammal

(i)

(ii)

(iii)

28) What is the scientific name of modern man? ----------

29) List the three general principles of classification of living things

i)

(ii)

(iii)

30) Name three divisions of kingdom plantae?

(i)

(ii)

(iii)

APPENDIX 2

STUDENTS' ATTITUDE QUESTIONNAIRE (SAQ)

STUDENT NO_____ CLASS_____ AGE_____ GENDER____

We are interested to know how you feel about this biology course

INSTRUCTION:

1. This is not a test and there are no RIGHT or WRONG ANSWERS
2. It is important that you tell us your HONEST feeling.
3. Read the items carefully and try to understand before choosing what truly reflects your honest opinion.
4. Circle around the letter that corresponds with how you really feel towards the biology course.
5. The letter CHOICES are SA= Strongly agree, A= Agree, U= Undecided, D= Disagree, SD= Strongly disagree.

Questions

1.	The biology lessons were understandable	SA A U D SD
2.	The biology lessons were dull	SA A U D SD
3.	The biology lessons were friendly	SA A U D SD
4.	The biology lessons were useful	SA A U D SD
5.	The biology lessons were meaningless	SA A U D SD
6.	The biology lessons were unimportant	SA A U D SD
7.	The biology lessons were difficult	SA A U D SD
8.	The biology lessons taught by the teacher were easy	SA A U D SD
9.	The biology lessons taught by the teacher were interesting	SA A U D SD
10.	The biology lessons taught by the teacher were friendly	SA A U D SD
11.	The biology lessons taught by the teacher were simple	SA A U D SD
12.	I was uncomfortable with the biology lessons taught by the teacher	SA A U D SD

13. The biology lessons via the new method were difficult SA A U D SD
14. The biology lessons were useless SA A U D SD
15. The biology lessons taught via the new method were interesting SA A U D SD
16. The biology lessons taught via the new method were clear SA A U D SD
17. The biology lessons taught via the new method were unfriendly SA A U D SD
18. The biology lessons were important SA A U D SD
19. The biology lessons taught via the new method were meaningful SA A U D SD
20. I like the biology lessons taught without the use of the new method SA A U D SD

APPENDIX 3

TEACHER INTERVIEW GUIDE (TIG)

1. What was your first experience like of having to use the new method to teach biology?

.....

.....

.....

.....

2.What do you think your role should be when teaching the biology course using this new method?

.....

.....

.....

.....

3.Do you think students worked well in the co-operative groups?

.....

.....

.....

.....

4.How has using the new method affected your teaching –learning of biology lessons in your class?

.....

.....

.....

.....

5.Compare the students who did and those who never used the new method. Do you think the students who used co-operative learning learnt any better?

a) Yes

b) No

Explain your answer

.....

.....

.....

6.If you were asked to, would you use the new method in your other courses?

a) Certainly-why?

b) Never-why?

.....

.....

.....

7.Do you think the new method had an influence on the way students learn the Biology Course?

a) A lot-explain

b) Some-explain

c) No-explain

.....

.....

.....

.....

8. Describe briefly your view about the use of the new method.

.....

.....

.....

.....

.....

.....

.....

.....

APPENDIX 4

STUDENTS INTERVIEW GUIDE (SIG)

1.My first learning about Biology through the co-operative learning method was:

a) exciting
b) depressing
c) fun
d) confusing

2.What would you say your teacher should do when you are learning the biology course through the co-operative learning method?

a) leave us alone and help when we need his/her help
b) tell us what we should be doing
c) discuss with us
d) supervise our work
e) other (explain)

3. What do you think of the way the biology lessons were presented?

a) easy to understand
b) confusing and not easy to follow
c) made me want to learn more about biology
d) made me hate the biology course

4. Learning Biology lessons through the new method was:

a) a source of anxiety for me
b) something to look forward to
c) not exciting for me
d) other (explain)

5. The way the new method received and responded to the answers was:

a) motivating because one could make errors and correct without feeling embarrassed
b) frustrating and discouraging
c) other-explain

6. Describe your experience about learning biology through the new method in five sentences

.....

.....

.....

.....

.....

7. Did you like working in groups?

.....

.....

.....

.....

