INFLUENCE OF COOPERATIVE LEARNING ON STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY IN SECONDARY SCHOOLS IN NAROK NORTH SUB-COUNTY, KENYA

By

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DECLARATION

Declaration by the Candidate

I declare that this thesis is my original work and has not been presented for examination in any institution. No part of this work may be reproduced without the prior permission of the author and/or University of Eldoret.

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DEDICATION

This thesis is dedicated to my family; my parents Mr. and Mrs. Serem for moral and financial support, as well as their encouragement and laying down the foundation of my education; my brothers; Joseph, Wesley, Richard, Simon, Alfred and sisters: Judy, Bilia , Vilevia, Priscilla, Caroline, Lily and Sharon for their motivation and encouragement throughout my study.

ABSTRACT

This study was designed to determine the effect of cooperative learning as an intervention on students' achievement in biology. Biology is one of Kenya Certificate of Secondary Education (KCSE) subjects that have registered low performance for the last many years (KNEC, 2004 - 2010). The specific objectives of the study were to: investigate the methods commonly used in teaching Biology in Narok North sub-county, effect of cooperative learning on student academic achievement in Biology in Narok North Sub-County, establish the attitudes of both teachers and students towards cooperative learning, establish the challenges of cooperative learning. The study was carried out in six selected secondary schools in Narok North Sub-County, Kenya, where students have persistently scored low grades in the subject. Experimental research design was employed in the study. Six secondary schools were purposively sampled from the 23 secondary schools in Narok North sub-county. Two girls' schools, two boys' schools and two co-educational schools of almost similar resources were selected. In each school, form two students were selected because all students take Biology in form two while in form three and four, they choose two sciences out of the three. Form one students were not included in the study because they were not well conversant with the school system. The topic gaseous exchange was chosen because it is applicable in real life situation. It will be widely applied in tertiary and higher education level for example terrestrial ecology. A total of 482 students and 28 teachers were used as the respondents for the study. Teachers were instructed on how to carry out the learning activity. The selected students in each school were divided into two classes and given a test before carrying out learning activity. One class was taught using cooperative learning and the other class which was a control group taught using conventional methods. Data was collected from the six secondary schools using Biology Achievement Test (BAT). In addition, questionnaires for the teachers and students were used to gather information on teaching methods, attitudes and challenges of using cooperative learning methods. Data was analyzed through descriptive statistics mostly the measures of central tendency and also inferential statistics mainly Chi-square and analysis of variance (ANOVA). The level of significance was computed at $\alpha=0.05$. The results of study groups were compared. Quantitative techniques, tables, bar graphs and percentages were used to present data and make conclusion. The results indicated that most of the teachers (42.9%) use lecture method in teaching Biology while only 17.9% used cooperative learning method very often. In addition, most teachers (75%) had a positive attitude towards cooperative learning. It was also evident that 49% of the students actively participated when the teacher used cooperative learning in teaching biology. Generally, most of the students (75%) had a positive attitude towards cooperative learning. The findings of the study indicated that students in cooperative learning group outscored those in the lecture group in an achievement test. Since cooperative learning has been proven to have numerous benefits that include improvement in academic performance and enhanced class participation more emphasis should be placed by institutions on promoting this alternative technique. The findings of this study are beneficial to the curriculum implementers, KNEC, KICD developers, Biology teachers and other stakeholders.

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LIST OF ACRONYMS

ANOVA	Analysis of Variance
ASEI	Activity, Student-centered, Experiments Improvisation
BAT	Biology Achievement Test
CEO	County Executive Officer
K.C.S.E.	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KNEC	Kenya National Examination Council
NACOSTI	National Council of Science, Technology and Innovation
PDSI	Plan, Do, See and Improve
PISA	Programme for International Student Assessment
PLTL	Peer-Led Team Learning
ROK	Republic of Kenya
SMASSE	Strengthening of Science and Mathematics in Secondary Schools
SPSS	Statistical Package for the Social Scientist
STI	Science, Technology and Innovation
STS	Science/Technology/Society
TSC	Teacher Service Commission
UNESCO	United Nation Educational Scientific and Cultural Organization

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CHAPTER ONE

INTRODUCTION

Overview

This chapter presents the background information to the study, statement of the problem, research objectives, research questions and hypotheses, justification and significance of the study, scope and limitations, theoretical and conceptual frameworks and operational definition of terms.

1.1 Background to the Study

Brown, Kozinets and Sherry (2003) define teaching and learning as an attempt to help someone acquire or change some knowledge, skills, or attitude. Ayot (2009) further defines teaching and learning as a process where one person, the teacher, intentionally passes information to another person, the learner. Therefore, the goal of teaching is to bring about desirable learning in students. For effective teaching and learning to occur, the teacher must use an effective approach of conveying the information to the learner (Brown, Kozinets, and Sherry, 2003).

Cooperative learning involves structuring classes around small groups that work together in such a way that each group member's success is dependent on the group's success (Kaufman, Felder and Fuller, 2000). Cooperative learning is an instructional strategy in which a teacher organizes students in small groups so that they can work together to maximize their own and each other's learning. This enhances student learning through a number of techniques that include sharing information among students and motivating them to learn from each other. These techniques also include providing formative feedback as well as increasing social skills among students (Borich, 2013).

The programme for international student assessment has noted that performance of a country's students in science subjects have implications for the part, which that country will play, in tomorrow's advanced technology sector and for its general international competitiveness (Ray and Margaret, 2003). This report has further emphasized on the critical role of science subjects in the socio-economic developments of a country.

One of the main reasons for teaching science to students in school is that it enables them to be exposed to new development in science on an everyday basis (Juma and Yee-Cheong, 2005). Students need to be aware of how rapidly science can progress, and should be able to argue for positive scientific development having learned a basic level of scientific literacy at school (DeBoer, 2000).

The application of cooperative learning to classroom teaching finds its root in the 1970s when Israel and United States began to design and study cooperative learning models for classroom context (Felder and Brent, 2001). It is applied in almost all secondary schools and is increasingly being used in college and University contexts all over the world and is claimed to be an effective teaching method by scholars in developed countries (Johnson & Johnson, 2000) and in developing countries (Chen and Hoshower, 2003). Alqood (1995) asserted that cooperative learning is the best option for all students because it emphasizes active interaction between students of diverse abilities and backgrounds. Various scholars like Entwistle (1998), Slavin, Hurley and Chamberlain (2003) and Alqood (1995) demonstrate more positive student outcomes in academic achievement, social behaviour, and effective development with cooperative terms.

Cooperative learning approach has its foundation on social constructivist perspectives of learning. In this approach, the classroom environment is characterized by cooperate tasks and incentive structures and by small group activity (Ray and Margaret,2003).

The knowledge of how teaching and learning approaches affect students' learning may help science teachers to select teaching and learning approaches that improve teaching quality by ensuring effectiveness and accountability to learners and the public (Wachanga and Mwangi, 2004). Research on learning no longer supports a transmissive style of lecturing. It has been found that learning through memorization and reproduction does not result in knowledge that can be used to reason and to solve problems in new situation. Similarly, Wambugu and Changeiywo (2008) noted that the teaching approach that a teacher adopts is one factor that may affect student's achievement. Therefore, use of an appropriate teaching approach is critical to the successful teaching and learning of science.

Cooperative learning is one of the main active learning pedagogies, along with collaborative learning and learning communities. Arendale (2004) pictures the relationship among the three pedagogies as shown in Figure 1.1. It is well documented that students retain more knowledge when actively engaged in the learning process, and cooperative learning is often cited as an extremely effective instructional strategy (Felder & Brent, 2007).

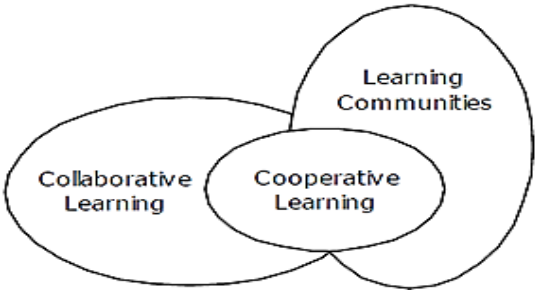

Figure 1.1: Relationship among collaborative learning, cooperative learning and learning communities

Source: Arendale (2004)

The terms collaborative learning, cooperative learning, and learning communities are sometimes used interchangeably with one another. Although they share similarities with one another, a more precise differentiation is needed to help explore the area and the utility of each for its intended educational outcomes (Cooper, Carlisle, Gibbs and Watkins, 2001). Regarding their historical development and appearance within the professional literature in the United States, collaborative learning appeared first, cooperative learning second, and learning communities last (Chiappetta and Fillman, 2007).

Collaborative learning refers to a wide range of formal and informal activities that include any form of peer student interaction (Wachanga and Mwangi, 2004). This is the broadest and most general of the three terms. This term describes any classroom activity by an instructor that involves student peer-to-peer involvement. Cooperative learning is more narrowly defined as a subset of collaborative learning.

Collaborative learning groups, cooperative learning groups and learning communities are distinguished by their focus on interactive peer learning. Learning communities are often more focused on enhanced curricular and pedagogical outcomes. In addition to often employing some version of student interactive learning, learning communities take several approaches to modifying the classroom experience by restructuring the curriculum. (Gabelnick, Haug and Lumpe, 2006).

Collaborative learning is considered to be the largest construct, both due to its general definition as well as its numerical ranking as frequently cited in professional literature (Vermette Harper and DiMillo, 2004). A smaller construct lies within collaborative learning which is cooperative learning. While it holds the same generalizations and goals of collaborative learning, it is much more specific in its implementation and

following of specified protocols for its use. A related term to both collaborative and cooperative learning is that of learning communities. While learning communities often utilize some peer collaborative or peer cooperative learning activities as part of its pedagogy, it is generally focused on changing of curricular. However, it is possible to implement some aspects of learning communities without extensive use of either collaborative or cooperative learning. The focus may be more on team teaching by biology teachers and the integration of academic content material (cluster course that merges the content of an introduction to science with an ethics course) rather than extensive use of student peer interactive learning activities.

Collaborative learning is a method of teaching and learning in which students team together to explore a significant question or create a meaningful project. A group of students discussing a lecture or students from different schools working together over the Internet on a shared assignment are both examples of collaborative learning. Cooperative learning, is a specific kind of collaborative learning. In cooperative learning, students work together in small groups on a structured activity. They are individually accountable for their work, and the work of the group as a whole is also assessed. Cooperative groups work face-to-face and learn to work as a team (Brody, 1995).

Therefore, the researcher views cooperative learning as a subsection of collaborative learning, which involves the interaction of students through groups during learning. This enables the students to share ideas and material.

Biology is one of the science subjects that are offered at secondary school education cycle in Kenya (KICD, 2002). The knowledge of biology contributes to scientific literacy so that people can understand the world around them and enable them to

make informed choices about their health care, their environment and the society in which they live (DeBoer, 2000).

Biology lays the foundation for careers in agriculture, which is the engine for economic growth in Kenya, contributing 60% of foreign exchange earnings and providing employment to over 70% of the population (ROK, 2007).

Through the knowledge of biology, researchers have been able to develop high yielding disease resistant and fast maturing food crops and animals to meet the food requirements of an ever-increasing world population. Biology is a prerequisite subject for admission into courses in the health profession such as human physiology, veterinary science, medicine, pharmacy, and dentistry among others. Performance in Biology at KCSE level that is examined by KNEC has been low over the years (MoE, 2011).Table 1.1 show that in the year 2004 only 12.03% attained the high quality grades B+ to A. This declined to 7.7% in 2005, 6.13% in 2006, 8.79% in 2007, 5.08% in 2008, 4.39% in 2009, and 5.88% in 2010, showing that high quality grade passes are very low. On the other hand in 2004, 36.67% of the candidates obtained low quality passes D-E. In the years 2005 it was 43.61%, 2006 it was 49.64%, 2007 it was 40.76%, 2008 it was 34.08%, 2009 it was 32.11% and 2010 it was 29.4%. These results shows that majority of the candidates had low quality passes (KNEC, 2004 - 2010). Table 1.1 shows the summary of national percentage passes in biology for seven years.

Table 1.1: National Percentage Passes in Biology

YEAR	High quality % Passes B+ - A	Low quality % Passes D-E
2004	12.03	36.67
2005	7.70	43.61
2006	6.13	49.64
2007	8.79	40.76
2008	5.08	34.08
2009	4.39	32.11
2010	5.88	29.40

Source: KNEC Reports (2004-2010)

In Narok North Sub-County, achievement in biology at KCSE has been low and a similar trend of poor performance, which has been lower than the national average, is observed for the years under review. In 2008, 3% of the candidates attained A to B+ while 35% attained grade D to E (KNEC, 2010). In 2010, candidates who attained A- to B+ were 3.19% and D to E was 34% (KNEC, 2011). The following are some of the schools and their percentage results in 2011 in Narok North Sub-County: School J had 46 candidates, those who attained A to B+ were 6.5% and D to E was 19.6%. School N had 17 candidates, those who attained A to B+ were 17.6% and D to E was 35.3%. School A had 207 candidates, those who attained A to B+ were 5.8% and D to E were 36.7% (KNEC, 2012).

The table 1.2 shows the means scores for Biology in Narok County from the year 2007 to 2012.

Table 1.2: Means Scores in Biology 2007-2012

School	2007	2008	2009	2010	2011	2012
A	4.346	5.482	4.841	4.981	4.604	5.071
B	5.125	5.212	5.415	5.678	4.330	4.990
C	4.215	3.458	4.222	4.123	4.667	4.193
D	3.121	3.212	3.150	3.211	-	2.325
E	3.581	3.678	3.212	3.812	-	-
F	2.815	2.856	3.231	2.850	-	-
G	3.885	4.711	4.382	4.957	4.678	5.085
H	1.760	2.940	2.321	3.160	3.240	2.701
I	3.212	3.481	3.567	3.012	-	-
J	6.500	6.054	6.06	6.348	6.854	6.427
K	2.527	2.235	2.720	3.140	2.722	1.964
L	-	-	-	-	-	2.911
M	-	-	3.110	3.860	4.400	3.880
N	-	-	-	5.880	6.090	5.550

Source: Narok North Sub-County Director of Education Examination Office (2013)

The specific performance in Biology in terms of each grade entry scores for the year 2011 in the Sub-County was as shown in Table 1.3 below.

Table 1.3: Performance in Biology per Grade and School

SCHOOL	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E	Entry	Mean Points	Mean Grade
A	2	4	11	25	11	34	39	35	17	12	1	0	191	6.5131	C+
J	0	1	3	4	8	22	15	16	6	2	1	0	78	6.3718	C
N	0	0	0	3	4	5	2	0	5	2	1	0	22	6.0909	C
G	0	0	1	2	8	8	5	15	20	26	5	0	90	4.6778	C-
C	0	0	2	2	4	8	10	11	16	27	4	1	85	4.6471	C-
O	0	0	0	1	0	7	6	11	8	17	0	0	50	4.6400	C-
B	1	1	1	7	3	11	10	26	18	46	20	4	148	4.3311	D+
M	0	0	0	0	0	1	2	4	2	6	2	0	17	4.0588	D+
I	0	0	0	0	1	1	3	6	6	29	9	0	46	3.5870	D+
P	0	0	1	1	0	0	1	5	1	13	14	0	36	3.3611	D
D	0	0	0	0	0	0	1	6	3	11	9	0	30	3.3000	D
H	0	0	0	0	2	2	4	5	6	29	26	1	75	3.2400	D
E	0	0	0	0	1	1	4	9	6	30	26	4	81	3.1358	D
F	0	0	0	0	0	0	0	1	6	10	11	1	29	2.8276	D
K	0	0	0	0	0	0	0	1	0	10	7	0	18	2.7222	D
Total	**3**	**6**	**19**	**45**	**42**	**100**	**102**	**151**	**120**	**261**	**136**	**11**	**996**	**4.6647**	**C-**

Source: Narok North Sub-County Director of Education Office (2013)

From Table 1.3 results, performance in biology at KCSE in Narok North Sub-County has been low and below the National average. Almost half of the candidates who sat for KCSE biology subject in Narok North Sub-County for the years under review failed to attain the expected subject mastery level, which locked them out of careers where biology is a prerequisite subject. Therefore, the performance in biology at

secondary school level in Narok North sub-county is below average. Several reasons have been advanced for low performance, with teaching methods being one of them. This study sought to determine the effect of cooperative learning approach on mean achievement scores in biology in secondary school students. Teaching approach employed by a teacher is one of the important explanations of poor performance in science subjects at KCSE (KNEC, 2012).

1.3 Statement of the Problem

Student performance in Biology in secondary schools in Narok North Sub-County has recorded a low performance in the last five years as evidenced in County Education Annual Report (2011).A number of factors are attributed to low performance in biology in Narok North Sub-County such as cultural factors, attitudes and inadequate resources, Strengthening of Science and Mathematics in Secondary Schools (SMASSE) Project (2008) attributed the poor performance among others to traditional teaching approaches adopted by teachers.

While it is acknowledged that learner centered teaching approaches promote higher academic achievement and a more positive attitude towards a subject as compared to teacher centered approaches, the teacher centered approaches are predominantly practiced in secondary school teaching in sub-Saharan Africa (UNESCO, 2004; Kolawole, 2008). Efforts to improve achievement have proposed the use of child centered approaches, which include the use of cooperative learning. Little research information is however available on the effect of cooperative learning on student achievement and particularly in Narok North Sub-County. But in the neighboring County, Keter (2014) found out that cooperative learning is an effective approach that teachers need to incorporate into their teaching and that it promotes deep learning of materials and helps students to achieve better grades. This study therefore sought to

establish the influence of cooperative learning on student achievement in biology in Narok North Sub-County.

1.4 General Objective of the Study

This study investigated the effect of cooperative learning as an intervention on students' achievements in Biology.

1.4.1 Specific Objectives of the Study

The study was guided by the following specific objectives:

i. To establish common methods used in teaching of Biology in Narok North Sub-County
ii. To investigate the influence of cooperative learning on student achievement
iii. To establish whether there is a statistically significant difference in the level of interdependence among learners who use cooperative method and those who use conventional methods to learn Biology.
iv. To establish the attitudes held by both teachers and students towards cooperative learning in Narok North Sub-County
v. To establish the challenges of the use of cooperative learning approach in Narok North Sub-County

1.5 Research Questions

The study sought to answer the following research questions:

i. What are the common methods used in teaching Biology in Narok North Sub-County?
ii. What is the influence of cooperative learning on student achievement?

iii. Is there any statistically significant difference in the level of interdependence among the learners who use cooperative method and those who use conventional methods to learn Biology?

iv. What are the attitudes held by both teachers and students towards cooperative learning in Narok North Sub-County?

v. What are the challenges that affect the use of cooperative learning in Narok North Sub-County?

1.6 Research Hypothesis

HO_1 There is no significant difference in achievement among students taught using cooperative learning approach and those taught using conventional approaches.

HO_2 There is no statistically significant difference in the level of interdependence among learners who use cooperative method and those who use conventional methods to learn Biology.

1.7 Justification of the Study

There is little effort to improve the quality of education through better teaching strategies. An investigation into the use of cooperative learning as a strategy to improve student learning is therefore timely. It has been noted that Biology has registered dismal performance in the last five years in Narok North despite concerted effort at improving student achievement. It has been shown that through effective instructional strategies, performance in any subject can be improved (Biott, 1999). Good performance in Biology will lead many students to medical careers, and equip them with biological knowledge, which is applicable in increased food production, promotion of health care, control of pollution and other fields, hence participation in national development. Good performance will lead to development of positive attitude

towards the subject. It also helps in attainment of vision 2030 and the millennium development goal by producing quality personnel who can promote scientific research, hence better development. Therefore, there is need to study the effect of cooperative learning in Biology.

1.8 Significance of the Study

The study has various advantages to the stakeholders in education. Firstly it is important to teachers and students as they can apply cooperative learning strategies in biology. Understanding of cooperative teaching strategies and its effective use can lead to improved learning by students. Teachers will also know how they can utilize cooperative method of teaching in enhancing student centered learning in biology. Students will benefit from co-operative learning through sharing and in this way; they will discover new ideas in biology. Curriculum developers and other education stakeholders who will be made aware of the effect of cooperative learning will be expected to incorporate the method in the school curriculum hence performance of Biology will be expected to improve.

1.9 The Scope of the Study

This study was carried out in Narok North Sub-County which is in southern part of the Rift Valley province. The County covers an area of 4,766 square kilometers with an estimated secondary school student population of 5906 out of which 2951 are girls and 2955 boys. There are 23 secondary schools in the region, two of which are private secondary schools.

This study was carried out in six secondary schools including two girls', two boys 'and two co-educational schools in Narok North Sub-County using Biology teachers

and students taking biology as respondents. The six schools were used because they had similar resources academic resources like laboratories and library. They had also done exams for many years hence; the researcher was able to compare the current biology results with previous results. It was carried out in form two classes because all students in form two take biology subject while in form three and four, they choose two sciences out of the three. Form one students were not included in the study because they were not well conversant with the school system. The topic gaseous exchange was chosen because it is applicable in real life situation. It will be widely applied in tertiary and higher education level for example terrestrial ecology. The research process was carried out for a period of one month. The study investigated the effect of cooperative learning.

Despite the availability of other teaching methods, this study zeroed on the use of only cooperative learning in teaching Biology. This is because the effectiveness of most of the methods has been accessed in different environments.

1.10 Limitation of the Study

The research encountered the following limitation:

i. Exposing students to cooperative method called for consistency in working with students in specific groups that interact with each other. This resulted in time consuming which influenced the results obtained. To avoid this, dedication in the part of the teacher and constant follow-up was recommended to encourage the learners to remain consistently in their groups.

1.11 Theoretical Framework

This study was guided by the cooperative learning theory formulated by Sharan (1990). According to this theory, students learn more by doing something active than by simply watching and listening. Cooperative learning is by its nature a learner-centered active method and thus it enhances learning. Weak students working individually are likely to give up when they get stuck but when working cooperatively, they keep going. Bright students faced with the task of explaining and clarifying material to weaker students often find gaps in their own understanding and fill them in. Students working alone may tend to delay completing assignments or skip them altogether, but when they know that others are counting on them, they are motivated to do the work in a timely manner. At the initial stages, instructors who attempt it encounter resistance and sometimes open hostility from the students. Bright students complain about being held back by their slower teammates; weak or unassertive students complain about being discounted or ignored in group sessions; and resentments build when some team members fail to work hard. Patient instructors find ways to deal with these problems, but others become discouraged and revert to the traditional teacher-centered instructional strategies, which is a loss both for them and for their students. Although students effectively complete most of their assignments in teams, using integrated methods is advocated by this theory. One obvious reason is to provide a measure of individual accountability. Laboratories and field projects may also be carried out by teams. This implies that the team grades will be adjusted for individual performance. The theorist also formulated the jigsaw cooperative learning structure applicable to team assignments that call for expertise in several distinct areas. In this case, the students are grouped into small teams and the instructor designates specific members with specific areas. The assigned students are

given specialized training, which may involve getting handouts or presentations by the course instructor. The students then return to their home teams and guide the rest of the member to understand the concepts and complete the assignment.

The theorist also formulated the peer-led team learning (PLTL) which is a sub-set of cooperative learning. In this case, class lessons are supplemented by weekly 30 minutes workshops in which students work in six- to eight-person groups to solve challenging structured problems under the guidance of trained peer leaders. The problems should be sufficiently challenging and directly related to the course tests and other assessment measures. Hundreds of research studies of team-based learning have been conducted based on this theory, with most of them yielding positive results for a variety of cognitive and affective outcomes (Slavin, 2011; Gillies, 2002; Pedersen and Digby, 2014).

Johnson and Johnson (1999) devised five pillars of cooperative learning based on the original theory by Sharan (1990). These include individual accountability, positive interdependence, face-to-face promotive interaction, group processing, and interpersonal small group skills.

In relation to this study, the researcher applied the theory to mean that the method of teaching is student centered. This means that the student works in a group to complete tasks collectively toward academic goals. This strategy makes the learner to be active in learning activity where he/she is involved in discovery of ideas. One of the methods of student-centered learning activity is cooperative learning. In this study the learners were divided into groups and guided by the teachers to discuss the topic given hence generated the ideas. Therefore, cooperative learning created classroom

environment that enabled the student to listen to others, exchange ideas and be on task most of the time.

1.12 Conceptual Framework

Figure 1.2 below shows the relationship between cooperative learning and performance in Biology. In this case, the independent variable is cooperative learning, the dependent variable is performance in biology and the intervening variables are learners and teacher's attitude, learning resources and availability of time. When the teaching method changes, learning activities will be affected, for example, in cooperative type of teaching method its elements are interfered. For instance, individual accountability may be limited amongst students hence performance is also affected. Therefore performance depends on method of teaching, which in this study was cooperative learning. The method indeed is independent; in this case it relies on performance. There are some factors which may affect the performance in biology despite the type of teaching method chosen. These include learning resources, availability of time, and level of interdependence amongst the learners, learner's and teachers' attitude.

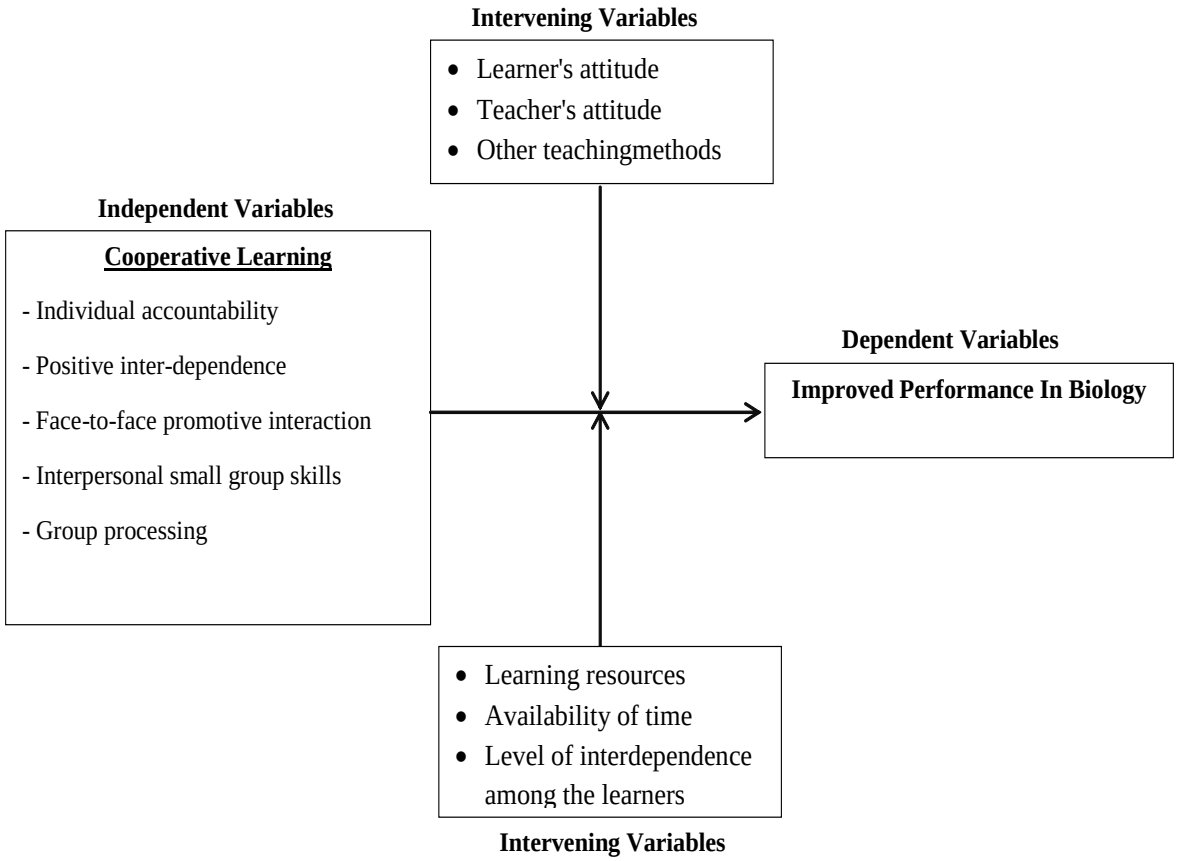

Figure 1.2: Conceptual Framework

Source: Author (2013)

1.13 Operational Definitions of Terms

The following terms were used in the study as defined below:

Academic Achievement: the extent to which a student, teacher or institution has achieved their educational goals.

Co-educational schools refer to mixed secondary schools (secondary schools in which boys and girls learn together).

Collaborative learning is a subset of active learning in which students interact with one another while they learn and apply course material.

Conventional learning is usually a teacher-centred learning method whereby the teacher is the controller of the learning environment (lecture method).

Cooperative learning is a method of instruction that has students working together in groups usually with the goal of completing a specific task. It involves structuring class around small groups that work together in such a way that group members 'success is dependent on each member's success.

Effect a change that is a result or consequence of an action or other cause.

Face-to-face promotive interaction occurs when members share resources and help, suupport, encourage and praise each others efforts to learn.

Group processing is an assessment of how groups are functioning to achieve their goals or tasks. By reviewing group behavior the students and the teacher get a chance to discuss special needs or problems within the group.

Individual accountability is the measurement of whether or not each group member has achieved the groups' goal. It refers to a case whereby each group member is held accountable for his or her work.

Influence is the capacity to have an effect on the character, development, or behavior of someone or something, or the effect itself

Interpersonal small group skillsareskills that help to build stronger cooperation among group members. Leadership, decision-making, trust-building, and communication are different skills that are developed in cooperative learning.

Learning approach*:* describes what students do when they go about learning and why they do it.

Level of interdependence: refers to interaction, mutual dependence among the learners in terms of consultation, sharing resources and preference to work in groups.

Positive interdependence is linking students together so one cannot succeed unless all group members succeed. Group members have to know that they sink or swim together."

Stakeholders refer to anybody in the school environment with interest in academic performance of the school.

1.14 Chapter Summary

In this chapter the following have been discussed: introduction of the study, statement of the problem; which shows that though a number of factors (such as cultural factors, attitudes, inadequate resources) are attributed to low performance in biology in Narok North Sub-County, SMASSE Project (2008) attributed, among others, traditional teaching approaches adopted by teachers. It also describe the purpose and objective of the study, research questions, justification, significance, assumption, scope and limitations of the study, theoretical and conceptual framework and operational definitions of the terms have also been discussed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The aim of this chapter is to give a general review of the literature related to cooperative learning. The following were also discussed: history of cooperative learning, concepts of "cooperative learning", elements of cooperative learning, types of cooperative learning, factors affecting cooperative learning, guidelines for cooperative learning, three keys to using learning groups effectively, minimizing interactional problems in cooperative learning, principles of cooperative learning, methods used in the teaching of science, SMASSE project innovation: ASEI movement and the PDSI approach, teaching and learning of science in secondary schools in Kenya, attitudes towards the teaching and learning of science and summary and critical analysis of knowledge gap

2.2 History of Cooperative Learning

Prior to World War II, social theorists such as Allport, Watson, Shaw, and Mead began establishing cooperative learning theory after finding that group work was more effective and efficient in quantity, quality, and overall productivity when compared to working alone (Ashman and Gillies, 2003). It wasn't until 1937 when researchers May and DoobMay and Doob (1937) found that people who work together to achieve shared goals, were more successful in attaining outcomes, than those who strived independently to complete the same goals. They also found that independent achievers had a greater likelihood of displaying competitive behaviours.

Philosophers and psychologists in the 1930s and 40's such as John Dewey, Kurt Lewin, and Morton Deutsh also influenced the cooperative learning theory practiced

today (Sharan, 2010). Dewey believed it was important that learners develop knowledge and social skills that could be used outside of the classroom enviroment and in the democratic society. This theory portrayed students as active recipients of knowledge by discussing information and answers in groups, engaging in the learning process together rather than being passive receivers of information .

Lewin's contributions to cooperative learning were based on the ideas of establishing relationships between group members in order to successfully carry out and achieve the learning goal. Deutsh's contribution to cooperative learning was positive social interdependence, the idea that the student is responsible for contributing to group knowledge (Sharan, 2010).

Since then, David and Roger Johnson have been actively contributing to the cooperative learning theory. In 1975, they identified that cooperative learning promoted mutual liking, better communication, high acceptance and support, and even demonstrated an increase in a variety of thinking strategies among learners in the group (Johnson, and Johnson, 1988).

In 1994 Johnson and Johnson published elements of cooperative learning which positive interdependence, individual accountability, face-to-face interaction, social skills, and processing which are important for effective group learning, achievement, and higher-order social, personal and cognitive skills like problem solving, reasoning, decision-making, planning, organizing, and reflecting (Johnson, and Johnson, 1994).

Cooperative learning is not a new concept. It has endured as an important way of learning in some cultures for generations (Tobin and Fraser, 2003). Socratic Method of learning used some form of cooperative learning when he engaged his students in group questioning and argument to develop their philosophical ideas (Mola, 2005).

Early 20th century when American students were schooled in a system based on authoritarian teaching and rote learning, educator John Dewey espoused a teaching philosophy that contained elements of cooperative learning. Dewey realized the importance of learning by doing and urged establishing laboratory and workshop courses to foster creativity and cooperation among students (Dewey, 1916). With cooperation, members of small groups help each other master assigned materials, and students reach their goals only if the others in their group also reach theirs.

Living in a society that often placed high value on the benefits of competition, Johnson & Johnson (1999) exposed common societal myths about competition. One myth is that most human interaction in all societies is competitive. The use of competition, under most conditions, will increase the quality of a student's work, enhances the capacity for adaptive problem solving. The students prefer competitive situations and the competition builds self-confidence and self-esteem. Muraya and Kimamo (2011) research over more than two decades has served to dispel a number of these myths and has demonstrated the benefits of cooperative learning under a variety of conditions.

During the past decade, evidence has accumulated on the effectiveness of cooperative learning in classrooms from preschool to college and beyond. In a wide variety of disciplines, cooperative learning methods have been applied in the Physical Science (Land and Hannafin, 2000), Biology (Gillies and Ashman, 2000), Humanities (Jingcheng and Wei, 2001), Mathematics (Adeyemi, 2008) and in the Social Sciences (Johnson and Johnson, 2009).

2.3 Concepts of "Cooperative Learning"

Researchers have defined cooperative learning in different ways; Johnson and Johnson (1999) state that "cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning. He defines cooperative learning as an instructional task design that engages students' actively in achieving lesson objectives through their own efforts and the efforts of their small teams.

Students work in small groups to accomplish shared learning goals. They learn the assigned material and ensure that all other group members also learn it.

Brown *et al.* (2003) describes a cooperative learning class as a learner-based class that is not competitive. It is a class where students have the chance to share ideas and knowledge while working in groups. Thus it enhances student learning through a number of techniques that include sharing information among students and motivating them to learn from each other. These techniques also include providing formative feedback as well as increasing social skills among students.

Slavin (2011) defines cooperative learning as a concept based on group work in which the learners are responsible for others' learning as well as their own learning. A major feature of cooperative learning is that it involves learner-to-learner interaction in the process of fostering successful learning.

Cooperative learning is an instructional strategy in which a teacher organizes students in small groups so that they can work together to maximize their own and each other's learning. Specifically, the cooperative learning approach to instruction is where students are arranged in pairs or small groups to help each other learn assigned material (Trowbridge and Bybee, 1996). Interaction among students in cooperative learning groups is intense and prolonged (Borich, 2013). In cooperative learning

groups, unlike self-directed inquiry, students gradually take responsibility for each other's learning.

Johnson and Johnson (1999) introduced the differences between cooperative learning and other group work patterns. According to them, there are four types of group work: pseudo learning group, traditional classroom learning group, cooperative learning group, and high-performance cooperative learning group. In the first category, Johnson and Johnson (1999) explain, learners are not interested in working in groups because, in most cases, they are aware that they will be evaluated on an individual basis. The second category, however, is where learners are assigned to work in groups and they accept that they have to work on the activity together. The third and fourth categories are when learners are aware of the benefits of cooperative learning and all members of the group work towards accomplishing common goals. A major difference is that the fourth category "outperforms" due to learners' exceptional devotion to their group while working on the activity (Johnson and Johnson, 1999).

2.4 Elements of Cooperative Learning

Not all groups are cooperative (Johnson and Johnson, 1999). Placing people in the same room, seating them together, telling them they are a group, does not mean they will cooperate effectively. Trowbridge and Bybee (1996) and Borich (2013) identified four basic elements in cooperative learning models. Small groups must be structured for positive interdependence; there should be face-to-face interactions, individual accountability, and the use of interpersonal and small group skills.

To be cooperative, to reach the full potential of the group, five essential elements need to be carefully structured into the situation: positive interdependence, individual and group accountability, promotive interaction, appropriate use of social skills, and group processing activity (Johnson and Johnson, 1999). Mastering the basic elements of

cooperation allows teachers to: Take existing lessons, curricula, and courses and structure them cooperatively, Tailor cooperative learning lessons to unique instructional needs, circumstances, curricula, subject areas, and students, and diagnose the problems some students may have in working together and intervene to increase the effectiveness of the student learning groups.

Therefore elements of cooperative learning according to Johnson and Johnson (1999) are discussed as follows:

Positive interdependence exists when group members perceive that they are linked with each other in a way that one cannot succeed unless everyone succeeds. Group members should realize that each person's efforts benefit not only himself/herself, but all other group members as well. Positive interdependence creates a commitment to other people's success as well as one's own and is the heart of cooperative learning. Cooperation does exist where there is no positive interdependence.

Each member of the group must be accountable by contributing his or her share of the work (which ensures that no one "hitch-hikes" on the work of others).The group has to be clear about its goals and be able to measure (a) its progress in achieving them and (b) the individual efforts of each of its members. The purpose of cooperative learning groups is to make each member a stronger individual in his or her right. Students learn together so that they can subsequently perform better as individuals.

Promotive interaction occurs when members share resources and help, support, encourage, and praise each other's efforts to learn. Cooperative learning groups are both an academic support system (every student has someone who is committed to helping him or her learn) and a personal support system (every student has someone who is committed to him or her as a person). There are important cognitive activities

and interpersonal dynamics that can only occur when students promote each other's learning. This includes orally explaining how to solve problems, discussing the nature of the concepts being learned, teaching one's knowledge to classmates, and connecting present with past learning. It is through promoting each other's learning face-to-face that members become personally committed to each other as well as to their mutual goals.

In cooperative learning groups, students are required to learn academic subject matter (task work) and also learn the interpersonal and small group skills required to function as part of a group (teamwork). Cooperative learning is inherently more complex than competitive or individualistic learning because students have to engage simultaneously in task work and teamwork. Group members must know how to provide effective leadership, decision-making, trust-building, communication, and conflict-management, and be motivated to use the prerequisite skills. Teachers have to teach teamwork skills just as purposefully and precisely as teachers do academic skills. Since cooperation and conflict are inherently related, the procedures and skills for managing conflicts constructively are especially important for the long-term success of learning groups (Johnson and Johnson, 2009).

Group processing activity exists when group members discuss how well they are achieving their goals and maintaining effective working relationships. Groups need to describe what member actions are helpful and unhelpful and make decisions on what behaviors to continue or change. Continuous improvement of the process of learning results from the careful analysis of how members are working together.

Social skills which include leadership, decision-making, trust-building, communication, and conflict management skills must be taught, just as academic skills are taught. Cooperative learning groups can consists of two to five students, but

groups of three to four are also effective. Classes can be divided up into several groups. The groups should contain high achievers and low achievers. Therefore, the group should contain a mixture of high achievers and low achievers. These common features enhance the effective of cooperative learning groups.

When activities are designed and structured appropriately, cooperative learning can be very effective. According to Ormrod (2004), students of all ability levels show higher academic achievements.

The research by Johnson, Johnson, and Smith, (1998) shows that cooperative learning leads to: higher achievement and increased retention, more frequent higher-level thinking, deeper-level understanding, and critical thinking ,more on-task and less disruptive behavior, greater achievement motivation and intrinsic motivation to learn, greater ability to view situations from others perspectives, more positive, accepting, and supportive relationships with peers regardless of differences in ethnicity, gender, physical or mental ability, or social class ,greater social support more positive attitudes toward teachers and other school personnel, more positive attitudes toward subject area, learning, and school, greater psychological health, adjustment, and well-being, more positive self-esteem based on self-acceptance and greater social competencies.

2.5 Types of Cooperative Learning

According to Panitz (1999) there are four types of cooperative learning including formal cooperative learning, informal cooperative learning, cooperative base groups and integrated use of all three types of cooperative learning.

Formal Cooperative Learning consists of students working together, for one class period to several weeks, to achieve shared learning goals and complete jointly specific tasks and assignments.

Informal Cooperative Learning consists of students working together to achieve a joint learning goal in temporary, ad-hoc groups that last from a few minutes to one class period. Informal cooperative learning ensures students are actively involved in understanding what is being presented. It also provides time for teachers to move around the class listening to what students are saying. Listening to student discussions can give biology teachers direction and insight into how well students understand the concepts and material being as well as increase the individual accountability of participating in the discussions.

Cooperative Base Groups are long-term, heterogeneous cooperative learning groups with stable membership. Members' primary responsibilities are to ensure all members are making good academic progress (positive goal interdependence), hold each other accountable for striving to learn (individual accountability), and provide each other with support, encouragement, and assistance in completing assignments (promotive interaction). Cooperative base groups are heterogeneous in membership especially in terms of achievement motivation and task orientation.

The three types of cooperative learning discussed above may be integrated together. A typical class session may begin with a base group meeting, which is followed by a short lecture in which informal cooperative learning is used. The lecture is followed by a formal cooperative learning lesson. Near the end of the class session, another short lecture may be delivered with the use of informal cooperative learning. The class ends with a base group meeting.

2.6 Factors affecting Cooperative Learning

The following are some factors that should to be considered when implementing cooperative learning. Organisational factors which include:

(a) Group size

Three or four students per group is the optimal size according to Heller, Keith, and Anderson (1992) say that a greater individual accountability is obtained with a smaller sized group. The gender and performance composition of the group should be balanced.

(b) Assignment of Roles to Group

Another factor to be considered is that of equitable participation from all group members. The problem of dominance or passiveness by one student can be addressed by the assignment of roles to group members. The roles can be organised such that one group member becomes a recorder, another manager and the third being a sceptic (Heller, *et al.*, 1992).

(c) Facilitators

Another important factor that is influential in the running of biology group problem solving tutorials is the role that facilitators play. The tutorials involve students working cooperatively on tasks with assistance from a number of roving tutors (Allie and Buffler, 1998). These tutors are typically postgraduate students. They act as both facilitators and consultants (Vermette and Foote, 2001). The tutors are supposed to help students see the Biology behind the questions and also help them with procedures in problem solving. They are there to see to it that problem solving becomes a meaningful activity for students. Another role for the tutors is that they should make sure that students are working cooperatively so as to enjoy the benefits

offered by cooperative learning. Many students see the tutor as having all the answers and may have a tendency of depending on the tutor to do the work for them or give them solutions. Many tutors likewise will be tempted to give students direct answers to their questions lest they are perceived by students as incompetent. As much as the students are the focus of the whole activity, the tutors are the pivot around which the whole activity revolves. Students view the tutors as experts.

(d) Task Design

Setting appropriate tasks is a crucial skill for the instructor preparing a group problem-solving tutorial. The choice of questions such as context-rich problems that promote conversation is important. The nature of the problems is that they should be designed such that there is something to discuss initially (Johnston, James, Lye, and McDonald, 2000). This helps in getting the attention of the entire group to focus on the tasks at hand. It also helps establish rapport. The problem must be complex enough so that none of the students can solve it immediately. Students should not be able to solve it in a few steps by plugging numbers into formulae. They must however be simple enough that the solution once arrived at can be understood and appreciated (Parkay, Stanford and Gougeon, 2010).

The design of the problem is crucial to the development of problem-solving expertise of the student (Sutherland, 2002). The crucial factor in a task is to have some ground for interpreting problem solving and reasoning that use intuitive knowledge.

2.7 Guidelines for Cooperative Learning

Braundy (1997) offers the following guidelines for cooperative learning: Divide the students into subgroups of four to six. Make sure the students are seated next to each

other to facilitate interaction, Clearly state the problem or issue that they are supposed to address and write it on the board, Provide hand-outs, refer to your website or use an overhead projector to ensure that the students understand what is to be addressed, Have the group members select a recorder and spokesperson to keep track of the progress of the group, Briefly discuss approaches to the issue and deal with any questions and Have participants deal with the issue for the designated period of time while you circulate from group to group assisting as necessary.