8. Would you like to work in co-operative groups again?

.....

.....

.....

.....

APPENDIX 5

A CO-OPERATIVE LEARNING MODULE ON CLASSIFICATION OF LIVING ORGANISM IN BIOLOGY

Lesson 1

Topic: CLASSIFICATION OF ORGANISM

Subtopic: Review of binomial nomenclature and the general principles of classification.

Objectives: by the end of the lesson learners should be able to:

c) State briefly the general the general principles of classification of living things

c) State the major divisions of the plant kingdom

Introduction: (5 min).

- Teacher leads the class in a review of the classification of organisms studied in form one. Students then proceed to their 5-member teams.

Lesson development: (30 min)

- Students discuss the principles that guide classification of living things
- They also compare and contrast the terms used in the taxonomic process
- Finally they identify the major divisions of plants
- Teachers attends to groups each at a time

Conclusion: (5 min)

- Teacher summarises on principle of classification and major divisions of plant kingdom. Pupils make notes. Assignments are given.

Lesson 2 and 3

Topic: CLASSIFICATION OF LIVING ORGANISMS

Subtopic: Division phycophyta

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

a) State the main characteristics of division phycophyta

b) Discuss the economic importance of algae

Introduction: (10 min)

- The teacher briefly set inducts the learners on plants that are commonly called algae.

- Learners then proceed to the group teams.

Lesson development: (50 min)

- Learners observe slides of Euglena and spirogyra and draw labelled diagrams
- Learners then discuss common characteristics of organisms in the division phycophyta
- The teachers attends to learners problems as well as helping groups that need help

Conclusion: (20 min)

- Teacher leads a class discussion on the economic importance of Algae
- The learners taken down brief notes and take part in discussion
- The teacher summarises on the topic and give assignments to be discussed in groups
- Groups will then hand in their group work later

Lesson 4

Topic: CLASSIFICATION OF LIVING ORGANISMS

Subtopic: Division mycophyta

Objectives: a) State the main characteristics of division mycophyta
b) List examples of fungi
c) Discuss economic importance of fungi

Introduction: (5 min)

- Teacher leads a discussion on fungi as a group of plants

Class development : (30 min)

- Learners discuss the main characteristics of mycophytes and lists them down
- Learners observe examples of fungi like mushrooms, mothballs, bread mould and yeast
- They also suggest other examples of fungi and list them

Conclusion : (5 min)

- Teacher reviews the work covered in the lesson
- Teacher leads a discussion of economic importance of fungi
- Learners take down notes
- Assignments

Lesson 5

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: Division Bryophyta

Objectives: a) State the main characteristics of division Bryophyta

b) Discuss the life cycle of moss plants and liverworts

Introduction: (3 min)

- Teacher presents materials and specimens to groups
- Teacher briefly explains what learners are expected to do in their groups
- Learners proceed to their group teams

Lesson development: (30 min)

- Learners discuss the main characteristic of division Bryophyta
- Learners discuss a diagrammatic representation of life cycles of mosses and liverworts

Conclusion: (8 min)

- Teacher summarises the main stages in the life cycles of mosses and liverworts
- The teacher give examples of mosses and liverworts

Lesson 6

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: Division Pteridophyta

Objectives a) State the main characteristics division Pteridophyta

b) Discuss the life cycle of a fern

Introduction (5 min)

- The teacher briefs the learners on what is expected in their teams
- Learners proceed to their groups

Lesson development (30 min)

- Learners discuss the main characteristics of ferns and records their discussion notes
- Learners discuss the outline of the life cycle of the fern (presented in a diagram)
- Groups discuss the classes of the division Pteridophyta

Conclusion: (5 min)

- Teacher leads a discussion on the main stages of the fern life cycle
- Teacher summarises the topic by listing main points
- Learners part in the discussion and record short notes.

Lesson 7 & 8

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: Division Spermatophyta

Objectives:

a) State the main characteristics of division Spermatophyta

b) State the structural differences between organisms in class Angiospermae and Class gymnospermae

c) Identify the main orders in the two classes of division spermatophyta

Introduction (5 min)

- The teacher leads a general discussion on seed producing green plants.
- Take the learners then proceed to their group teams.