For assessment, it is useful for the groups set to work on a particular project, design, or research project, to have an opportunity to evaluate the group effectiveness. For a start, give the students a question to resolve, such as this: "Who are the key professionals, besides the architect, involved in designing, financing and constructing a building?" Tell each group to generate as many responses as possible in three to four minutes. Ask a designate spokesperson from each group to provide items from their list. The contributions from the small groups will form as a bigger, comprehensive picture for the larger group.

2.8 Three Keys to Using Learning Groups Effectively

According to Jacobs and Michaels (2007), there are three keys to using learning groups effectively, namely:

Promoting On-going Accountability: If students fail to prepare for group work, group assignments are likely to force bright students to “carry” their less willing and/or less able peers. Further, improperly managed small-group discussions are likely to degenerate into social events in which little if any learning occurs. Both problems can be avoided almost entirely. The key lies in using assignments and practices that hold individuals and groups accountable for their behaviour.

Individual accountability; Biology teachers can use three quite different mechanisms to promote responsible individual behaviour. The most basic mechanism is requiring students to complete preparatory individual assignments (especially graded ones) prior to group discussion (For example, requiring students to turn in written concept summaries at the beginning of class on group assignment days). A second mechanism is using procedures or assignments that cause members to express their point of view during group discussions. For example, some biology teachers assign one member to make sure that everyone is asked to provide input. The third mechanism is to include peer evaluation in the grading system. One very effective way to promote individual accountability is the readiness assurance process in team learning (Michaelsen, Fink, and Black, 1996). This process requires individuals to complete a test (typically true-false/multiple-choice) over a set of pre-assigned readings and turn in their answers. Next, the groups re-take the same test and turn in their consensus answers for immediate scoring. This process incorporates all three mechanisms for promoting individual accountability. First, students are directly accountable because the individual scores count as part of the course grade. Second, during the group test, each member is invariably asked to voice and defend their choice for every question. The resulting discussions produce immediate feedback that provides clear evidence of both the degree to which individual members have prepared, in advance, for the group work and the importance of obtaining input from everyone on all important decisions. Third, members who fail to complete the assigned readings almost invariably receive a low peer evaluation.

Using Linked and Mutually Reinforcing Assignments -- "3S's": The second key to using groups effectively is making sure that the assignments at each stage of the learning process are linked and mutually reinforcing. When this is done, assignments

in the first two stages have a powerful positive effect on the learning that occurs in the next stage. To obtain the maximum overall payoff, assignments at each stage should be characterized by "3 S's":

a) **Same problem**: Individuals/groups should work on the same problem, case, or question.
b) **Specific choice:** Individuals/groups should be required to use course concepts to make a specific choice.
c) **Simultaneously report:** Whenever possible, groups should report their choices simultaneously.

Adopting Practices that Stimulate Idea Exchange: The degree to which group discussions expose students to new perspectives from their peers depends on two factors. The first factor is the extent to which the instructor uses assignments and creates conditions that foster give-and-take group interaction. The other factor is the diversity of opinions, ideas, and perspectives that exist within each group.

Using assignments that require group interaction; the most common reason for a low level of group interaction is the use of assignments that can be completed by independent individual work. For example, if assignments are too easy, one member will simply act on behalf of the group. Assignments that require a great deal of writing are also likely to limit both interaction and learning. If asked to produce a lengthy document, group discussions seldom produce very much learning for two reasons. First, discussions tend to be limited in duration (students feel pressured to get going on the real work). Second, they tend to focus on working out who will write which piece of the total product rather than on the substance of the issues that will be contained in the paper. By contrast, assignments that require students to use course

concepts to make difficult choices (for example the medical school example above) always produce high levels of both interaction and learning (Michaelsen *et al.*, 1996).

As groups become more cohesive, trust and support typically build to the point that even naturally quiet members are willing to engage in intense give-and-take interactions with little worry about being offensive or misunderstood (Watson, Michaelsen, and Sharp, 1991). As group members come to see their own success as tied to the success of their group, they are motivated to invest considerable personal energy into doing group work.

In-class group work: Interaction is also likely to be limited unless groups are allowed to do their work in class. In many cases, the cost of meeting outside of class is so great that students will meet just long enough to share the work. They will then complete the assignment individually and learn little from each other. Their output is a group product in name only and, any cohesiveness developed during the initial meeting, is likely to be offset by concern that other members might fail to do their part.

Creating diverse groups: Another way to expose students to new ideas is making sure that groups are relatively large (5-7 members) and as diverse as possible. Creating diverse groups involves two steps. The first is identifying the dimensions that make a difference in student performance in each specific subject, for example, previous subject work. The other is sorting learners into groups so that they are spread as evenly as possible across groups (Michaelsen *et al.,* 1996).

To obtain the best results using small groups, biology teachers must observe above keys in managing each of the three opportunities (shown as “3 Boxes” in Figure 2.2) to engage students with course concepts: individual work, small group work, and total class discussion.

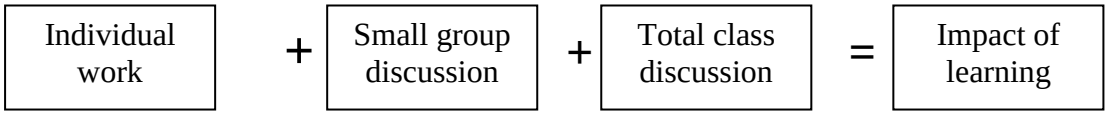

Figure 2.1: Engaging students with course concepts

Source: Adopted from Michaelsen *et al.* (1996) and modified

2.9 Minimizing Interactional Problems in Cooperative Learning

The optimal approach to facilitation of group work is to prevent interactional problems from occurring. What the instructor can do is establish conditions that minimize the impact of interactional problems on group functioning, alert students to the types of problems they might encounter, and equip them with tools to deal with those problems. According to Johnson *et al.* (1998) cooperative learning indicate that setting up engineering groups to include only one female jeopardizes the female's chances of a full participatory role in the group.

Johnson *et al.* (1998) further noted that combined expertise of group members is required to complete assignments. The study suggested that group members pre-work the relatively straightforward parts of their assignments before their group meeting and even that they go as far as outlining solutions to the more complex problems ahead of time, leaving the details of the calculations for the group meeting.

2.10 Principles of Cooperative Learning

Principles of cooperative learning as outlined by Felder and Brent (2001) include classroom organization and the learners' skill. Classroom organization is the conditions that educator must create like positive interdependence, face-to face interactions, and individual and group accountability. Learner skills refer to the participation skills for effective contribution to the cooperative learning environment.

They include small group social interaction and group processing which involves careful listening, and evaluating.

Li and Lam (2005) summarizes the following condition, which should be considered during cooperative learning.

i. No member should dominate by doing all or most of the talking and work.
ii. Each member should contribute a fair share to the workload.
iii. The group should stick to the given task.
iv. The group should keep the task moving.

According to Roth and Roychoudhary (1994), cooperative learning is a convenient way to support the construction of individual knowledge of members in a variety of ways. When learners are required to explain, elaborate, or defend their position, they construct a deep understanding because they have to evaluate, integrate, and elaborate upon their existing knowledge. Learning through cooperatives problem solving gives rise to insights and solutions that would not come about without them.

This view is supported by Haller, Gallagher, Weldon, and Felder, (2000) when they indicate that cooperative learning creates a classroom learning environment which contributes to the positive perception students have towards social and cognitive aspects of the learning process; since learners are able to make more friends and practice more helpful behaviour.

They hold that cooperative learning creates a classroom environment in which learners listen to each other, develop love for peers, exchange ideas, and be on task most of the time. Learners learn to cooperate and cooperate to learn. Communication abilities of listening and questioning as well as the learners' polite interaction are

improved. Cooperative learning requires that learners engage both their physical and mental activity in order to construct knowledge.

Weak students benefit from interaction with brighter students and when bright students explain their ideas to others, they learn the material they are explaining in more depth and remember it longer. In cooperative group, bright students are also seen as resources and are valued by teammates. Hence, the higher achievements reported (Johnson and Johnson, 1999).

Among the many studies that measure the effects of cooperative learning in biology, there is wide variation in quality with some succumbing to the pitfall of research involving human subjects, including small sample size lack of random distribution and assignment to test conditions of students and teachers, and built in bias in training teachers and teaching the material. However, several studies have shown that cooperative learning methods are effective for learning certain types of biological concepts. Shernoff, Csikszentmihalyi, and Shneider, (2003) found that high school students in a cooperative classroom spend more time focusing on their assignment and achieved in biology unit that demanded inquiry and high level thinking than did students in a traditional competitive classroom

In an attempt to minimize bias in their studies, Okebukola (1992) conducted a number of large, controlled, studies of middle-school biology students in Nigeria, in which the teachers were randomly assigned, carefully trained, and observed during the course of their teaching. Their results showed that students who preferred cooperative learning benefited the most from it and that cooperative learning was a powerful way to help students develop favorable attitudes towards laboratory work (Slavin *et al.*, 2003).

The work of other researchers points to the benefit of using cooperative learning in the classroom settings in biology. In addition to promoting academic achievement,

cooperative learning has considerable value in affecting students' attitudes towards the subject matter and themselves. This cannot be over-looked as researchers search for new ways to make biology more accessible to all students who perceive the science classroom to be an alien and unwelcoming place.

Some educators have conducted studies within their own classrooms. One such is Mourtos (1997) who implemented cooperative learning strategies in engineering courses over a four year period commencing in Spring 1993. He made an effort to implement these strategies in projects, lectures and examination. Mourtous is of the view that cooperative learning in engineering courses is important since:

1. Students learn better when working together than in isolation.
2. It forces students to practice team and small group communication skills.

In other societies cooperation rather than competition is promoted. In this regard, Meng (2005) outlined an experiment conducted by Tang (1996) in Hong Kong in which he tested Chinese students' habitual learning approaches, tendency to collaboration and their distribution of test and assignment. Based on the findings Chinese students tended to be in cooperative learning groups which were at times spontaneous, student centred and based on group effort-individual reward structure. This cultural phenomenon of collectivism is opposite to the western idea of individualism. Meng (2005) in concluding indicated that cooperative learning is an effective motivating style and can be applied to many instructional fields. He however, noted that students' characteristics and cultural backgrounds must be considered, as such it should be flexible and change depending on the situation.

Other studies also concluded that cooperative is an effective teaching learning strategy one such by Felder and Brent (1994). Felder taught five chemical engineering courses in five (5) consecutive semesters using several non-traditional

instructional methods including cooperative (team-based) learning. The aim was to examine the benefits, problems and solutions to cooperative learning in technical courses.

Felder and Brent (1994) found that students became so accustomed to working in groups that this work translated into other courses. For instance, in the third semester of the study the same group of students were in the class with a traditional instructor who utilised lectures. It was noted that in this traditional classroom students typically gained average of 50%, however, the group that was involved in the study of cooperative learning gained an average of 72% on the first test and 78% on a second test. Felder and Brent (1994) therefore concluded that the cooperative learning technique had the desired effect of changing students' work ethic.

There have been surveys conducted in Third World countries such as Nigeria to assess student views of cooperative learning strategies. One such as conducted by Akinbobola (2009) to discover the attitude of students towards the use of cooperative, competitive and individualistic learning strategies in Nigerian senior secondary school physics. The research design for this study was quasi-experimental. There were a total of one-hundred and forty (140) students taking part in the study who were selected by a 27 random sampling technique. A structured questionnaire on 4-point scale was used to collect the data. Poor student performance can be attributed to poor teaching methods. Also, in the present Nigerian educational system, competition is valued over cooperative learning strategies (Akinbobola, 2009).

The findings also showed that cooperative learning strategy was the most effective in facilitating students' attitude towards physics. This was then followed by competitive strategies with the individualistic learning strategies being seen to be the least facilitative.

Akinbobola (2009) concluded that the result was not surprising because in cooperative learning, students are trained on how to interact positively, resolve disputes through compromise or mediation and encourage the best performance of each member for the benefit of the group. Akinbobola (2009) contends that when students are successful, they view the subject with a very positive attitude because their self-esteem is enhanced.

A study by Abu and Flowers (1997) was conducted to determine the effects of the cooperative learning approach of Student Teams-Achievement Divisions (STAD) on the achievement of content knowledge, retention, and attitudes toward the teaching method.

An achievement test and an attitude questionnaire were administered (Abu and Flowers, 1997). He found that there was also no significant difference in student attitudes toward the teaching methods. They contend that even though the study showed no significant difference between competitive and cooperative learning, the literature suggests there may be additional reasons to use cooperative learning. For instance, the ability to work with others within a group and to develop interpersonal skills may be justification for using cooperative learning strategies. Abu and Flowers (1997) therefore contend that cooperative learning methods were as effective as non-cooperative methods with regard to achievement and retention of knowledge.

Another research was conducted within the secondary educational context in Jamaica. Kirby (2007) conducted an action research of cooperative learning in an Accounting Class at a High School in Rural Jamaica. The researcher's aim was to find out how effective the use of cooperative learning is in improving academic performance among Grade Nine (9) students. The study was a descriptive design with a sample size of thirty (30) students. The researcher collected the data through formal

questionnaires, learning journals and focus group interview. He or she discovered that based on the attitude questionnaire only 28% of students thought that accounting class was interesting using traditional teaching strategies, however this increased to 86% after the implementation of cooperative learning strategies. Overall, students believe that cooperative learning positively impacted on their learning experience (Kirby, 2007)

Kirby (2007) concluded that there was an improvement in the minimum and maximum scores of students. Students believed that cooperative learning allowed for a more relaxing environment where they exhibited better understanding, Students' self esteem was enhanced; they stated that they felt more comfortable in answering questions. Student were more accepting of the help received from peers and they did not feel inferior to any other student as they all helped one another and

Students developed team spirit during and after implementation. The majority of the material reveiwed revealed that student centred strategies are key to unlocking students' potential. This is so because, students receive hands on experience. Student centred learning also enables students to interact more intimately with their lecturer as well as their peers.

A more recent study by Ajaja and Eravwoke (2011) in Nigeria reaffirmed the ability of cooperative learning when used as an instructional strategy to bring about significant improvement in students' achievement in school science subjects. The findings of the study indicated that students in cooperative learning group outscored those in the lecture group in an achievement test and a non – significant difference in achievement scores between male and female students in the cooperative learning group.

The major disadvantages of cooperative learning include:

a) not all members of a group will participate in solving the problems they are confronted with;
b) some very active members of a group may overshadow less active ones;
c) the method is time consuming; and
d) low ability students who solely depend on the teacher for all information may not be able to make any contributions during cooperative learning.

While there is growing consensus on the benefits of cooperative learning Lake(2001) as cited in Ransdell and Moberly (2003) reports that students see this alternative teaching style as unscholarly; rather akin to unstructured group work where one student works diligently, to carry the group, and the others do little or nothing. A major concern of some students is that even if all members do not pull their weight, all students in the group receive the same grade, regardless of their contribution (Kagan, 1995 as cited in Ransdell and Moberly, 2003). Students' course evaluations of their professors suggested that students placed a lower value on cooperative learning strategies than they did on the more traditional lectures (Lake, 2001). This shows students uneasiness with the idea of cooperative learning. It is noted that students have various fears about group work. Some of the common fears about working with groups include student fears that each member will not pull their weight as a part of the group; students are also scared that their grade will be lower as a result of the group learning versus learning they do individually .

Analyses of the research support the following conclusions:

Individual student performance was superior when cooperative methods were used as compared with competitive or individualistic methods. The performance outcomes measured include knowledge acquisition, retention, accuracy, creativity in problem solving, and higher-level reasoning. Other studies show that cooperative learning is

superior for promoting metacognitive thought, persistence in working toward a goal, transfer of learning from one setting to another, time on task, and intrinsic motivation For example, students who score in the 50th percentile when learning competitively would score in the 69th percentile when taught cooperatively (Johnson *et al.*,1998).

Similar positive effects of group interactions have been found specifically for chemistry courses. In a meta-analysis of research on cooperative learning in high school and college chemistry courses, (Bowen,2000) found that students in the 50th percentile with traditional instruction would be in the 64th percentile in a cooperative learning environment.

Several studies of cooperative instruction report positive effects on a variety of cognitive and affective outcomes. In a compilation of pre-post test gains in force concept inventory scores obtained by students in introductory physics courses, the use of instruction involving "interactiveengagement" led to an average gain two standard deviations greater than was observed fortraditionally-taught courses (Hake,1998). Students in engineering capstone design courses taught with active and collaborative approaches outperformed traditionally-taught students in acquisition of design skills, communication skills, and teamwork skills (Terenzini, Cabrera, Colbeck, Bjorklund, and arente, 2001). The use of coperative methods had significant positive effects on understanding science and technology, analytical skills, and appreciation for diversity, among other outcomes(Cabrera, Colbeck, and Terenzini, 2001).

Affective outcomes were also improved by the use of cooperative learning. Relative to students involved in individual or competitive learning environments, cooperatively taught students exhibited better social skills and higher self-esteem (Bilgin and Geban,2006) as well as more positive attitudes about their educational experience, the subject area, and the college (Johnson *et al.*,1998). Towns, Kreke, and Fields, (2000).

used fieldnotes and survey data to analyze students' attitudes toward group activities in a physical chemistry class. The students viewed the group work as a positive force in their learning, and the also valued the interactions for promoting a sense of community in the classroom.

Treisman's model has been used at many institutions with comparable success (Felder and Brent, 1996). In another study, George (1994) tested several cooperative learning techniques on a predominantly African-American psychology class and compared their performance with that of a control group taught non-cooperatively. She found that group work led to significant improvements in both academic achievement and attitudes toward instructions.

Felder and Brent (1994) report a study of cooperative learning in a sequence of engineering courses. Students responded to group work with overwhelming approval, but many indicated that they tended to assume less active roles in group discussions and some reported that their ideas tended to be devalued or discounted within their teams. The likelihood of these occurrences is reduced if a team contains more than one member of the minority population.

A two-year study conducted by Slavin (2011) compared elementary schools implementing cooperative learning to schools that use standard instructional methods. Two treatment schools and three comparison schools were matched, deriving a sample of 873 second through sixth grade students. The treatment group fully adopted cooperative learning and utilized the method regularly within the classroom environment. Prior to the study, teachers and administrators in the treatment group participated in training programs that educated them on how to make their school fully represent the values of cooperative learning.

Alazzi and Abudalbo (2013) conducted a study in Jordan to examine the effect of using cooperative learning methods on achievement in the geography curricula. She used two groups: one control group taught by traditional methods and an experimental group taught through cooperative learning methods. The study results revealed that the experimental group taught through cooperative learning performed higher than control group taught by a traditional method (Alazzi and Abudalbo, 2013).

Similar study was earlier conducted by Alqood (1995) to establish the effect of the cooperative learning approach on tenth grade achievement in the geography curricula. He used the step-by-step experimental approach to analyze the data. Alqood divided the subjects into two groups: a control group and an experimental group. The researcher found that the experimental group did better than the control group, who were taught using the traditional method. Mola (2005) conducted a study in the United States on high school students' attitudes toward science education. The researcher used the cooperative learning strategy and compared it with the traditional method. The study concluded that no significant differences exist among students, who were taught by cooperative learning, and students, who were taught using competitive learning. This scenario could be attributed to the fact that students who learned through cooperative method had not understood the meaning and the use of this method. This is because students do not participate or cooperate on group work.

In another study, Alazzi (2012) conducted a study on secondary school social studies teachers' attitudes toward critical thinking. The researcher wanted to find out whether the teacher used cooperative learning strategy with critical thinking. The researcher used a ground theory qualitative approach to analyze the data. The study revealed that teachers preferred to teach using cooperative learning more than competitive learning.

Cooperative learning tended to be the hardest student-centred method to sell initially, especially to high academic achievers and strong introverts. Perhaps the most effective selling point for cooperative learning involves grades. A research study has demonstrated that students who learn cooperatively get higher grades than students who try to learn the same material individually (Slavin, 2012).

In a study carried out by Felder and Brent (1996), an instructor taught an introductory computer science course three times, once with the students working individually and twice using group work, with common examinations in the first two classes. In the first class, only 36% of the students earned grades of C or better, while in the classes taught cooperatively, 58% and 65% of the students did so. Those earning A's in the course included 6.4% (first offering) and 11.5% (second offering) of those who worked cooperatively and only 3% of those who worked individually. There was some student resentment about group work in the first cooperative offering and almost none in the second one, presumably because the instructor was more skilled in the method the second time and possibly because the students in the second cooperative class knew about the results from the first class.

A study done by Muraya (2011) in Machakos sub-county found that the cooperative learning method promote higher academic achievement of secondary school students in biology as compared to the lecture teaching methods. This also enhanced higher academic achievement of secondary school students in biology at knowledge, comprehension and application levels of the cognitive domain as compared to the regular teaching method. The study noted that it enhances conceptual understanding more than the regular teaching method. Another study by Wachanga (2004) in Nakuru Sub-County established that cooperative learning method facilitates students'

chemistry achievement more than the lecture methods do. Keter (2014) found out that cooperative learning is an effective approach that teachers need to incorporate into their teaching and that it promotes deep learning of materials and helps students to achieve better grades.

2.11 Methods used in the Teaching of Science

McCarthy (1992) states strengths of class discussion as; pools ideas and experiences from group, and allows everyone to participate in an active process. It is a free verbal exchange of ideas between group members or teacher and students. For effective discussions, the students should have prior knowledge and information about the topic to be discussed. Kochhar (2000) states that a problem, an issue, a situation in which there is a difference of opinion, is suitable for discussion method of teaching.

Lecture Method; A lecture is a talk or verbal presentation given by a lecturer, trainer or speaker to an audience. With all the advancement of training systems and computer technology, lecture method is still a backbone widely used in teaching and training at higher level of education (Davis,1993). McCarthy (1992), states strengths of lecture method presents factual material in direct, logical manner, contains experience which inspires, stimulates thinking to open discussion, and is useful for large groups.

Sullivan and McIntosh (1996) argue that with planning and effective presentation techniques, the lecture can be a highly effective and interactive method for transferring knowledge to students. A lecture gives the students training in listening and taking rapid notes (Kochhar, 2000).

Lecture method view of teaching and learning sees teachers as passing over their knowledge to their learners (Borich, 2013; Trowbridge and Bybee, 1996). This view is strongly linked to expository teaching; teachers standing at the front telling their

learners about scientific ideas. The transmission view implies that the learner's role in the learning process is largely passive, and that a learner's mind is a tabula rasa- a blank slate on to which knowledge can be written. The lecture or traditional teaching method has the following advantages:

1. It is easy to create interest in a topic or subject by the teacher.
2. Students easily acquire knowledge, new information, and explanation of events or things.
3. It helps students to clarify and gain better understanding of a subject, topic, matter or event.
4. Students and teachers cover more content materials within a short period of time.

The major limitation of this method is that there is relatively little student activity and involvement (Ajaja and Eravwoke, 2011; Borich and Tombari, 2004; Trowbridge and Bybee, 1996). Thus, the students are said to be passive .The limitation experienced with the transmission approach led to the development of other views of science teaching and learning.

Assignment method: Written assignments help in organization of knowledge, assimilation of facts and better preparation for examinations. It emphasizes on individual pupil work and the method that helps both teaching and learning processes (Kochhar, 2000)

Demonstration: It is a teaching method used with both large and small groups. It becomes more effective when verbalization accompanies them. For example, in a half demonstration-half lecture, an explanation accompanies the actions performed. It is a generally accepted learning theory that the greater the degree of active participation

and sensory involvement by the learner, the more effective learning will be (Newby, Stepich, Lehman, and James, 1996). Demonstrations utilize several senses; students can see, hear, experience an actual event, and stimulate interest, and present ideas and concepts more clearly.

Experimental teaching method helps to improve students' hand skills, makes them more productive and increases their active involvement in learning. Students can create relationship between theory and practice using experimental teaching method and by applying what they learn into their real life problems through experiments, hence they can make their life more meaningful (Okan, 1993). Using concrete and tangible explanations, students become more involved and absorbed in the lesson (Algan, 1999). With this method, students are given an opportunity to learn by drill and practice.

2.11.1 SMASSE Project Innovation: ASEI Movement and the PDSI Approach

The acronym ASEI/PDSI stands for Activity, Student-centered, Experiments and Improvisation/Plan, Do, See and Improve. Recent studies in science education indicate that school science teaching should by far be learner centered. The teacher's role should be that of a facilitator, guide, counselor, motivator, innovator and researcher. As such, it is recommended that there must be as many activities during any one lesson as possible. These must be student-centered activities, involving many improvisations in the experiments (SMASSE Project, 2008).

SMASSE Project Impact Assessment Survey Results (SPIASR) was undertaken nationwide to assess the impact of the INSET. The aim was to find out how SMASSE activities are practiced in the classroom and how they translate into achievement. It was conducted in form two classes of selected schools. Teachers taking the classes in

sciences subject and mathematics, and the principals of the schools, participated in the survey (Liburu, 2012, SMASSE Project, 2012).

The SMASSE project expected that attitude would be positive for teachers and students. Teachers are expected to practice more effective teaching methodologies and develop efficient teaching and learning materials. The reform would improve administration and management of schools in the long run as the students become active in the learning process. Curriculum and pedagogical changes in biology depend on teachers becoming the agents of change rather than the targets (SMASSE, 2008). The quality of teaching has an impact on students learning. Thus substantial resources need to be invested in the professional development of teachers. Cooperative teaching and learning is a very demanding approach that calls for special skills on the teacher. To improve teacher's ability to use it will call for deliberate training on part of the teachers (Liburu, 2012).

Research has found that teachers when asked to change features of their teaching often modify the features to fit their pre-existing system instead of changing the system itself. The system assimilates individual changes and overwhelmed them. When this happens, anticipated improvements in student's learning fail and everyone wonders why that has happened (Stigler and Hiebert, 2009).

2.11.2 Teaching and Learning of Science in Secondary Schools in Kenya

The common practice in our schools in Kenya today is that science teaching is not integrated. The Science teaching is divided into theory and practical parts as indicated by the double lesson per week. The theory follows a didactic type of pedagogical instruction whereas the practical is taught to confirm the theory (KICD, 2002). Research has indicated that most teachers tend to resort to the old ways of teaching

even after being exposed to the new methods of instruction due to the influence of the methodologies used during their initial training (Odundo, 2013).

The science teacher needs to be pro-active in seeking solutions to the problems that stand in the way of effective teaching and learning of science. The teacher must try to create and sustain interest in science by involving students in the lesson. This can only be done through the application of appropriate teaching methods. The guiding principle should be activity focused and Student-centred, with experimentation and improvisation forming the core of the teaching/learning process (SMASSE Project, 2008).

The study also revealed that science classes at all levels have consisted of lecture and little discussion as well as of separate laboratory period once or perhaps twice each week. In all schools, a double period is available for laboratory work. Teachers, use a text book as the central point of focus for their courses. A supplementary manual or workbook or worksheet used in conjunction with the laboratory manual may be more or less related to the textbook and lectures. The teachers assume the roles of authorities and dispensers of information. The laboratory commonly is a place where students prove the theories proposed by the teacher and textbook. Work book or work sheet exercises are mainly concerned with vocabulary drill rather than with scientific processes (SMASSE Project, 2008).

2.12 Attitudes towards the Teaching and Learning of Science

Pianta and Cox (1999) and Watson (2003) have described teaching as an intensely psychological process and believe a trainer's capability to maintain productive classroom environments, motivate students, and make decisions depends on her personal qualities and the capability to create personal relationships with there

students. These effective attitudes and actions employed by teachers ultimately can make a positive difference on the lives of their students.

Attitudes mainly determine what students learn and their willingness to learn. Negative attitude can strongly inhibit intellect and curiosity and keep us from learning what is well within our power to understand (Vermunt and Verloop, 1999). According to Vogel, Bohner and Wanke, (2014), attitude is a general feeling of approval or otherwise towards some stimulus. One of the factors that affect output when carrying out a task is one's attitude towards that duty or towards the people with whom they carry out the task. A positive disposition will allow one to "push" on with the task despite adverse situations.

Attitudes towards science, scientists, and learning science have always been a matter of interest for science educators. Attitude is generally used in discussing issues in science education and is often used in different contexts. Two broad categories are distinguishable. The first one is attitude toward science. Attitude towards science can be described as the feelings, beliefs, and values held about an object that may be the attempt of science, school science, the impact of science and technology on society, or scientists. The second one is scientific attitude (i.e., open-minded, honesty, or skepticism). Scientific attitude is the desire to know and understand, questioning to all statements, search for data and their meaning, search for verification, and consideration of effects (Osborne, Simon and Collins, 2003).

Research studies that show positive correlations between achievement in science courses and positive attitudes toward science, attitude and certain features of the classroom environments that include personal support, use of different teaching strategies, innovative learning activities, and student-centered instructional designs

have all been reported in the recent research journal (Osborne, Simon and Collins, 2003; French and Russell, 2006). Attitudes towards science and scientists affect views of science, future career awareness, and classroom participation. Students who have positive attitudes show better attention to classroom instruction and contribute more in science activities (Jarvis and Pell, 2005).

Most studies indicate that students develop more negative attitudes toward studying science, toward their science classes, and toward their science trainers the longer they study typical school science (Jones, Howe and Rua, 2000). It is imperative to develop student positive attitude toward science. When they have positive attitudes, the studying of scientific information and science process skills are improved (Osborne *et al.,* 2003). After fourth grade, student attitude toward science begins to decline through junior and high school (McComas, Clough and Almazroa, 2002). Assessment of student attitudes toward science have been performed and reported. Student responses indicate that student interest in science reduces the longer the students study science (Jones, Howe and Rua, 2000). Reasons why students develop more negative attitudes towards science as they move through elementary school comprise; learners are involved in a number of non-school activities when they get older, low achievement with school work, More emphasis on specific science facts, More emphasis on test outcomes and Not much opportunity for learners to enjoy science (Wabwile, 2010)

Research studies show numerous factors influencing attitudes toward science. Probably gender is the most significant variable which relates student attitudes toward science (Jarvis and Pell, 2005). Children get messages about gender and ethnic stereotypes daily from television programs and commercials, books, and other people around them. They also see pictures of scientists most of whom are all males, are all

white, and have unusual manners. The strong relationship between attitude toward science and achievement indicate little difference between girls and boys. Also, more positive attitudes are essential for girls to enable them to achieve high scores (Weingburgh, 1995; Jarvis and Pell, 2005).

The National Science Teachers Association defined the Science/Technology/Society (STS) style as the teaching and learning science and technology in the context of human experience (Weingburgh, 1995). STS means focusing upon current issues and attempts at their resolution as the smart way of training learners for current and future citizenship roles. This means pinpointing local, regional, national, and international challenges with students, preparing for individual and group activities which address them, and moving to actions designed to solve the issues researched. The emphasis is on responsible decision-making in the real world of the learner. STS offers ways for attaining scientific and technological literacy for all. The emphasis is on responsible decision-making in the real world of the student where science and technology are components.

The view of the learner where the STS approaches are used make classrooms very dissimilar than they are where traditional teaching is used. In traditional teaching the teacher chooses which topics to include, in what order, and in what ways to deliver the knowledge to the learners. The trainer is the authority and students are the passive recipients. Conversely, learners are central in the STS approach. Students generate personal questions rather than merely relying on the questions provided by others. Based on their own questions, learners view their own previous perceptions of the problem and issues. Student-directed questions further serve to explain challenges, potential resolutions, and actions needed to resolve them. This enables learners to

see/do science in the same way that scientists do. This makes science more relevant, exciting, and appropriate for most students. The main objective of the STS approach is to achieve scientific literacy for all. It creates student-centered environments where students advance on their own ideas, raise questions, and undertake investigations. The STS approach starts with real world matters, and problems that related to students lives. Table 2.1 indicates the dissimilarities between students involved in an STS program and those in a traditional science program in terms of the attitude domain.

Table 2.1: Differences between students involved in an science/Technology/Society program and those in a traditional science program

Learners involved in STS program	Learners taught using Traditional methods
Learners continually offer original ideas	Learners express few original ideas
Learners become more curious about learning science	Learners reduce curiosity in learning science
Learners see the teacher as a facilitator/guide	Learners see the teacher as a source of information
Learners see science as a way of dealing with problems	Learners see science as information to learn

One of the issues that were found to contribute to the low ability of students in science in secondary education is the negative attitude towards the teaching profession by the teachers themselves and towards the students that they teach (SMASSE Project, 2008). SMASSE Project (2008) showed that there was a general feeling among some teachers, students and key stakeholders that Science is a difficult subject. This feeling was even greater in girls than boys. There are various reasons that have led to this feeling. Poor performance during national examinations made students consider it a waste of time to concentrate on subjects they will not pass (Wabwile, 2010).

2.13 Summary and Critical Analysis of Knowledge Gap

The research and anecdotal evidence confirming the effectiveness of cooperative learning nis at this point overwhelming. Regardless of the objective specified, cooperative learning has repeatedly been shown to be more effective than the traditional individual/competitive approach to education.

Obstacles to the widespread implementation of cooperative learning at the secondary school level are not insignificant, however. The approach requires teachers to move away from the safe, teacher-centred methods that keep them in full control of their classes to methods that deliberately turn some control over to students. They have to deal with the fact that while they are learning to implement cooperative learning they will make mistakes and may for a time be less effective than they were using the traditional methods. The message of this report, is that the benefits of cooperative learning more than compensate for the difficulties that must be overcome to implement it. Biology teachers who pay attention to cooperative learning principles when designing their courses, who are prepared for initially negative student reactions, and who have the patience and the confidence to wait out these reactions, will reap their rewards in more and deeper student learning and more positive student attitudes toward their subjects and toward themselves. It may take an effort to get there, but it is an effort well worth making.

Regularly teaching about cooperative learning in development workshops find that the participants fall into two broad categories. On the one hand are the skeptics, who creatively come up with all sorts of reasons why cooperative learning could not possibly work for their subjects and their students. The researchers know all the reservations about cooperative learning, having once done it, and they will satisfy most of the sceptics that the problems they anticipate may not occur, and if they occur

they are solvable. Worry is more about the enthusiasts. Despite the best efforts, they often charge off and simply turn students loose in groups, imagining they will immediately see the improved performance and positive attitudes that the cooperative learning literature promises them. The reality may be quite different. Many students especially bright ones begin with a strong resistance or outright hostility to working in teams, and they may be quite vocal on the subject when told they have no choice. Moreover, interpersonal conflicts usually having to do with differences among team members inability, work ethic, or sense of responsibility inevitably arise in group work and can seriously interfere with the embattled group's morale and effectiveness. Biology teachers unexpectedly confronted by these problems might easily conclude that cooperative learning is more trouble than it is worth (Mola, 2005).

The Vision 2030 on industrialization may remain theoretical if no action is taken to improve the quality of science in secondary schools. Though experimental method has been recommended as the best approach of teaching science, inadequate teaching and learning resources has contributed its use. Therefore there was a need to look at cooperative learning to compliment other forms of teaching.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter presents the methodology employed in carrying out the study. It covers the research design, the study area, the target population, the sample size, the sampling procedure, the data collection instruments, validity and reliability of the research instruments, data collection procedure and data analysis techniques.

3.2 Research Design

Burns and Grove (2003) define research design as a blueprint for conducting a study with maximum control over factors that may interfere with validity of the findings. The research design of a study outlines the basic approach that researchers used to answer their research question (Polit and Beck, 2010). To meet the aims and objectives of the study it is important that the researcher selects the most appropriate design for achieving the aims of the study (Parahoo, 2006).

This study sought to determine the effects of cooperative learning approach on student achievement in Biology among secondary school students. The study utilized experimental design where the teaching approach was the independent variable while the mean achievement scores in biology was the dependent variable. An experimental design is a strong design for a researcher to test hypothesis to reach valid conclusions between independent and dependent variables (Best and Kahn, 2003).

The researcher adopted the explanation of Robson (2003) which says that an experimental design is employed where participants will be exposed to different conditions and modified it to suit this study. To get the true effects of the program or intervention, it is necessary to have both a treatment group and a control group. As the

name suggests, the treatment group receives the intervention. The control group, however were taught using lecture method, meaning they only receives interventions that they would have gotten if they had not participated in the study. By having both a group that received the intervention and another group that did not, researchers control the possibility that other factors not related to the intervention (For example, students getting accustomed to a test, or simple maturation over the intervening time) are responsible for the difference between the pre-test and post-test results. It is also important that both the treatment group and the control group are of adequate size to be able to determine whether an effect took place or not. While the size of the sample ought to be determined by specific scientific methods, a general rule of thumb is that each group ought to have at least 10 participants. It was also important to make sure that both the treatment group and the control group were statistically similar. While no two groups will ever be exactly alike, the best way to be sure that they are as close as possible is having a random assignment of the study participants into the treatment group and control group. The participants were randomly assigned such that any difference between the treatment group and control group is due to chance alone, and not by a selection bias.

This experimental design adopted symbols as proposed by De Vaus and de Vaus (2001). Groups E1 and E2 were classes that were randomly assigned to the experimental and control groups. O_1 and O_3 were pre-tests (tests given to the students before the learning activity to determine their performance) while O_2 and O_4 were post-tests (test given to the students after the learning activity to determine their performance). The assessment given to the control and experimental groups for the pre-test and post-test was the Biology Achievement Test (BAT) which was constructed by the researcher for the purpose of the study. X represents the treatment

variable which in this study was the cooperative learning method approach, while -- represents the control condition which in this study was the lecture teaching method.

Table 3.1: Pre-test and Post-test Experimental research design

GROUPS		PRE-TEST		PROCESS		POST TEST
E1	⇨	O_1	⇨	X	⇨	O_2
E2	⇨	O_3	⇨	--	⇨	O4

Source: De Vaus & de Vaus (2001).

Key

E1 Experimental group

E2 Control group

O_1 Observation before manipulation for the Experimental group

O_2 Observation after manipulation for the Experimental group

O_3 Observation before manipulation for the Control group

O_4 Observation after manipulation for the Control group

X Exposure to independent variable (Treatment)

⇨ Movement through time

--- No treatment given

This study fits this description of an experimental design in that the effects of cooperative learning approach was compared with the conventional teaching method at the end of one month treatment period to determine whether it had significant effect on secondary school students' achievement scores in biology. Experimental design procedure is hereby shown in figure 3.2.

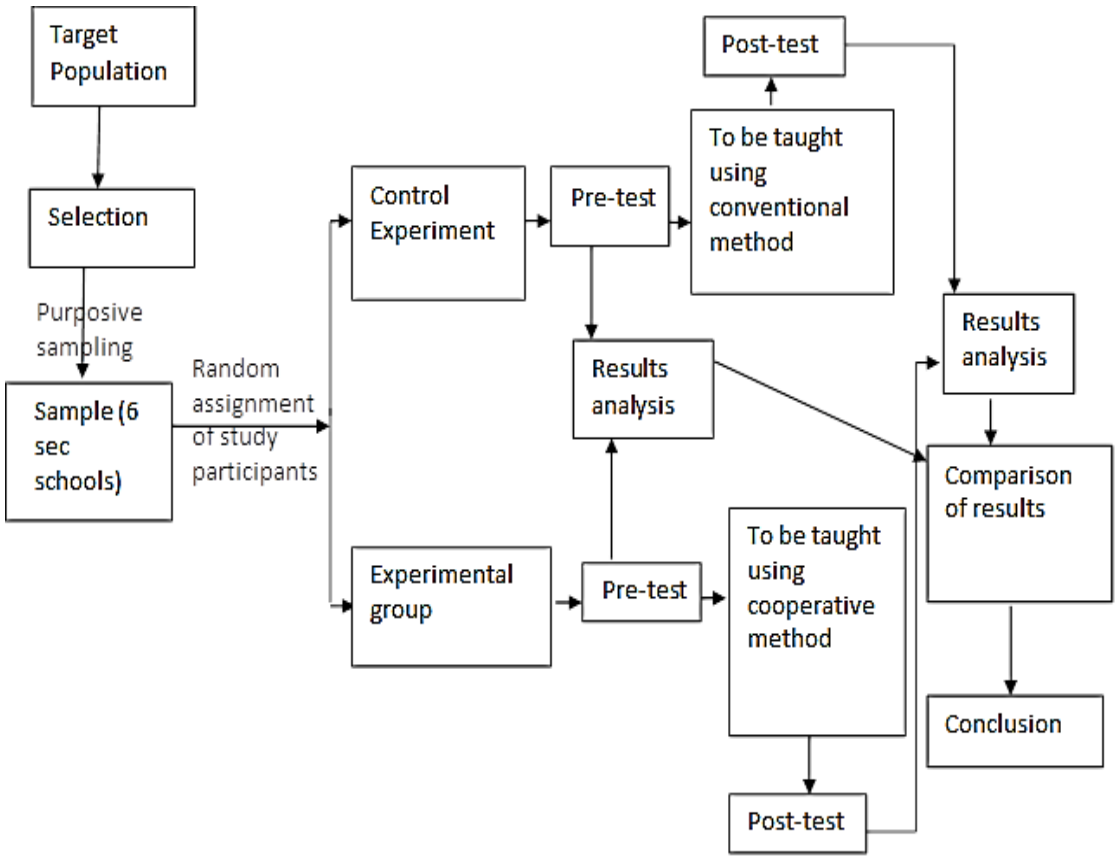

Figure 3.2: Experimental design procedure

Source: Author, 2013

3.3 Study Area

The study was carried out in the Narok North sub county. Narok is a town west of Nairobi along the Great Rift Valley (See the map in appendix V). Narok North Sub County is bordered by Narok South, Bomet and Naivasha. Narok North sub county is located between the longitudes 35° 37′ 0″ E and latitude 1° 15′ 0″ S. The County covers an area of 4,766 square kilometers with an estimated population of 850,920 (Mcmillan Kenya, 1994). It was noted from the sub- county director's education office that the estimated secondary school student population is 5906 out of which 2951 are girls and 2955 boys. There are 23 secondary schools in the region, two of which are private secondary schools.

The area is largely occupied by pastoral community the Maasai whose main economic activity is pastoralism, with some others being engaged in both large and small-scale wheat and barley farming. It also partly acts as a tourist attraction.

Education among the Maasai is low due to some cultural practices. Some particular factors in the Maasai culture do affect the educational standards in the region. Retrogressive cultural practices such as female genital mutilation (FGM) is still rampant in some regions coupled with early and forced marriages, which have adversely affected the education of the girl-child in the region. Their nomadic way of life led to no attachments to possessions, and togetherness banded by the age sets of those who underwent circumcision ritual together.

Culturally, the Maasai community works together in the performance of communal tasks such as hunting, pastoralism, circumcision and other cultural practices (see appendix XIII).The researcher wanted to find out whether their lifestyle would have an impact on method of teaching most appropriate for this community. The researcher thus concluded that adoption of cooperative learning would be easy since they like performing activities in unison.

3.4 Target Population

Burns and Grove (2003) describe a population as all the elements that meet the criteria for inclusion in a study. Parahoo (2006) defines a population as "the total number of units from which data can potentially be collected". According to LoBiondo-Wood and Haber (2010), a population in research refers to those elements

that make up the focus of the study that fit fixed criteria. A target population on the other hand refers to the general population under study, to which the results of the investigation ought to be generalized (Best and Khan, 2003).

Since it was not possible to reach all the members of a target population, the researcher identified the portion of the population which was accessible. An accessible population is the subject available for sampling (for example mailing list) the population of subjects available for a particular study, is often a non-random subset of the target population. The nature of the accessible population depends on the time and resources of the researcher.

The target population in this study was form two students and biology teachers in Narok North sub-County, Kenya. The accessible population was form two students and biology techers in six secondary schools selected in Narok North Sub - County. The six schools were used because they had done exams for many years hence; the researcher was able to compare the current biology results with previous years. They also had almost similar academic resources like laboratories and libraries. The sample (six schools) was obtained from the following schools as shown in Table 3.2.