Lesson development (55 min)

- Learners observe and draw examples of seed bearing plants and cone bearing plants.
- Learners discuss the main common features of spermatophytes.
- Learners discuss the differences between: -
- Angiosperms and gymnosperms
- Monocotyledons and dicotyledons.

Conclusion (15 min)

- Teacher summarises on the main features of spermatophytes and different classes of the division.
- Learners take short notes.

Lesson 9

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: (i) The animal kingdom (Kingdom Animalia)

(ii) Phylum Protozoa

Objectives (a) State the main characteristics of the animal kingdom.

(b) State the main characteristics of phylum protozoa.

Introduction (10 min)

- The teacher leads a discussion on the distinguishing characteristics of different groups of animals.
- The discussion should eventually lead to ten major groups (phyla) of the animal kingdom.

Lesson development (25 min)

- In their team groups, learners discuss the main characteristics of phylum protozoa.
- Learners identify the structures of locomotion in four classes – flagella, (Euglena) Rhizopoda (Amoeba) Ciliata (Paramecium) and Sporozoa (Plasmodium).

Conclusion (5 min)

- Teacher summarises on the main points of the lesson.
- Learners take brief notes.

Lesson 10

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: (i) Phylum porifera

(ii) Phylum coelenterata

Objective - State the main characteristics of phylum porifera and phylum coelenterata.

Introduction (3 min)

- Teacher briefly explains what the group teams and expected to do.
- Group teams proceed to their locations.

Lesson development (25 min)

- Learners discuss the main characteristics of the two phyla.
- Learners compare the characteristics and discuss diagrams of examples of these organisms - Sponges
- Hydra (Hyrozoa), sea anemone (Anthozoa), jellyfish (Scyphozoa).

Conclusion (10 min)

- Teacher leads a summary discussion on main features of sponges and coelenterata.

Lesson 11

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: (i) Phylum Platyhelminthes

(ii) Phylum Nematoda

Objective – State the main characteristics of phyla platyhelminthes and nematoda.

Introduction (13 min)

- Teacher briefly explains the tasks for group teams and learners proceed to their groups.

Lesson development (30 min)

- Learners discuss the main characteristics of the phyla platyhelminthes & Nematoda.
- Teacher moves from group to group to assist in any learning problems.
- Learners compare and contrast on the two phyla using diagrams of organisms in the two phyla.

Conclusion (7 min)

- Teacher summarises on the main points of the topic and solves any problems encountered in the discussion.

Lesson 12 & 13

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: (i) Phylum Anelida

(ii) Phylum Echinodamata

(iii) Mollusca

Objectives

a) State the main characteristics of phyla Anelida, Echinodamata & Mollusca.
b) Identify and classify various organisms using observable external features.

Introduction (5 min)

- Teacher briefly explains the tasks to be performed by the group teams.
- Teams proceed to their groups.

Lesson development

Stage 1 (20 min)

- Learners discuss and summarize the main feature of organisms in the phyla Anelida, Echinodamata and Mollusca.
- Learners also compare and contrast the features of organisms in these phyla.

Stage 2 (40 min)

- Learners observe organisms in different phyla (Mollusca, Coelenterata, Annelida, Nematoda, Platyhelminthes, Echinodamata).
- Learners identify and classify each organism in the discussion groups

NB: Teacher assists in any problems encountered by learners in their group teams.

Conclusion (15 min)

- Teacher leads a diagnostic discussion on the lesson & solves any questions from the learners.

Lesson 14

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: Phylum Arthropoda.

Objectives (a) State the main characteristics of Phylum Arthropoda

(b) List the classes of phylum arthropoda

Introduction (10 min)

- Teachers lead a brief discussion on phylum Arthropoda citing the numerous diversity, segmentation, exoskeleton and jointed legs.

Lesson development (20 min)

- Learners discuss the main features of arthropods, their varied habitats and feeding habits.
- Teacher moves from group to group to assess lesson development.

Conclusion (10 min)

- Teacher leads a discussion to summarise on arthropod classification and the four main classes – insecta, arachnida, myriapoda and crustacea.
- A reading assignment of the topic to prepare for the practical system.