Table 3.2: Types and Number of Schools Comprising the Target Population

Type of school	**Number of schools**
Girls' boarding Schools	4
Boys' boarding school	1
Mixed day and boarding school	2
Boys' day and boarding school	2
Girls' day and boarding school	2
Mixed day schools	12
Total schools	**23**

Source: Narok North Sub-County Director of Education Office

3.5 Sample Size

In quantitative research, the size of the sample should be calculated at the design stage (Proctor *et al.,* 2010). According to Polit and Beck (2010) quantitative researchers should select the largest sample possible so that it is representative of the target population. A sample of six selected secondary schools in the Narok North sub county was obtained using purposive sampling since the researcher targetted two girls' schools (girls' boarding school and girls' day & boarding school), two boys' schools (boys' boarding school and boys' day & boarding school) and two mixed schools (mixed day school and mixed day & boarding school). The researcher selected the six schools purposively because they had particular characteristics for example similar resources like libraries, laboratories and classrooms.This assisted the reseacher in carrying out research because the individual participants were able to contribute appropriate data, both in terms of relevance and depth.

The figure of the sample size was approximately 30% of the target population. According to Borg and Gall (2003), at least 30% of the total population is well representative for any study thus, this number was adequate for the study.

The sample size in the research was 482 form two students picked from 727 form two students from the six sampled schools. All the 28 Biology teachers in the sampled schools also participated in the study.

Table 3.3: Sample size table for schools, teachers and students in Narok North sub-county

Name of the school	Type of school	No. of biology teachers sampled	Total No. of Students in Form 2	No. of students sample	
				Control	Experimental
• Maasai Girls' Secondary	Girls'	7	202	40	40
• St. Mary's Girls' Secondary	Girls'	4	90	45	45
• Narok Boy's Secondary	Boys'	7	224	50	52
• Fanaka Boys' Secondary	Boys'	3	40	20	20
• Masikonde Mixed Secondary	Mixed	3	60	30	30
• Nkoitoi Mixed Secondary	Mixed	4	111	55	55
TOTAL		**28**	**727**	**240**	**242**

3.6 Sample and Sampling Procedures

A sample according to Gerrish and Lacey (2010) is a subset of a target population. According to Polit and Beck (2010), sampling is the process by which researchers select a proportion of the target population, to represent the entire unit. It is more practical and economical to work with samples rather than with large target populations.

Sampling may further be defined as "the selection of a fraction of the total number of units of interest to decision makers for the ultimate purpose of being able to draw general conclusions about the entire body of units (Parasuraman *et al.,* 2004,). A conclusion can be made from the sample about the population to achieve the research

objective (Saunders *et al.*, 2007). It is, therefore, uncommon for a research to survey the entire population due to time and financial constraints, especially, when the population is very large. The study utilized five-step procedure for drawing a sample based on Churchill and Iacobucci's (2002). The following diagram illustratively presents the procedure adopted in this thesis.

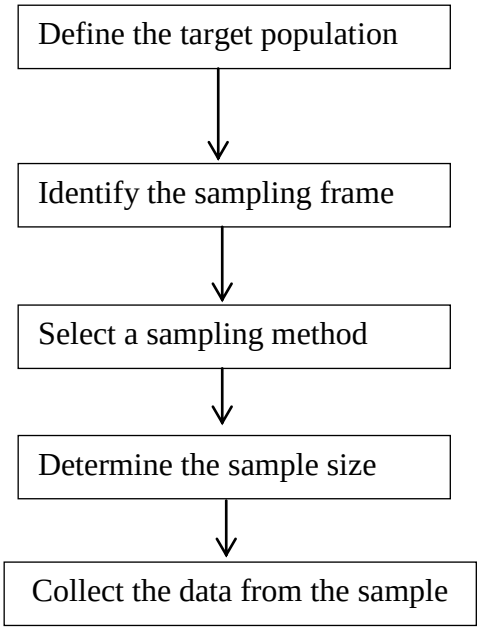

Figure 3.3: Five step procedure for drawing a sample

Adopted from Churchill and Lacobucci (2002) and Wilson (2006)

This study adopted purposive sampling to select the six secondary school (two coeducational schools, two boys schools and two girls schools) with comparable characteristics (mentioned above) from Narok North Sub-County. Purposive sampling is predominantly used in quantitative research (Parahoo, 2006). It involves the researcher selecting individuals who have knowledge of the phenomena studied or deemed potential information rich cases (Mapp, 2008).

Purposive sampling also is appropriate where the researcher has previous knowledge of the population and has a specific purpose for the study and therefore uses personal judgment to select a sample (Fraenkel and Wallen, 2006). A list of secondary schools

in Narok North Sub County was obtained from the County Education Office, from which a sample of six schools was selected.

This study therefore was carried out in six secondary schools (two girls, two boys' schools and two mixed schools) in Narok North Sub County. It targeted form two students and biology teachers in these schools. Form two students were selected because all students take Biology in form two take biology while in form three and four, they choose two sciences out of the three. Form one students were not included in the study because they were not well conversant with the school curriculum. The research process ran for a period of one month.

Out of the 727 form two students in the six schools sampled, a sample of 482 students was used as the respondents. In the 4-streamed schools (Maasai Girls' and Narok Boys') the researcher used simple random sampling to obtain the control and experimental groups. In this case, the researcher used lottery method whereby she wrote and rolled 2 YES paper slits and 2 NO paper slits. The researcher then used the 4 class prefects from each stream to pick the rolled slits of paper from a bowl. She then instructed them to unfold the picked paper. The researcher decided to use the two streams represented by the prefects who picked YES and left out the two streams represented by the prefects who picked NO. For the two streams represented by the prefects who picked YES, the researcher decided to use one stream as the control group and the other as the experimental group whereby the same method was used to obtain the groups. The experimental group was further subdivided into smaller manageable groups.

In the 2-streamed schools (St. Mary's Girls', Nkoitoi Secondary, Fanaka Secondary, and Masikonde Secondary) the researcher also used simple random sampling to obtain the control and experimental groups. In this case, she used lottery method

whereby she wrote and rolled 1 YES paper slit and 1 NO paper slit. The researcher then used the 2 class prefects from each stream to pick the rolled slits of paper from a bowl. She then instructed them to unfold the picked paper. The researcher decided to use the stream represented by the prefect who picked YES as the experimental group and the stream represented by the prefect who picked NO as the control group. The experimental group was further subdivided into smaller manageable groups. The students who were not involved in the study and the control group were later taught using cooperative learning to avoid biasness in the learning activity.

3.7 Data Collection Instruments

According to Parahoo (1997) a research instrument is a tool used to collect data. It is designed to measure knowledge attitude and skills. Data collection refers to gathering specific information aimed at proving or refuting some facts. In data collection, the researcher must have a clear understanding of what they hope to obtain and how they hope to obtain it. The researcher must have a clear vision of instruments used, the respondents and the selected area. Data collection is important in research as it allows for dissemination of accurate information and development of meaningful programmes.

Data collection procedure should be objective, systematic and repeatable. Robson (2007) maintains that a researcher should use the simplest manner of collecting the data to get answers to the research question and should not collect any more data than necessary. Mindful of these conditions; the data collection instrument selected for this study was the Biology Achievement Test (BAT) which was used to measure students mean achievement score in biology and questionnaire for the teachers and the students.

3.7.1 Biology Achievement Test (BAT)

The BAT consisted of fifteen short answer structured questions with a maximum score of 25 marks based on Gaseous exchange in plants and animals a topic that is taught at form two, as prescribed in the secondary education syllabus-volume two (KICD, 2002). The topic was used because as per the syllabus, it is taught in form two during the second term and data collection was done between June and August 2013. Therefore, it was convenient to teachers, the researcher and also it did not interfere with the school program. The topic also is experimental hence allows Experimental design procedures for learners to apply scientific skills like observation in cooperative learning. The short answer item format was modeled along the Kenya national examination council (KNEC) biology paper one, which was considered appropriate as it was the format used at secondary school level in Kenya (KNEC, 2012). The test items were set and categorized into three cognitive domain levels adapted from blooms taxonomy of Educational objectives in the cognitive domain (Bloom, 1956). The BAT test item was based on the first three cognitive levels of knowledge, comprehension, and application. This classification of the BAT items into three cognitive domain levels enabled the researcher to determine the effects of cooperative learning approach on student achievement in the three cognitive abilities. The BAT was used to obtain data on effect of cooperative learning on student achievement in biology (objective ii).

3.7.2 Questionnaire for the Teachers and Students

The data was also collected using questionnaire. A questionnaire is a tool of data collection that asks participants to give written or verbal replies to a written set of questions (Parahoo, 2006). It is a quick, convenient and inexpensive method of

collecting standardized information (Jones and Rattray, 2010). Questionnaires were used to collect information on attitudes of students and teachers towards cooperative learning. Structured written questionnaires that use a quantitative self-report technique, as outlined by Polit and Beck (2010) were used to collect data in this study. The questionnaires were organized into parts with part A capturing demographic details of the participants whereas the rest focused on questionnaire the objectives number i, iii, iv and v of the study (see the objectives). The questionnaire for the teachers had three parts (see Appendix VII). Part A used a fill the box format and gathered data on demographic details, the academic and professional background and experience of teachers. Part B and C of the questionnaire was used to gather data on the attitudes of teachers towards cooperative learning and common methods used in teaching Biology in Narok North sub-county. A fill in format box was used in part B and open-ended questions were included to allow free responses from the respondent. Likert scale was used in part C. The questionnaire of part C consisted of worded statements with 4 different response options ranging from Excellent to poor.

A Likert scale was used to gauge the degree of response in terms of strength or weakness on a scale of one to four the score for each item was reported individually. Questionnaire for the student was also used (see appendix VIII).In part A, a fill in format box was used to capture bio data of the student and part B captured the objectives on attitudes of the students towards cooperative learning and level of interdependence between the learners in Biology lessons. There was one open ended question in part B capturing the challenges of the use of cooperative learning in teaching Biology.

Questionnaires tend to have a low return rate (Parahoo, 2006). In an attempt to overcome this problem the researcher took the following steps:

i. A cover letter (see Appendix I) was sent with the questionnaire explaining the aim of the research study and guaranteeing confidentiality of the responses. A reminder letter was sent to respondents three weeks after the initial contact.

ii. According to Parahoo (2006), 'respondent burden' puts a pressure on respondents through the time and effort necessary to complete a questionnaire. To reduce this burden closed-ended questions which are more efficient and less time consuming for respondents were used and instructions were made clear (Polit and Beck, 2010). The questionnaire was administered and, drop and collect method was used to ensure higher response rate.

3.8 Validity and Reliability

Validity is the extent to which an instrument measures what it is supposed to measure and performs as it is designed to perform. It is rare, if nearly impossible, that an instrument be 100% valid, so validity is generally measured in degrees (Polkinghorne, 2007).

Reliability refers to the accuracy of measurement. Reliability for quantitative research focuses mainly on stability and consistency of the content of research instrument (Polit and Beck, 2010).According to Parahoo (2006) reliability is a necessary but not sufficient condition for validity.

3.8.1 Validity of the BAT

To ensure that the BAT was valid enough for data collection, the researcher gave it to her lecturers and supervisors to assess its quality. The researcher then corrected all the errors including language and grammar.

3.8.2 Validity of the Questionnaire

Polit and Beck (2010) defines the validity of a questionnaire as the degree to which the instrument measures what it is intended to measure. The questionnaire should adequately address all aspects of the issues being studied. Face validity and content validity are the validity issues most frequently reported in the literature (Parahoo, 2006).

Face validity basically checks that the questionnaire measures the concept being tested (LoBiondo-Wood and Habeer, 2010) and this was assessed by getting friends to test-run the instrument to see if the questions were relevant, clear and unambiguous as outlined by Jones and Rattray (2010).

A content validity test checks that there are enough relevant questions covering all aspects being studied and that irrelevant questions are not asked (Parahoo, 2006). The test is based on judgment as no objective methods exist. A panel of experts is used to evaluate the content validity of new questionnaires (Polit and Beck, 2010). The questionnaire was submitted to supervisors to check that the questions reflect the concepts being studied and that the scope of the questions is adequate, in the manner proposed by LoBiondo-Wood and Haber (2010). The judges included course lecturers in Research.

The supervisors validated the questionnaire. The expectations were that the content validity of the items in the questionnaire was ensured through the researcher's constant consultation with the supervisor and reference books used for the study.

3.8.3 Reliability of BAT

To ascertain reliability of the Biology achievement test instrument, the test was pilot-tested using a co-educational school in Narok South Sub-County that was not part of the study but had comparable characteristics as sample scores. The reliability

coefficient of the BAT was calculated using the Cronbach's alpha. Mugenda and Mugenda (2003) suggest that any value above 0.7 is considered an appropriate threshold. A similar view is held by Newby (2010). The reliability coefficient of the BAT was 0.8 which was considered high enough to ascertain the reliability of the instrument.

3.8.4 Reliability of Questionnaire

Reliability of a questionnaire refers to its ability to yield the same data when it is re-administered under the same conditions but it is difficult to obtain a replication of data when you are dealing with people (Robson, 2007). The reliability coefficient of the questionnaire was also calculated using the Cronbach's alpha. The reliability coefficient of the questionnaire was 0.7 which was considered high enough to ascertain the reliability of the instrument and having a good internal consistency.

3.9 Piloting of Research Instrument

Piloting is a key stage in the development of the questionnaire allowing evaluation of the instrument before the main study is conducted (Parahoo, 2006). Before the collection of data, a pilot test was conducted in two schools in the neighboring Narok South sub-County, Kenya. The choice of Narok South sub-County was because the two Counties share similar conditions concerning physical facilities and resources such as libraries, laboratories, classrooms and teachers to prevent contamination of the sample population (Gay and Korre, 2006).This enabled the researcher to curb some issues, which may have arisen in the actual research. The pilot study was conducted in the same manner as the main study.

3.9.1 Piloting of the BAT

To pilot test the BAT, the researcher used two groups of form 2 students from 2 schools from neighboring Narok South sub-county. The pilot study was conducted in the same manner as the main study. The supervisors and the researcher amended all the inconsistencies from the piloting process. Language, grammar errors and other evident errors in the BAT were also noted and corrected.

3.9.2 Piloting of the Questionnaire

The researcher used two schools from neighboring Narok South sub-county in pre-testing the questionnaire for the teachers and students. The pilot study was conducted in the same manner as the main study. The pilot study gave the researcher the opportunity of checking if the respondents understood the questions in the same way, if all questions were relevant and if all the instructions were clear. The pilot study also allowed a check on whether the length and structure of the questionnaire were problematic (Parahoo, 2006). The validity and reliability of the questionnaire can be checked at the pilot study stage (Jones and Rattray, 2010). Pilot participants were debriefed to check for problems with the questionnaire and issues concerning it. The structure and content of the questionnaire were amended accordingly.

3.10 Data Collection Procedure

For the purpose of this study, the researcher used gaseous exchange in animals (insect and fish) as the subject of choice (see Appendix X). The topic was chosen because it is widely applicable in tertiary and even higher levels of education, for example terrestrial ecology. The experimental group in each of the sampled school was taught using cooperative learning and the control group was taught the same content using lecture method (see appendix XV) by the Biology teachers.

3.10.1 Experimental Group

Week One: During the study, the teacher introduced the sub topic of gaseous exchange in animals. The learners were grouped then instructed on how to discuss the topic. In the first lesson, learners discussed gaseous exchange surfaces in animals; cell membrane, gills, buccal cavity, skin and lungs. Thereafter, they discussed the characteristics of gaseous exchange surfaces.

In second and third lessons, learners discussed in the same groups gaseous exchange in insects. They used hand lens to observe the spiracles and other parts of the insects. They also discussed the mechanisms of gaseous exchange in the fourth lesson.

Week Two: During the first lesson of the week, learners discussed adaptation of insect's tracheoles for gaseous exchange. They exchanged ideas on the area and wrote notes. The second, third and fourth lessons, learners discussed gaseous exchange in bonny fish e.g. tilapia. They removed the gill from the opeculum of the fish (see appendix) then each group discussed the structure of the gill (see appendix).

Week Three: The first and second lessons, learners discussed mechanisms of gaseous exchange in fish, countercurrent flow and parallel flow systems. The third and fourth lessons, learners wrote notes and discussed the overview of the sub-topic chosen.

In the fourth week, learners were given BAT (see appendix). For the control group, the sampled students were taught in classrooms whereby the Biology teachers in the selected six schools used lecture and solely handled the learning aids. They used the same lesson as discussed in experimental group but learners were passive in the learning activity. They listened and wrote notes.

After learning, the students were given the Biology Achievement Test (BAT) to measure their mean achievement of the content learnt. This test consisted of fifteen

questions structured with a maximum score of 25 marks based on the content of the topic taught.

After the test, the researcher collected the completed test scripts and marked them. The scores for each group were recorded and analyzed.

3.11 Data Analysis

According to Parahoo (2006), data analysis is "an integrated part of the research design", and it is a means of making sense of data before presenting them in an understandable manner. Descriptive analysis was carried out on the data collected.

Descriptive statistics were used in analyzing the quantitative data. In this case, frequency distribution and measures of central tendency such as mean as well as measure of dispersion such as percentages, range and standard deviation was calculated. Data was presented using tables, pie charts and graphs.

The data was then coded and themes within documents that relate to the research questions in the study were identified. The quantitative data was then interpreted by attaching significance to the themes and the patterns observed. Alternative explanations were also considered by looking at the differences in responses recorded in data collection (Mugenda & Mugenda, 2003). The data collected was coded and entered in the computer for analysis using the Statistical Package for Social Sciences (SPSS). This was because this program helps in organizing the data and presentation of data through charts in an easy way (Mugenda & Mugenda, 2003). ANOVA and Chi-square were used to analyze the differences between group means.

Back-up of computer records was requested throughout the analysis process. The data was stored on a computer made secure by passwords. The completed questionnaires were kept in a secure place both for back-up and security reasons.

3.12 Ethical Considerations

According to Polit and Beck (2010), researchers must deal with ethical issues when their intended research involves human beings and other animals. Research is viewed as a scientific human endeavor that is organized according to a range of protocols, methods, guidelines and legislation (Gerrish and Lacey 2010). Research ethics is that domain of enquiry that identifies ethical challenges with a view to developing guidelines that safeguard against any harm and protects the rights of human subjects in research (Rogers, 2008).The participants were not asked to give their names in the questionnaire thus maintaining their privacy and anonymity. The researcher also obtained the permit from National Council of Science, Technology and Innovation (NACOSTI) before commencing the research see appendix II and III.

Therefore, the researcher maintained professional ethics and conduct while carrying out research. The researcher ensured respondents privacy and confidentiality. The respondents were informed of the objectives and significance of the study.

3.13 Chapter Summary

In this chapter research design has been explained, the target population where the sample was picked, method of sampling which the study used to obtain the sample from the population. The section has also discussed the research instruments used in data collection which were questionnaire and BAT. The methodology of their validation and testing reliability has also been discussed. The researcher has also shown how she conducted pilot study for all her instruments. The procedure used to obtain the required data from the respondents has also been discussed. Finally, the method of data analysis which was used is also discussed.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION OF THE FINDINGS

4.1 Introduction

This chapter presents the analysis of the data collected, interpretations and discussions of the findings.

The data for this study was collected using BAT issued to students from the sample schools and questionnaires that were issued to students and biology teachers.

Data was analyzed using both descriptive and inferential statistics. For descriptive statistics, frequencies and percentages were used and for inferential statistics ANOVA and chi square were used to test the hypothesis at $\alpha=0.05$ level of significance at appropriate degree of freedom. The findings are presented under headings of four objectives and related research questions.

4.2 Demographic information of the respondents

4.2.1 Students' Gender

The sample respondents comprised of 241 male (50%) and 241 female (50%) students in form two from the sample schools.

Table 4.1: Students' Gender

Gender	Frequency	Percentage
Male	241	50%
Female	241	50%

4.2.2 Teachers' Gender

The study established that majority of the teachers who participated in the study in the selected secondary schools in Narok North sub county were males; 20 (71.4%) and a minority 8 (28.6%) were female teachers which made a total of 28 teachers (100%).

Table 4.2: Teachers' Gender

Gender	Frequency	Percentage
Male	20	71.4%
Female	8	28.6%

4.2.3 Age Distribution of teachers Involved in the Study

From figure 4.1 below, it can be noted that out of the 28 teachers sampled, majority of them were in the age bracket of 39-45 years (39.3%) and only a few 1 (4%) were in the over 46 years age group. This indicates that most of the teachers have been in the service for long times hence, were expected to have experience in teaching methods.

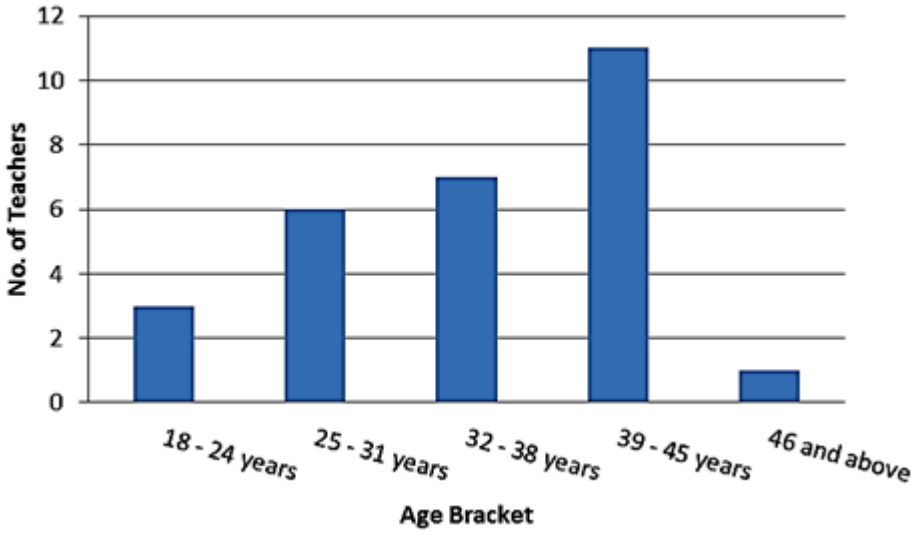

Figure 4.1: Age Distribution of teachers

4.2.4 The Qualification of the Teachers

The qualification of the teachers who participated in the study are presented in figure 4.2 with majority of the teachers being holders of Bachelor of education degrees (science), 18(64.3%) and a minority, 10.7% were holders of diploma in education science making a total of 75.0%. 25% comprised of teachers who were holders with of Bachelor of Science, Master of Education and those who didn't respond.

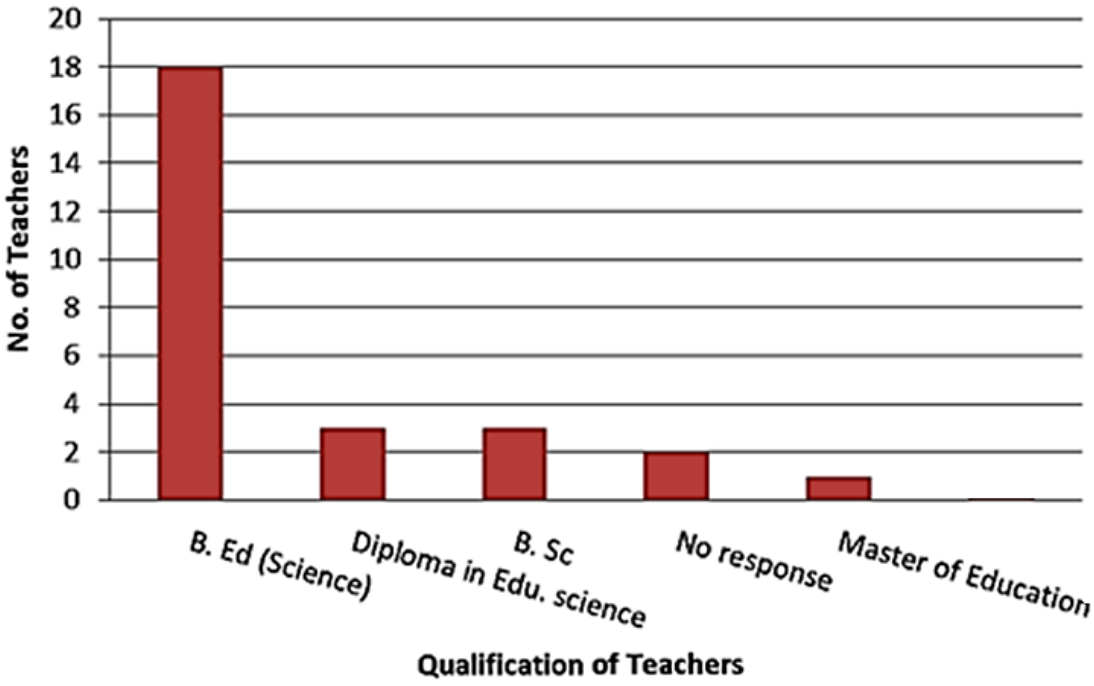

Figure 4.2: Qualification of the Teachers

This is clear indication that most of the biology teachers in Narok North Sub County are qualified to teach the subject.

4.2.5 Teachers' Experience in Teaching Biology

Investigations into the teaching experience of the respondents revealed that a majority of the teachers had taught for a period of 11 years and above which translates to 68.8% hence, most of them are experienced and therefore they were able to develop meaningful cooperative learning groups and create efficient working groups.

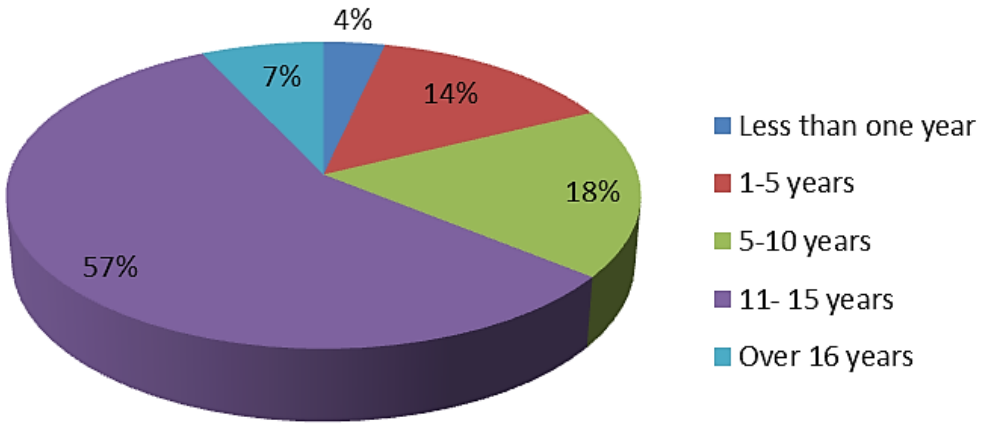

Figure 4.3: Teaching Experience

4.3 Presentation of the Findings

The researcher gathered information needed for analysis from identified respondents who were drawn from six secondary schools in Narok North Sub County

4.3.1 Common Methods used in teaching Biology

The first objective of this study was to investigate the common methods used in teaching biology in Narok North sub –county. To achieve this, the teachers were asked to state the methods they used in teaching biology (teacher's questionnaire part b (i)).

It was noted that majority of the teachers 12 (42.9%) said that they used lecture method very often, while 13 (46.4%) used often and only 3(10.7%) rarely used. 2 (7.1%) used experimental method very often, 14 (50.0%) used it often and only 10 (35.7%) rarely used, 2(7.1 %) never used experimental method at all. 5 (17.9%) of the teachers said they use cooperative learning very often, 5 (17.9%) used it often, 18(64.3%) used it rarely and none of them did not use it at all. 26 (92.9%) used field strip rarely and 2 (7.1) used it often, 6(21.4%) of the respondents indicated that they use demonstration method very often 12(42.9%) indicated that they used it often and

10(35.7%) rarely used it which gives a total of 28(100%). The results are summarized in figure 4.4:

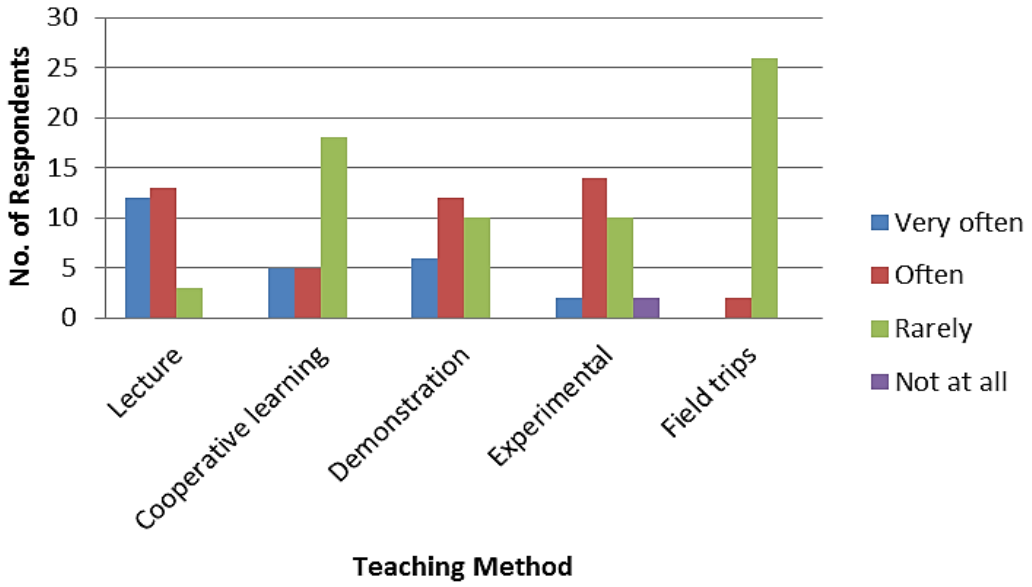

Figure 4.4: Type of Teaching Method Used

Based on the teacher's responses in the table 4.1 above, most of the teachers (42.9%) very often use lecture method in teaching Biology while only a few (17.9%) use cooperative learning method. This implies that in these schools, the pupil's role in the learning process is largely passive, and that a pupil's mind is a *tabula rasa*- a blank slate onto which knowledge can be written. These finding are in line with those of a study conducted by Moyer, Hackett and Everett (2007) who found that many students today are learning science in a passive way in classrooms where information is organized and presented to them by their teacher. According to Trowbridge *et al.* (2000) most teachers prefer the lecture or conventional teaching method because it has the following advantages:

a. It is easy to create interest in a topic or subject by the teacher.

b. Students easily acquire knowledge, new information, and explanation of events or things.

c. It helps students to clarify and gain better understanding of a subject, topic, matter or event.

d. Students and teachers cover more content materials within a short period of time.

Research conducted over the past few decades (Lake, 2001) shows it's impossible for students to take in and process all the information presented during a typical lecture, and yet this is one of the primary ways Narok Sub County students are taught. According to CIRTL (2015), other limitations of the lecture method include:

i. Places students in a passive rather than an active role, which hinders learning.

ii. Encourages one-way communication; therefore, the lecturer must make a conscious effort to become aware of student problems and student understanding of content without verbal feedback.

iii. Requires a considerable amount of unguided student time outside of the classroom to enable understanding and long-term retention of content. In contrast, interactive methods (discussion, problem-solving sessions) allow the instructor to influence students when they are actively working with the material.

iv. Requires the instructor to have or to learn effective writing and speaking skills.

4.3.2 The Effect of Cooperative Learning on Students' Achievement

The second objective of this study sought to determine the effect of cooperative learning on students' achievements in Biology. To achieve this, the students were randomly divided into two groups; one group was taught using cooperative method (experimental group) and the other group was taught using the conventional methods (control group). But before teaching the two groups, it was first necessary to ensure

that the groups had the same learning potential in Biology. Therefore, the groups were given a pre – test. The students' responses to the test items were scored out of hundred marks. Their performance in the pre – test are presented in tables 4.3 and 4.4

Table 4.3: Students Mean and standard deviation in Pre - Test

Method	N	Mean	Std. Deviation
Group 1 (Cooperative method)	240	57.07	15.95
Group 2 (Lecture method)	242	54.04	16.53
Total	482	55.55	16.30

The values presented in Table 4.2 show that the means of group one and two in the pre – test were 57.07 and 54.04 per cent respectively. To find out whether the differences in the performance noted were significant or due to chance, the data was tested using one-way analysis of variance (ANOVA). The details of the findings are presented in Table 4.4

Table 4.4: Analysis of variance of the students test in pre - test

	Sum of Squares	d.f.	Mean Square	F	Sig.
Between Groups	1102.882	1	1102.882	2.064	0.304
Within Groups	256484.160	480	534.342		
Total	257587.042	481			

Significance at $\alpha = 0.05$

Table 4.4 shows the results of the inferential test undertaken. It indicates that the significance (or p-value) obtained is 0.304 and F value of 2.064. This implies that indeed there was no significant difference in students' performance in the pre - test. It also means that the two groups had the same learning potential in Biology.

After this was noted, group 1 was taught using cooperative method and group two was taught using conventional method. Thereafter a post – test was administered to

the two groups. The performance in the post – test is presented in table 4.5. The values in table 4.4 suggest that there seem to be differences in the performance in the post – test. Those taught using cooperative learning had a mean of 71.27 (SD = 14.96, N = 240), while those taught using conventional method had a mean of 61.20 (SD = 18.18, N =242).

Table 4.5: Students Mean and standard deviation in post - test

Method	N	Mean	Std. Deviation
Cooperative method	240	71.27	14.96
Conventional method	242	61.20	18.18
Total	482	66.21	17.38

To ascertain whether the differences noted were significant or due to chance, the data was tested using one-way ANOVA. The hypothesis was: $H0_2$: There is no significant difference in performance in Biology between the two methods. Table 4.6 gives the details of the findings.

Table 4.6: Analysis of variance of the students test in post - test

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	12204.978	1	12204.978	44.020	.000
Within Groups	133086.012	480	277.263		
Total	145290.990	481			

Significance at $\alpha = 0.05$

Table 4.6 provides a summary of the outcome of the inferential test undertaken. It shows that, at 0.05 significant level, the F value was 44.020 and the significant value obtained was 0.000. This implies that indeed there is a difference in students' performance when the two different methods were used. Consequently, the null hypothesis that there is no statistically significant difference among the learners taught using cooperative learning method and those taught using conventional methods was rejected, HO_2 was rejected.

These results imply cooperative method of teaching has a significant effect in performance in Biology. These results agree with researchers for example a study which was carried by Tschumi (1991) which showed that students taught using cooperative learning perform better than those taught using lecture method.

It also concurs with a study conducted by Wambugu and Changeiywo (2008) showed that secondary school students with minimal prior knowledge of specific physics content had higher achievement when taught through the cooperative learning approach than those taught through the regular teaching method. Armstrong *et al.* (2007) in a study that compared cooperative learning approach and traditional lecture method in an undergraduate biology course reported that the experimental group that was instructed through cooperative learning approach showed greater improvement in overall test scores than control group that was taught using a traditional lecture approach. Similarly Wachanga and Mwangi (2004) found that the cooperative learning approach produced significantly higher achievement scores among secondary school chemistry students as compared to the regular teaching method. This is also substantiated by Li and Lam (2005) who stated that cooperative learning has the following advantages:

i. Celebration of diversity. Students learn to work with all types of people. During small-group interactions, they find many opportunities to reflect upon and reply to the diverse responses fellow learners bring to the questions raised. Small groups also allow students to add their perspectives to an issue based on their cultural differences. This exchange inevitably helps students to better understand other cultures and points of view.

ii. Acknowledgment of individual differences. When questions are raised, different students will have a variety of responses. Each of these can help the

group create a product that reflects a wide range of perspectives and is thus more complete and comprehensive.

iii. Interpersonal development. Students learn to relate to their peers and other learners as they work together in group enterprises. This can be especially helpful for students who have difficulty with social skills. They can benefit from structured interactions with others.

iv. Actively involving students in learning. Each member has opportunities to contribute in small groups. Students are apt to take more ownership of their material and to think critically about related issues when they work as a team.

v. More opportunities for personal feedback. Because there are more exchanges among students in small groups, students receive more personal feedback about their ideas and responses. This feedback is often not possible in large-group instruction, in which one or two students exchange ideas and the rest of the class listens.

4.4 Analysis of level of interdependence among the learners

4.4.1 Method of teaching used versus level of consultation

In order to compare the level of interdependence among the learners on the basis of consultation, sharing of resources and preference to work in groups (student questionnaire part B, questions 4, 5 and 6), a cross tabulation was done. Table 4.7 and Table 4.8 give a summary of the findings obtained.

Table 4.7: Descriptive Statistics on Method of teaching used versus level of consultation

		Level of consultation			Total
		Poor	**Good**	**Excellent**	
Method of teaching used	Lecture Method	40	120	80	240
	Cooperative Method	20	20	202	242
Total		60	140	282	482

Table 4.8: The Chi – square test on Method of teaching used versus level of consultation

			Level of consultation			Total
			Poor	Good	Excellent	
Method of teaching used	Lecture	Count	40	120	80	240
		Expected Count	29.9	69.7	140.4	240.0
	Cooperative Method	Count	20	20	202	242
		Expected Count	30.1	70.3	141.6	242.0
Total		Count	60	140	282	482
		Expected Count	60.0	140.0	282.0	482.0

Chi – square value = 130.87, Degrees of freedom = 2, Probability value (Sig.) = 0.000

From Table 4.7 and 4.8, it can be noted that a chi – square value of 130.87 and sig. of 0.000 was obtained. Therefore, the null hypothesis that there is no statistically significant difference in the level of consultation among the learners who use cooperative method and those who use cooperative learning to learn Biology was rejected. This means that indeed there is a dependency between method of teaching use and level of consultation. It also means that cooperative learning resulted in a better level of consultation among the learners.

4.4.2 Method of teaching use versus Sharing of Resources

Similarly, in order to compare the interdependence of method of teaching use and sharing of resources that were available, a cross tabulation was done. Table 4.9 and Table 4.10 give a summary of the findings obtained.

Table 4.9: Descriptive Statistics of Method of teaching used versus Sharing of Resources

		Sharing of Resources		Total
		Yes	No	
Method of teaching used	Lecture Method	80	160	240
	Cooperative Method	202	40	242
Total		282	200	482

Table 4.10: The Chi – square test on Method of teaching used versus Sharing of Resources

			Sharing of Resources		Total
			Yes	No	
Method of teaching used	Lecture	Count	80	160	240
		Expected Count	140.4	99.6	240.0
	Cooperative Method	Count	202	40	242
		Expected Count	141.6	100.4	242.0
Total		Count	282	200	482
		Expected Count	282.0	200.0	482.0

Chi – square value = 124.77, Degrees of freedom = 1, Probability value (Sig.) = 0.000

From Tables 4.9 and 4.10, it can be noted a chi – square value of 124.77 and sig. of 0.000 was obtained. Therefore, the null hypothesis that there is no statistically significant difference in the sharing of resources among the learners who use cooperative method and those who use cooperative learning to learn Biology was rejected was rejected. This means that there is a dependency between method of teaching used and sharing of resources. It also means that cooperative learning encouraged the sharing of resources.

4.4.3 Method of teaching used versus Preference to work in groups

In a similar manner, in order to find out the level of interdependence between method of teaching use and preference to work in groups, a cross tabulation was undertaken. Table 4.11 and Table 4.12 give a summary of the findings obtained.

Table 4.11: Descriptive Statistics Method of teaching used versus Preference to work in groups

		Preference to work in groups		Total
		Yes	No	
Method of teaching used	Lecture Method	160	80	240
	Cooperative Method	234	8	242
Total		394	88	482

Table 4.12: The Chi – square test Method of teaching use versus Preference to work in groups

Crosstab					
			Preference to work in groups		Total
			Yes	No	
Method of teaching used	Lecture	Count	160	80	240
		Expected Count	196.2	43.8	240.0
	Cooperative Method	Count	234	8	242
		Expected Count	197.8	44.2	242.0
Total		Count	394	88	482
		Expected Count	394.0	88.0	482.0

Chi – square value = 72.80, Degrees of freedom = 1, Probability value (Sig.) = 0.000

From Tables 4.11 and 4.12, it is noted a chi – square value of 72.80 and sig. of 0.000 was obtained. Therefore, the null hypothesis that there is no statistically significant difference in the preference to work in groups among the learners who use cooperative method and those who use cooperative learning to learn Biology was rejected was rejected. The results indicate that again there is a dependency between

method of teaching use and preference to work in groups. This means that cooperative learning encouraged the learners to prefer working in groups.

These results agree with those of Jeanie (2001) who reported that cooperative learning promotes positive interdependence among the learners. The findings are also in line with those of Tinzmann *et al.* (1990) who reported that cooperative learning enables the students to share knowledge, experiences and learning strategies.

4.5 Attitudes Held by Teacher's Towards Cooperative Learning

The fourth objective in this study was to establish the attitudes held by both teachers and students towards cooperative learning in Narok North sub-county. Therefore, the study intended to explore the attitudes that teachers have towards co-operative learning (teacher's questionnaire part C).The study revealed that all the teachers are aware of cooperative learning 28 (100%).

Table 4.13: Knowledge of Cooperative Learning

	Frequency	Percentage
Yes	28	100.0
No	0	0.0
Total	28	100.0

From table 4.13, teachers were asked to give perceptions/feeling about cooperative learning in part C of the questionnaire, they gave varying reasons. On the extent to which cooperative method promotes learning in biology, majority of teachers described it as a good method to promote learning in biology with 9(32.1%) indicating that it is excellent, 15(53.6%) observing that it is a good method, 3(10.7%) talked of it as being fair and only 1(3.6%) said it is poor.

Effort to establish teacher's attitudes towards cooperative learning in biology had the following results: 5(17.9%) felt it is excellent, 15(53.6%) good, 7(25 %) fair and

1(3.6%) poor. The researcher concluded that teachers had positive attitude towards cooperative learning.

On the extent to which cooperative learning in biology improves the coverage of the syllabus. The teachers gave the following responses 9(32.1%) felt it is Excellent, 10(35.7%) good, 6(21.4%) fair and 3(10.7) poor.

The respondents also gave the following responses on the extent to which biology teachers encourage students to use cooperative learning in biology 2(7.1%) observed that it is excellent, 15(53.6%) good, 8(28.6%) fair and 3(3.6%) felt that it is a poor method.

On the use of cooperative method in teaching biology 1(3.6%) use cooperative method excellently, 5(17.9%) good, 6(21.4%) fair and 16(57.1%) observing that they use it poorly, from this findings it appeared that the rate at which teachers use cooperative learning is below average (50%) for instance: 12 teachers (39.9%) uses it the rest 16(57.1%) showed that they use it poorly. Teachers gave several reasons why they rarely use cooperative learning method : the method is time consuming, problems of group formation, large class sizes creates problem for group, good candidates feel they are slowed down, weak students fear being ridiculed, lack of resources/equipment for discussion group.

Table 4.14: Frequencies of responses of teachers on cooperative learning

	Statement	Poor	Fair	Good	Excellent	Total
1	How will you rate the extent to which cooperative learning promotes learning in biology	1(3.6)	3(10.7)	15(53.6)	9(32.1)	28(100.0)
2	How can you rate teachers' attitude towards cooperative learning in biology	1(3.6)	7(25.0)	15(53.6)	5(17.9)	28(100.0)
3	To what extent does cooperative learning in biology improve the coverage of syllabus	3(10.7)	6(21.4)	10(35.7)	9(32.1)	28(100.0)
4	To what extent do biology teachers encourage students to use cooperative learning in biology	3(10.7)	8(28.6)	15(53.6)	2(7.1)	28(100.0)
5	Rate extent to which teachers use cooperative learning in teaching biology	16(57.1%)	6(21.4%)	5(17.9)	1(3.6)	28(100.0)

Table 4.15: Descriptive statistics on cooperative learning

	Statement	N	Mean	Std. Deviation
1	How will you rate the extent to which cooperative learning promotes learning in biology	28	3.1429	.75593
2	How can you rate teachers' attitude towards cooperative learning in biology	28	2.8571	.75593
3	To what extent to cooperative learning in biology improve the coverage of syllabus	28	2.8929	.99403
4	To what extent do biology teachers encourage students to use cooperative learning in biology	28	2.5714	.79015
5	Rate extent to which teachers use cooperative learning in teaching biology	28	2.3214	.81892

Teachers were asked in part B (iv) to state their personal feelings in the use cooperative learning in teaching Biology. It is presented in table 4.16 that teachers had different feelings towards cooperative learning. It is noted that majority of the teachers 12(42.9%) said it was a good method. 4(14.3%) observed that the method was effective in teaching and learning of biology, 7(25.00%) didn't give any responses about cooperative learning. Others gave different feelings like one teacher put it this way, "cooperative learning is quite interesting(3.6%), another one said it helps know student's ability(3.6%), weak students learn from bright students(3.6%),it makes students be on same level (3.6%) and promotes cooperation among students (3.6%), which made a total of 28 teachers (100%)

Table 4.16: Feelings about cooperative learning method

Personal feeling about the method	Frequency	Percentage
Good method	12	42.9
No response	7	25.0
Effective	4	14.3
Quite interesting	1	3.6
Help know student's ability	1	3.6
Weak students learn from bright students	1	3.6
Makes students be on same level	1	3.6
Helps cooperation among students	1	3.6
Total	28	100.0

Generally, most teachers (75%) have a positive attitude towards cooperative learning. These results disagree with the findings of a study conducted by Thanh (2011). According to him, the functions of cooperative learning were often not understood correctly because the teachers maintained that cooperative learning mainly helped the students remember information rather than develop a deep understanding of the text they were studying.