Lesson 15 & 16

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: Phylum arthropoda

Objectives: To compare external features of different classes of phylum arthropoda.

Introduction (5 min)

- Teacher briefly explains the group tasks for the group teams.
- Learners proceed to their group teams.

Lesson development (65 min).

- Learners observe preserved specimens of different classes of arthropod and draw labelled diagrams.
- Learners discuss the features common to members of same class and the differences between classes.
- Teacher attends to groups in turn.

Conclusion (10 min)

- Teacher leads a concluding discussion on the phylum arthropoda
- Learners take short notes.

Lesson 17

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: Phylum Chordata

Objectives (a) State the main characteristics of the phylum chordata

(b) List down the classes of phylum chordata and their characteristics

Introduction (10 min)

- Teacher leads a discussion on the general features of chordates, their success in inhabiting various habitats and their diversity.

Lesson development (25 min)

- In their groups, learners discuss the main characteristics of phylum chordata.
- They also identify and list down the five classes of the phylum chordata.
- Teacher assists in each group in turn.

Conclusion (5 min)

- Teacher summarises on the main features of chordates.

Lesson 18 & 19

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: Phylum chordata

Objectives (a) Identify organisms in the five classes of chordata phylum

(b) Discuss the distinguishing features of each class in phylum chordata.

Introduction (5 min)

- Teacher explains the tasks for the group teams
- Learners proceed to their groups.

Lesson development (60 min)

- Learners observe specimens or diagrams of chordates and make labelled diagrams.
- Learners discuss the main characteristics of each class in the phylum chordata and compare the classes.
- Teacher attends to each group in turn.

Conclusion (15 min)

- Teacher leads a short discussion to summarise the features of chordates.
- Learners take notes.

Lesson 20

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: The dichotomous key

Objective - Use external observable features to construct simple dichotomous key for plants and animals.

Introduction (10 min)

- Teacher leads a discussion on rules that should be observed when constructing a dichotomous key.

Lesson development (25 min)

- Learners observe diagrams of different organisms – a hydra (P), snail (Q), fish (R), spider (S) and a beetle (T) and list down the main feature of the organisms.
- From the lists of features, they discuss those that make each different from the rest.
- They then form pair of these features to make a key.
- They use the key to classify the organisms.

Conclusion (5 min)

- The teacher summarises on the construction and use of a dichotomous key.

Lesson 21 & 22

Topic: CLASSIFICATION OF ORGANISMS

Subtopic: The Dichotomous key

Objective - Use already constructed dichotomous keys to identify given organisms.

Introduction (7 min)

- Teacher explains the tasks for the group teams and supplies both the dichotomous keys and organisms or their diagrams to the learners.
- Learners proceed to their group teams.

Lesson development

Stage 1 (30 min) –Learners classify organisms (plants) using observable features and an already made dichotomous key.

Stage 2 (30 min) –Learners classify animals using diagrams and a ready dichotomous key. Teacher attends to any difficulties from group to group.

Conclusion (13 min)

- Teacher leads a concluding discussion to summarise on the dichotomous key.
- Assignment given.

APPENDIX 6

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

Telegrams: "EDUCATION", Nairobi
Telephone: Nairobi 334411
When replying please quote
Ref. No. MOEST 13/001/33C 342/2
and date

JOGOO HOUSE "B"
HARAMBEE AVENUE
P.O. Box 30040-00100
NAIROBI

14th November, 20 03

David Gitau University
P.O. BOX 536
NJORO

Dear Sir

RE: RESEARCH AUTHORISATION

Please refer to your application for authority to conduct research on 'Effects of A Co-operative learning module on students Achievement and Attitudes towards classsification of organisms in Biology in selected Secondary Schools in Nakuru District, I am pleased to inform you that you have been authorised to conduct research in Nakuru District for a period ending 28th February, 2004.

You are advised to report to the District Commissioner and the District Education Officer Nakuru District before commencing your study. You are further expected to deposit two copies of your research findings to this Office upon completion of your research project.

Yours faithfully

T. MOTURI
FOR: PERMANENT SECRETARY/EDUCATION

CC
The District Commissioner
Nakuru District

The District Education Officer
Nakuru District

EGERTON [illegible] LIBRARY