The findings of this study agreed with those of Zhang (2010) who conducted a study on cooperative learning in outdoor education. The participants of his study mainly had a very positive attitude towards group work in outdoor education, although some limitations were identified, for instance, students sometimes lost focus, were absent or were less involved. Teachers who use cooperative learning may feel that their time is spent more effectively. In addition, teachers who try cooperative learning techniques often adopt a fresh, new attitude toward their jobs. It can be exciting for a teacher when a group has the freedom to generate their own ideas and to make their own decisions. Some teachers who experiment with cooperative learning techniques are pleasantly surprised at how well their students perform in collaborative group settings (Thanh, 2008).

4.6 Attitudes held by students towards cooperative learning

The fourth objective also sought to establish the attitude held by students towards cooperative learning (student's questionnaire part B 1, 2 and 3). The results revealed that out of 482 students most of them 343(71%) enjoyed very much, 77(16%) just enjoyed and 62(13%) enjoyed biology lesson when cooperative learning is used. Table 4.17 shows the distributions on how the learners enjoyed biology lesson when cooperative learning is used.

Table 4.17: Attitudes held by students towards cooperative learning

	Frequency	**Percentage**
Enjoyed very much	343	71
Enjoyed	62	13
Just enjoyed	77	16
Total	**482**	**100**

It was also evident from the results, that at the time of the study, 323(67%) of the students highly participate, 92(19%) averagely participate and very few of them lowly participate 67(14%) in cooperative learning in biology.

Table 4.18: Student's participation in cooperative learning

	Frequency	**Percentage**
Highly participate	323	67
Averagely Participate	92	19
Lowly Participate	67	14
Total	**482**	**100**

It is also revealed that most learners 415(86%) said that cooperative learning help a lot to improve in biology, 48(10%) said it help a little and only 19(4%) said it do not help at all.

Table 4.19: Effects of cooperative learning on student performance

	Frequency	Percentage
Help a lot	415	86
Help a little	48	10
Do not help at all	19	4
Total	**482**	**100**

Generally, from table 4.17, 4.18 and 4.19 above most of the students (75%) had a positive attitude towards cooperative learn. These result was in line with the findings of Akinbobola (2009) that cooperative learning strategy promotes more positive attitudes toward the instructional experience than competitive or individualistic strategies. This is not surprising because in cooperative learning, students are trained on how to interact positively, resolve disputes through compromise or mediation and encourage the best performance of each member for the benefit of the group. When students are successful, they view the subject with a very positive attitude because their self-esteem is enhanced. The researcher concluded that the result is not surprising because in cooperative learning, students are trained on how to interact positively, resolve disputes through compromise or mediation and encourage the best performance of each member for the benefit of the group. This means that when students are successful, they view the subject with a very positive attitude because their self-esteem is enhanced.

It is also revealed from the results that learners have positive attitudes towards the approach on student achievement in biology which is supported clearly by Springer *et al.* (1999) by saying cooperative learning had significant positive effect on achievement, persistence and attitude and his study that examined cooperative learning in science.

It also concur with George (1994) who tested several cooperative learning techniques on a predominantly African-American psychology class and compared their performance with that of a control group taught non-cooperatively. She found that group work led to significant improvements in both academic achievement and attitudes toward instructions.

4.7 Challenges of using Cooperative Learning in Biology

The fifth objective of this study was to find out the challenges faced by cooperative learning in schools in Narok North Sub County (student's questionnaire part B question 7). Though from various studies including test study co-operative learning have been known to improve performance, it has been found from this study also that there are several challenges. Out of 482 students ,96(20%) said that when co-operative learning is used, some students do not cooperate. while 84(17.5%) do not attend the discussion, 58(12.0%) believed that it was time consuming 52(10.8%) said they doubt their solutions(They need a teacher to be present, 32(6.7%) revealed that some laughed at others suggestions hence the participants become shy, 32(6.7%) said some members were inactivate , 28(5.8%) said they lack materials to use like books, 20(4.2%) said some are lazy and others results as distributed below in table 4.20.

Table 4.20: Challenges of using co-operate learning in biology

Challenge	Frequency	Percentage (%)
Some do not cooperate. They have no commitment	96	20.0
Some do not participate while others do not attend	84	17.5
It is time consuming	58	12.0
We doubt our solutions. We need a teacher to be present	52	10.8
Some members are not active	32	6.7
Some laugh at others' suggestions hence they become shy	32	6.7
We lack of materials to use	28	5.8
Some members are lazy	20	4.2
Some members do not like Biology at all	16	3.3
It improve studies bring understand	16	3.3
Time is inadequate to do collaborative learning	14	3.0
Some student fail to attend because of school fees	14	3.0
No response	14	3.0
It is better to be alone	3	0.6
Total	**482**	**100**

In general, the results of this study show that cooperative learning faces some challenges in schools in Narok Sub County. These results agree with a study by Ajaja and Eravwoke (2010) reaffirmed the ability of cooperative learning when used as an instructional strategy to bring about significant improvement in students' achievement in school science subjects. The findings of the study indicated that students in cooperative learning group outscored those in the lecture group in an achievement test and a non – significant difference in achievement scores between male and female students in the cooperative learning group.

The major disadvantages of cooperative learning include: not all members of a group will participate in solving the problems they are confronted with, some very active members of a group may overshadow less active ones, the method is time consuming and low ability students who solely depend on the teacher for all information may not be able to make any contributions during cooperative learning.

The results also concurred with Ransdell and Moberly (2003) reports that students see this alternative teaching style as unscholarly; rather akin to unstructured group work

where one student works diligently, to carry the group, and the others do little or nothing. A major concern of some students is that even if all members do not pull their weight;, all students in the group receive the same grade, regardless of their contribution (Kagan, 1995 as cited in Ransdell and Moberly, 2003). Students' course evaluations of their professors suggested that students placed a lower value on cooperative learning strategies than they did on the more traditional lectures (Lake, 2001). This shows students uneasiness with the idea of cooperative learning. It is noted that students have various fears about group work. Some of the common fears about working with groups include student fears that each member will not pull their weight as a part of the group; students are also scared that their grade will be lower as a result of the group learning versus learning they do individually .

4.8 Chapter summary

This chapter has presented the findings of the study. The analysis and presentation of findings was based on the objectives of the study; methods used in teaching Biology, effects of cooperative learning on student achievement, level of interdependence of Biology content and attitudes held by teachers and students towards cooperative learning. Interpretation of the literature reviewed in chapter two.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings from the data collected, conclusion, recommendations and suggestions for further research.

5.2.1 Methods Used By Biology Teachers

The study revealed that in most of the schools in Narok north Sub County, there are several methods used during biology lessons. Lecture method was mostly used compared to other methods like cooperative learning. Though teachers indicated that cooperative learning is effective because they found it very helpful in enhancing student's performance especially slow learners, It was also motivating and interesting, they rarely used it because of the following reasons:. bright students complain about being held back by their slower teammates, weaker or less assertive students complain about being discounted or ignored in group sessions, and resentments build when some team members fail to participate. Biology teachers with sufficient patience generally find ways to deal with these problems, but others become discouraged and revert to the traditional teacher-centered instructional method, which is a loss both for them and for their students.

5.2.2 Effect of cooperative learning on student achievement in biology

The study found out that the students who were taught through cooperative teaching method achievedstatistically significantly higher scores in the BATcompared to those who were taught through conventional method. Thisimplies that cooperative teaching method is more effctive inenhancing students' achievement in biology.

5.2.3 Level of interdependence of Biology content

The study found out that the use of cooperative learning enhances the level of interdependence among the students. It encourages them to share learning resources, knowledge, experiences and learning strategies. It also promotes consultations among the learners and supports preference to work in groups.

5.2.4 Attitude of students

It was discovered that cooperative learning helps students develop the skills necessary to work on projects which are too difficult and complex for any one of them to do in a reasonable amount of time. The study found out that cooperative learning strategy is not only enjoyable to the students but also immensely improves their achievement and their interpersonal relationships. Cooperative learning approach also helps students to grasp subject knowledge and generic skills like communication skills and collaboration skills.The positive effect of cooperative learning for the performance in Biology can be easily generalized to all major subjects and for high, average, and low achievers.

5.2.5 Attitude of Teachers

The study found out that most teachers were largely using lecture method in teaching though they were very aware of cooperstive learning method. It was discovered that teachers could easily grasp different basic cooperative learning strategies or skills such as group dynamics with defined roles.If encouraged enough, teachers in the study area can embed cooperative learning into their classroom curricula to obtain the benefits widely attributed to this pedagogical practice.

5.2.6 Challenges of Cooperative Learning

The study identified several challenges to cooperative learning in schools in Narok North sub county. Firstly, cooperative learning is time consuming since it involves organizing groups, assigning them work, time to discuss discussions, supervision and summarizing the work. This leads to slow coverage of the required content.

Secondly, some students who engaged in group work were either on the sidelines or dominating the conversation. In most cases, it doesn't last. This ususlly derails the spirirt of groupwork since of the dominance of a single member of non-participation of some sidelined members.

Finally, group processing and sometimes the work of the group itself may depend on the ability of the members to give constructive criticism and their perception that it is "safe" to do so in their group. Many students have had little experience or bad experience with criticizing peers or are unwilling to receive criticism in return. Under these conditions, group members may simply each turn in their share of the project, not necessarily even looking at their partners' work, and move on to the next task. This can be a serious problem in pairs that have to work together throughout an entire term. A larger group (3 or 4) reduces the pressure to get along a little, especially if they are assigned to critically read a different person's work each time. It may also be necessary to teach students about how to give and receive constructive criticism.

5.3 Conclusions

The results of this study showed that cooperative learning strategy is more effective in enhancing students' attitude towards biology than lecture and other learning strategies.

Cooperative learning in secondary schools is an active method. Beyond that, it enhances learning in several ways. Weak students working individually are likely to

give up when they get stuck; working cooperatively, they keep going. Strong students faced with the task of explaining and clarifying material to weaker students often find gaps in their own understanding and fill them in. Students working alone may tend to delay completing assignments or skip them altogether, but when they know that others are counting on them, they are often driven to do the work in a timely manner.

However, the proven benefits of cooperative learning notwithstanding, biology teachers who attempt it frequently encounter resistance and sometimes open hostility from the students. Bright students complain about being held back by their slower teammates, weaker or less assertive students complain about being discounted or ignored in group sessions, and resentments build when some team members fail to work hard. Biology teachers with sufficient patience generally find ways to deal with these problems, but others become discouraged and revert to the traditional teacher-centered instructional paradigm, which is a loss both for them and for their students.

Based on the findings the following additional conclusions have been derived:

1. In spite of the potential benefits of cooperative learning, it is not fully accepted by all students at the institutions. Due to students fear, apprehension and

   past experiences, many prefer to work on their own rather than within a group.
2. Whenever students are a part of cooperative learning activities or assignments whether within the classroom or outside there is an improvement in

   their level of class participation and academic performance. The findings suggestthat student believe that cooperative learning facilitates good working relationships, and enhances socialization and creativity.

3. Based on the findings it was noted that cooperative learning is an underutilized tool. It was noted that students and teachers are not fully aware of the various cooperative learning techniques that can be utilized.

5.4 Recommendations

Based on the findings of the study and conclusion reached, the following recommendations were made:

i. Since cooperative learning has been proven to have numerous benefits such as improvement in academic performance and enhanced class participation more emphasis should be placed by the institution on promoting this alternative technique

ii. Biology teachers should arrange with the school administrations to ensure that there are enough resources required like texbooks to give room for effective interaction among students.

iii. Cooperative learning strategy should be used in teaching various concepts in Biology starting from form one to form four level to farmiliarise the learners in the secondary schools institutions.

iv. Seminars, workshops and conferences should be organized for Biology teachers to appraise them with the use of cooperative learning strategy hence help them to develop positive attutude towards this learniong strategy.

v. Biology teachers should adopt cooperative learning strategy as an effective learning strategy in order to enhance students' attitude towards the subject.

5.5 Suggestions For Further Research Study

1. A study aimed at determining ways to lessen students' apprehension of the use of

cooperative learning could be undertaken.

2. Experimental approaches could be utilised to assess the effectiveness of implementing particular cooperative learning strategies for various subject areas in biology.

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APPENDICES

Appendix I: Letter of Information to the Head Teacher/Principal

University of Eldoret
flame of knowledge and innovation

University of Eldoret
P. O Box1125, Eldoret.
1/02/2013

Dear Sir/Madam

RE: RESEARCH DATA COLLECTION

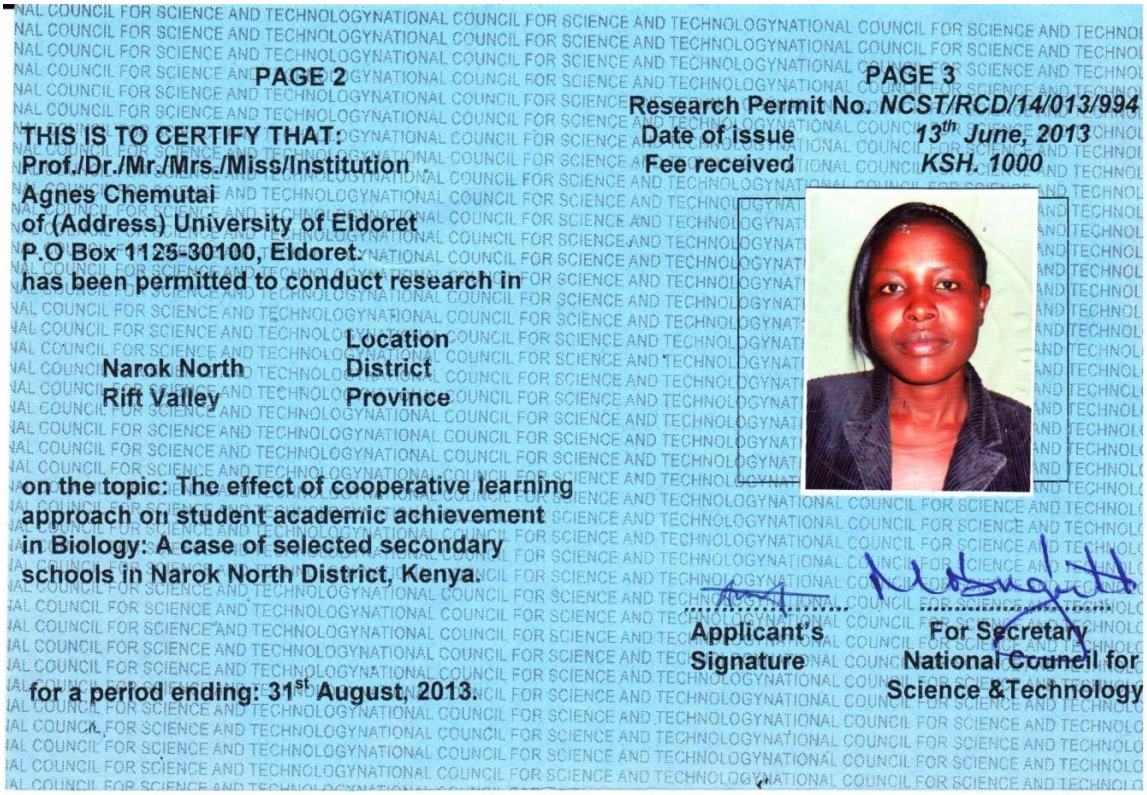
I am Masters Student at University of Eldoret School of Education and will be collecting data on effect of cooperative learning in biology performance in Narok North Sub County. This is an area of great concern to students, teachers, and education stakeholders in the country. Collection of the data will be through BAT, questionnaires. Form two students and biology teachers will be involve in the study.. The information so obtained shall be exclusively confidential and shall only be used for the research purpose of this study. I wish to kindly request you of my visit to your school between June 2013 and August 2013 .

Thanking you in advance

Yours faithfully

Agnes Chemutai
STUDENT RESEARCHER

Appendix II: Research Permit



PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution :
Agnes Chemutai
of (Address) University of Eldoret
P.O Box 1125-30100, Eldoret.
has been permitted to conduct research in
Narok North — Location
Rift Valley — Province
on the topic: The effect of cooperative learning approach on student academic achievement in Biology: A case of selected secondary schools in Narok North District, Kenya.
for a period ending: 31st August, 2013.

Applicant's Signature

PAGE 3

Research Permit No. NCST/RCD/14/013/994
Date of issue 13th June, 2013
Fee received KSH. 1000

For Secretary
National Council for
Science &Technology

Appendix III: Research Authorization Letter from NACOSTI

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787 , 0735 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/14/013/994**

Date: **13th June 2013**

Agnes Chemutai
University of Eldoret
P.O Box 1125-30100
Eldoret.

RE: RESEARCH AUTHORIZATION

Following your application dated **4th June, 2013** for authority to carry out research on ***"The effect of cooperative learning approach on student academic achievement in Biology: A case of selected secondary schools in Narok North District, Kenya."*** I am pleased to inform you that you have been authorized to undertake research in **Narok North District** for a period ending **31st August, 2013.**

You are advised to report to **the District Commissioner and District Education Officer, Narok North District** before embarking on the research project.

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

DR. M. K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:
The District Commissioner
The District Education Officer
Narok North District.

"The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development".

Appendix IV: Research Authorization Letter from District Educational Office

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787 , 0735 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/14/013/994**

Date: **13th June 2013**

Forwarded
13/6/2013
DISTRICT EDUCATION OFFICER
NAROK NORTH DISTRICT

Agnes Chemutai
University of Eldoret
P.O Box 1125-30100
Eldoret.

RE: RESEARCH AUTHORIZATION

Following your application dated **4th June, 2013** for authority to carry out research on "***The effect of cooperative learning approach on student academic achievement in Biology: A case of selected secondary schools in Narok North District, Kenya.***" I am pleased to inform you that you have been authorized to undertake research in **Narok North District** for a period ending **31st August, 2013.**

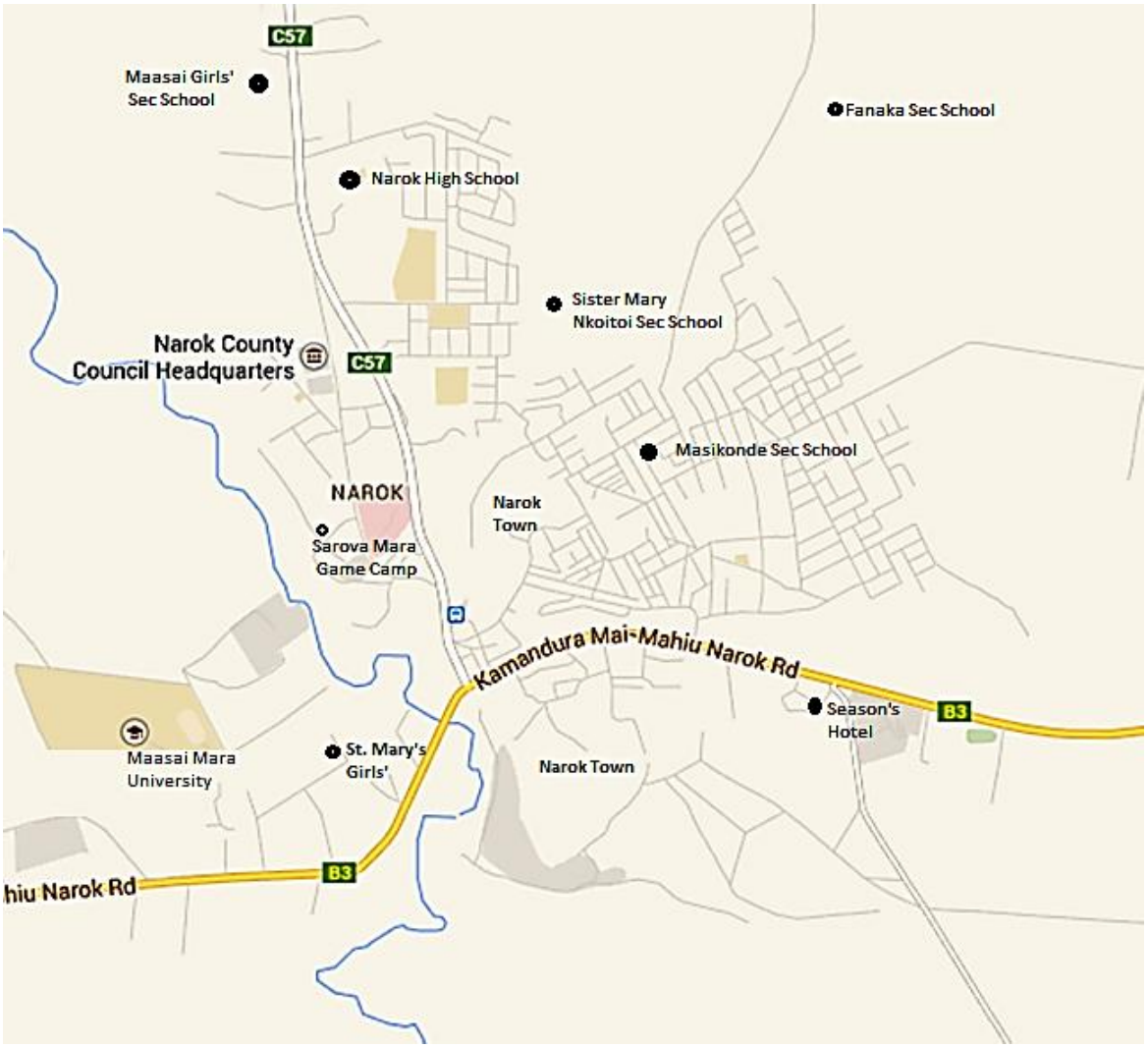
You are advised to report to **the District Commissioner and District Education Officer, Narok North District** before embarking on the research project.

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

DR. M. K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:
The District Commissioner
The District Education Officer
Narok North District.

Appendix V: Map of the Study Area



Appendix VI: Secondary Schools Enrolment and Staffing

SCHOOL	CATEGORY	ENROLMENT											STAFFING								
		FORM 1		FORM 2		FORM 3		FORM 4		TOTAL		GRAND TOTAL	MASTERS		DEGREE		DIPLOMA		TOTAL		GRAND TOTAL
		B	G	B	G	B	G	B	G	B	G		M	F	M	F	M	F	M	F	
Narok High	Public	234		224		225		218		921	0	921			18	11	4	3	22	14	36
Maasai Girls	Public		196		202		104		76	0	578	578	2		7	12	1	2	10	14	24
Ole Tipis Gilrs	Public		192		145		172		156	0	665	665		1	7	7	4	2	11	10	21
St. Mary's Girls	Public		111		91		85		86	0	373	373		1	2	7	4		7	8	15
EorEkule	Public	100	38	82	41	93	36	97	23	372	138	510			8	2		2	8	4	12
Nkareta	Public	52	39	30	37	39	22	37	23	158	121	279			6	1			6	1	7
Olasiti	Public	44	10	83	50	54	32	48	27	229	119	348			6	3			8	3	11
Sakutiek	Public	36	14	28	22	33	28	29	17	126	81	207			3	4			3	4	7
Kisiriri	Public	43	20	38	17	23	27	20	21	124	85	209			1	2	2		4	3	7
Olopito	Public	20	12	85	68	34	34			139	114	253							2	0	2
St. Anthonys	Public	36	18	63	58	83	36	55	39	237	151	388			7	1			7	1	8
Olpusimoru	Public	38	21	36	20	28	21	22	11	124	73	197			4				5	0	5
Ntimama	Public	16	11	10	9	10	11	7	11	43	42	85			3				3	0	3
Olorropil	Public	32	18	18	27	31	17	26	15	107	77	184			4		1		5	0	5
Olokurto	Public	25	15	18	11	17	6	22	9	82	41	123			2	1	3		5	1	6

Masikonde	Public	14	11	36	21	14	28	19	18	83	78	161		1	1	2	1		2	3	5
Olchorro	Public	39	26	41	22	61	39	46	26	187	113	300			5	2	1		7	3	10
Oloikirikirai	Public	12	3	7	14	11	3			30	20	50			1				1	0	1
Kipise Hills	Public	25	14	37	33	15	11	12	12	89	70	159			1				2	0	2
Saleita	Public	2	1	22	16	19	13			43	30	73			1				1	0	1
Entotol	Public	12	13	10	1					22	14	36							0	0	0
Total Public		780	783	868	905	810	725	658	570	3116	2983	6099	8	3	87	55	24	11	119	69	188
St Mary Nkoitoi	Private	69	58	63	47	65	48	67	43	264	196	460			11	2	4	2	15	4	19
Fanaka	Private	23	17	28	11	22	12	20	6	93	46	139			9	4	1		10	4	14
Total Private		92	75	91	58	87	60	87	49	357	242	599			20	6	5	2	25	8	33
Grand Total		872	858	959	963	897	785	745	619	3473	3225	6698	8	3	107	61	29	13	144	77	221

Appendix VII: Questionnaire for the Biology Teacher

This questionnaire seeks information on effects of cooperative learning on student`s achievement in biology in secondary schools in Narok North Sub County. All the information you give will be treated confidentially and for academic purpose only. Please respond to all items in the questionnaire.

PART A

INSTRUCTIONS

Put a tick (√) in the statement that relate to your situation.

Do not write your name

1. Your gender

   Male ☐

   Female ☐

2. Age

   18 - 24 years ☐

   25- 31 years ☐

   32- 38 years ☐

   39- 45 years ☐

   46 and above ☐

3. Your academic and professional qualification

   Bachelor of Science ☐

   Master of Education ☐

   Other (specify)

   _____

4. How long have taught biology?

Less than one year ☐

1-5 years ☐

5-10 years ☐

11-15 ears ☐

Over 16 years ☐

5. Type of school

Boys boarding ☐

Girls boarding ☐

Boys` day and boarding ☐

Girls' day and boarding ☐

Mixed day and boarding ☐

Mixed day ☐

Other (specify)

_____

6. Number of streams and students enrolment.

Single ☐ Double ☐ Triple ☐

Number ☐ Number ☐ Number ☐

Others

7. For the last three years how many students have gotten C+ and above in biology in Kenya Certificate of Secondary Education (KCSE).

_____

8. Number of teaching staff in biology

Under T.S.C ☐ under B.O.G ☐

9. What was your schools` mean score in Biology in the last KCSE examination

_____

PART B

Cooperative learning - is a method of instruction that has students working together in groups usually with the goal of completing a specific task. (Involves structuring class around small groups that work together in such a way that each group members 'success is dependent on the group's success.

i. What are the common methods used in teaching biology in Narok North Sub County?

.....

.....

.....

ii. Are you aware of cooperative method of teaching/learning? Yes/No

iii. If your answer to the question above is yes. How often do you use the method

Very often ☐ Often ☐ Rarely ☐ Not at all ☐

iv. what is your personal feeling about the method in the teaching and learning in biology

PART C

Study the following questions carefully and respond appropriately by ticking below a response that carries your feeling about cooperative learning.

Direction: put a tick the number that best describes your feelings about cooperative learning. The numbers represent the following responses 1= poor=Fair, 3=Good, 4 =Excellent

Statement	**1**	**2**	**3**	**4**
1. How will you rate the extent to which cooperative learning promotes learning in biology				
2. How can you rate teachers' attitude towards cooperative learning in biology				
3. To what extent to cooperative learning in biology improve the coverage of syllabus				
4. To what extent do biology teachers encourage students to use cooperative learning in biology				
5. Rate extent to which teachers use cooperative learning in teaching biology.				

Appendix VIII: Student Questionnaire

Part A

Cooperative learning - is a method of instruction that has students working together in groups usually with the goal of completing a specific task. (Involves structuring class around small groups that work together in such a way that each group members 'success is dependent on the group's success

Bio-data

Instructions:

Put a tick (√) in the statements that relate to your situation.

Do not write your name

1. Your gender

   Male ☐

   Female ☐

2. Age

   14-16 years ☐

   17- 19 years ☐

   20 – 22 years ☐

3. Number of the students in your class? _____

4. Number of streams in your school? _____

PART B

1. Do you enjoy biology lesson when cooperative learning is used?

   Just enjoyed ☐ Enjoyed much ☐ Enjoyed very much ☐

2. Do your group members participate in cooperative learning in biology?

Highly participate ☐ Averagely Participate ☐ Lowly participate ☐

3. Does cooperative learning help you to improve in biology?

   Help a lot ☐ Help a little ☐ Do not help at all ☐

4. Rate yourself in the level of consultation in biology when cooperative and lecture method is used in teaching biology.

   Cooperative method Poor ☐ Good ☐ Excellent ☐

   Lecture method Poor ☐ Good ☐ Excellent ☐

5. Do you share learning materials in cooperative learning?

   Yes ☐ No ☐

6. Do you work in groups?

   Yes I do ☐ No I don't ☐

7. State challenges faced in using cooperative learning in biology?

   _____

   _____

   _____

   _____

Appendix IX: Experimental Design Procedure for the Teacher

1. Divide the form two students into two group randomly (each group should have ten members)
2. Number the groups; group I and group II
3. Take group I to be control group and group two experimental group
4. Give them pre-test on gaseous exchange in plants and animals and analyses the results.
8. The two groups are taught gaseous exchange
9. Teach group I using normal lecturer method (conventional method) and teach group two using cooperative learning.

NB: Cooperative learning - is a method of instruction that has students working together in groups usually with the goal of completing a specific task. (Involves structuring class around small groups that work together in such a way that each group members 'success is dependent on the group's success

10. The two group are given post-test at the end of the two weeks, then results are analyze
11. compare the two results pre-test and post-test and give conclusion

Appendix X: Notes on Gaseous Exchange in Animals (Insects and Fish)

Gaseous Exchange in Animals

This takes place through gaseous exchange surfaces which include:-

- Cell membrane
- Gills
- Buccal cavity
- Skin and
- Lungs

Characteristics of Gaseous Exchange Surfaces

- Have a large surface area for exchange of gases.
- Have increased blood supply by means of an extensive network of blood capillaries i.e. highly vascularized.
- Have thin epithelium for faster diffusion of gases
- Are moist to dissolve the gases.
- Have a ventilation mechanism to ensure a continuous supply of air to the exchange surface and removal of waste air from the surface.
- Be connected to a transport system (for large animals) to transport the gases to and from the tissues where they are required or released respectively.

Gaseous Exchange in Insects

- Gaseous exchange in insects e.g. grasshopper takes place across a system of tubes penetrating into the body known as the tracheole system.
- The main trachea communicates with the atmosphere through tiny pores called spiracles.
- Spiracles are located at the sides of the body segments; two pairs on the thoracic segment and eight pairs on the sides of the abdominal segments.
- Each spiracle lies in a cavity from which trachea arises.

Spiracles are guarded with valves that close and thus prevent excessive loss of water vapour. A filtering apparatus i.e. hair also traps dusts and parasites which would clog the trachea if they gained entry. The valves are operated by action of paired muscles.

Ventilation in Insects

Ventilation in an insect is brought about by the contraction and relaxation of the abdominal muscles. In locust, air is drawn into the body through the thoracic spiracles and expelled

through the abdominal spiracles.

Air enters and leaves the trachea as abdominal muscles contract and relax.

The muscles contract laterally so the abdomen becomes wider and when they relax it becomes narrow.

Relaxation of muscles results in low pressure hence inspiration occurs while contraction of muscles results in higher air pressure and expiration occurs.

In locust, air enters through spiracles in the thorax during inspiration and leaves through the abdominal spiracles during expiration. This results in efficient ventilation.

Maximum extraction of oxygen from the air occurs sometimes when all spiracles close and hence contraction of abdominal muscles results in air circulating within the trachea.

The valves in the spiracles regulate the opening and closing of spiracles.

Mechanism of Gaseous Exchange in Insects

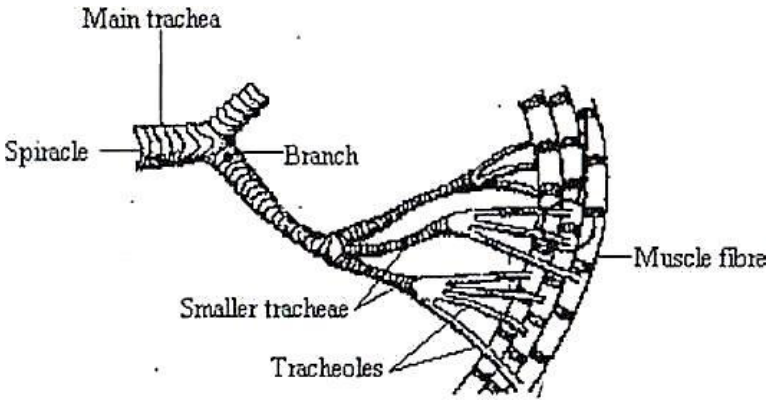
The main tracheae in the locust are located laterally along the length of the body on each side and they are interconnected across.

Each main trachea divides to form smaller tracheae, each of which branches into tiny tracheoles.

Each tracheole branches further to form a network that penetrates the tissues. Some tracheoles penetrate into cell in active tissues such as flight muscles. These are referred to as intracellular tracheoles. Tracheoles in between the cells are known as intercellular tracheoles.

The main tracheae are strengthened with rings of cuticle. This helps them to remain open during expiration when air pressure is low.

Tracheole System



Adaptations of Insect Tracheoles for Gaseous Exchange

- Tracheole membrane is very thin to provide a short distance for diffusion.
- The tracheoles have a moist surface to allow gases to diffuse in solution form.
- Ventilated through spiracles on either side of the insect's body.
- Trachea branches to numerous increasing the surface area for gaseous exchange.
- Tracheoles are in direct contact with tissues/cells of insect for gaseous exchange.
- Trachea has circular rings of chitin to prevent collapsing. This keeps the air passage always open.
- Spiracles have valves to enhance movement of gases into the trachea, and also to prevent drying of the trachea.
- They are made up of a single epithelial layer and have no spiral thickening to allow diffusion of gases.
- In some insects, tracheoles widen at certain places to form air sacs. These are inflated or deflated to facilitate gaseous exchange as need arises.
- Atmospheric air that dissolves in the fluid at the end of tracheoles has more oxygen than the surrounding cells of the tracheole epithelium. Oxygen diffuses into these cells along a concentration gradient.
- Carbon (IV) oxide concentration inside the cells is higher than in the atmospheric air and diffuses out of the cells along a concentration gradient. It is then removed with expired air.

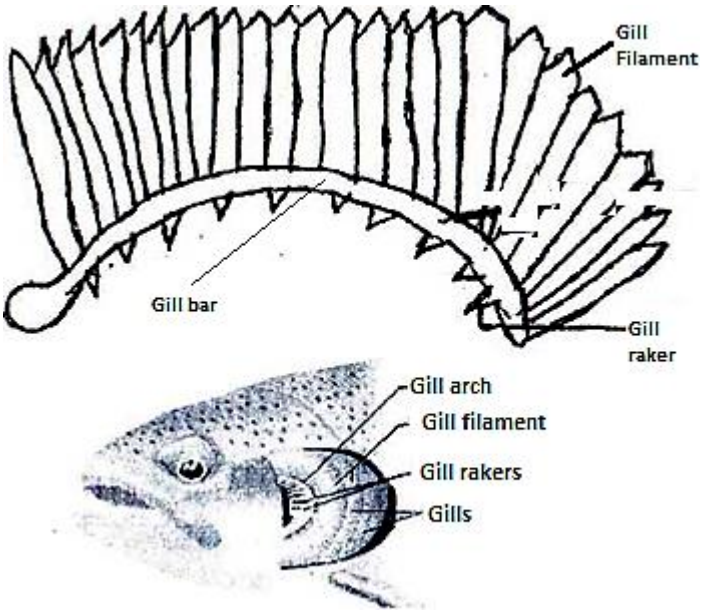
Mechanism of Gaseous Exchange in Insects

The process of gaseous exchange in insects involves the following events.

Inhalation	Exhalation
• Abdominal muscles relax	• Abdominal muscles relax.
• Abdomen and trachea increase in volume	• Abdomen and trachea reduce in volume
• Pressure in the trachea reduces compared to atmospheric pressure	• Pressure in the trachea reduces compared to atmospheric pressure
• Thoracic spiracles open	• Abdominal spiracles open
• Air enters in them into tracheoles. • Oxygen in the air dissolve in the moisture in the tracheoles then diffuses into the tissues. • Carbon (IV) oxide diffuses out of the tissue into the tracheoles.	• Air is forced out through the spiracles.

Gaseous Exchange in Bony Fish (e.g. tilapia)

- Gaseous in fish takes place between the gills and the surrounding water.
  - The gills are located in an **opercular cavity** covered by a lap of skin called **operculum.** Each gill consists of a number of thin leaf-like **lamellae** projecting from a skeletal base **bronchial arch** (gill bar) situated in the wall of the pharynx.
  - There are four gills within the opercular cavity on each side of the head. Each gill is made up of a bony gill arch which has a concave surface facing the mouth cavity (anterior) and a convex posterior surface. Gill rakers arc hony projections on the concave side that trap food and other solid particles which are swallowed instead of going over and damaging the gill filaments. Two rows of gill filaments subtend from the convex surface.



Adaptations of Gills for Gaseous Exchange

- Gill filaments are thin walled to facilitate diffusion of gases.
- Gill filaments are very many (about seventy pairs on each gill), to increase surface area. Each gill filament has very many gill lamellae that further increase surface area.
- Gill filaments are served by a dense network of blood vessels that ensure efficient transport of gases. It also ensures that a favourable diffusion gradient is maintained.
- The direction of flow of blood in the gill lamellae is in the opposite direction to that of the water (counter current flow) to ensure maximum diffusion of gases.

Counter current flow

In the bony fish direction of flow of water over the gills is opposite that of blood flow through the gill filaments.

This adaptation ensures that maximum amount of oxygen diffuses from water into the blood in the gill filament. This ensures efficient uptake of oxygen from the water. Where the blood is along the same direction (parallel flow) less oxygen is extracted from the water.

Mechanisms of Gaseous Exchange in Bony Fish

During gaseous exchange, water rich in oxygen passes through the mouth, over the gill rakers, gill filaments and through the operculum to the outside.

Inhalation	**Exhalation**
• Mouth opens	• Mouth closes
• The floor of the mouth is lowered	• Mouth is raised.
• Volume in the mouth cavity increases while pressure reduces.	• Volume in the mouth cavity reduces while pressure increases
• Water rushes into the mouth.	• Water rushes out of the mouth into the gill chambers.
• Operculum cavity bulges out but opercula flap presses on the body remaining closed.	• Operculum presses inwards.
• Volume in the gill chamber increases.	• Volume in the gill cavity reduces.
• Pressure decreases allowing in water from the mouth cavity.	• Pressure increases. • Opercula flap opens
• Water flows over the gills and filaments.	• Water is forced out of the gill chamber
• Oxygen in the water is at a higher concentration than that in the blood flowing in the gill. It diffuses from water through the gill filaments into the capillaries.	
• Carbon (IV) oxide is at a higher concentration in the blood than in the water. It diffuses out of the capillaries and into the water.	

Appendix XI: Biology Achievement Test for the Student

Admission Number:_____ Class:_____ Date:_____

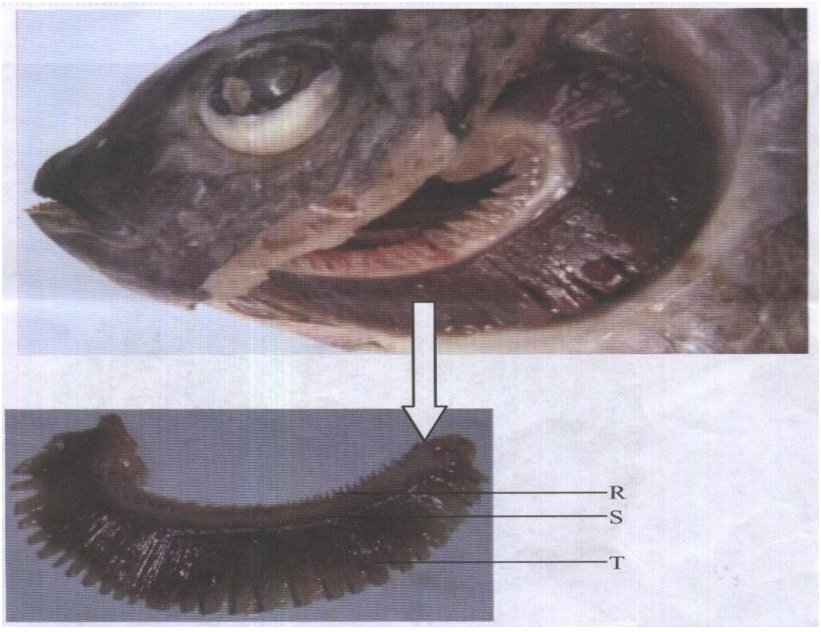
Instructions

Please answer all the questions

1. Define the term gaseous exchange (1Mk)
2. State two respiratory gases (2 Mks)
3. State two respiratory surfaces in animals (2Mks)
4. Explain three characteristics of gaseous exchange surfaces (6Mks)
5. State the functions of the following parts of the tracheal system in an insect (2Mks)

   (i) Spiracles

   (ii) chitin
6. State two adaptation of insect tracheoles for gaseous exchange (2Mks)
7. What is counter current flow in gaseous exchange in fish (1Mks)
8. The photograph below shows structures visible after removing the outer part operculum of a fish one of the structures is magnified using hand lens.



a) Name the parts labeled R,S and T (3 Mks)

R

S

T

b) Give the functions of each parts labeled above (3Mks)

R

S

T

c) Explain how each of the part named in (i.a) above is adapted to its functions

(3 Mks)

Appendix XII: Marking Scheme of the BAT

1. Gaseous exchange is the process of exchanging oxygen and carbon (iv) oxide between an organism and its surrounding across a respiratory surface. (Max 1 Mk)
2. Oxygen, Carbon(iv)oxide (Max 2 Mks)
3. Cell membrane, Gills, Buccal cavity, Skin, Lung. Any two (Max 2 Mks).
4. - Have a large surface area for exchange of gases.
   - Have increased blood supply by means of an extensive network of blood capillaries i.e highly vascularized.
   - Have thin epithelium for faster diffusion of gases.
   - Are moist to dissolve the gases.

   Any 3 well explained. (Max 6 Mks)
5. (i) Posses hairs which function as a filter system to prevent entry of debris into the tracheal system.

   (ii) Keep the trachea permanently opens (Max 2 Mks)
6. - Tracheole membrane is very thin to provide a short distance for diffusion.
   - The tracheoles have a moist surface to allow gases to diffuse in solution form.
   - Tracheoles are in direct contact with tissues/ cells for gaseous exchange.

   Any two (Max 2 Mks)
7. Countercurrent flow is a condition where by water flows through the gills in the opposite direction to the flow of blood in the capillaries in the gills (Max 1Mk).
8. (a) R-Gill rakers

   S-Gill bar

   T-Gill filaments (Max 3Mks)

   (b) R- Prevent food and any solids present in water from reaching delicate gill filaments.

   S- Support the gill bar and gill filament.

   T - Provide a large surface area for gaseous exchange. (Max 3 Mks)

(c) R-Appear as teeth-structures whose function is to prevent food and any solids present in water from reaching delicate gill filament.

S- The gills are supported by skeletal rods formed by the thickening of the basement membrane to support gill filament and gill rakers.

T-They are very many to increase the surface for gaseous exchange (Max 3Mks)

Appendix XIII: Maasai Pastoralists herding together

Appendix XIV: Students discussing on the structure of the gill in a discussion group

Appendix XV: A teacher instructing using lecture method