INFLUENCE OF CULTURE AND GENDER ON SECONDARY SCHOOL STUDENTS' LEVEL OF SCIENTIFIC CREATIVITY IN BIOLOGY EDUCATION IN TURKANA COUNTY, KENYA

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EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

DECLARATION

This thesis is my original work and has not been presented for a degree, diploma or any other award in this or any other university.

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RECOMMENDATION

This thesis has been submitted for examination with our recommendations as University Supervisors.

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DEDICATION

This thesis is dedicated to my beloved husband Samuel Nakope who has been an inspiration in my life and for his unwavering support and encouragement all through my studies.

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ABSTRACT

The world and the global economy are changing very fast. Collectively, we are faced with very significant economic, environmental and social challenges. Creativity and ingenuity will be keys to addressing the challenges. To be able to achieve Kenyan Vision 2030 (economic and social pillars), learners should be equipped with scientific creativity skills to enable them participate in nation building and take on present and future challenges in the world. Studies carried out in Kenya show that scientific creativity skills are very low amongst secondary school students. This means that there are factors that are hindering the acquisition of creativity skills among learners. Therefore there is need to find out whether culture and gender are among these factors. The purpose of this study was to investigate the influence of students' culture and gender on the level of scientific creativity in Biology Education among Form Three students in Turkana County. Descriptive research design was used. Cross sectional survey method was used. The target population comprised all form three students in sub county coeducational secondary schools and Turkana men and women of 55 years and above. A sample of 320 students (160 girls and 160 boys) from 4 sub county coeducational secondary schools and 10 adults (5 men and 5 women) were involved in the study. Selection of participating schools was by stratified random sampling and purposive sampling for the sub county coeducational secondary schools. Purposive sampling was used in selecting adults of Turkana tribe. Three instruments, namely; Students' Culture Evaluation Questionnaire (SCEQ), Biology Scientific Creativity Test (BSCT) and an Interview Schedule (IS) for the adults were used to collect data. Reliabilities of SCEQ and BSCT were measured using Cronbach coefficient alpha. The hypotheses were tested at α=0.05 significance level. The reliability coefficient for SCEQ was 0.74 while that of BSCT was 0.7. Validation of the instruments was done by seeking the opinion of experts from the Faculty of Education and Community studies of Egerton University. The test items were pilot tested in one sub county coeducational secondary school in Turkana County. The inferential statistics used were the chi-square and t-test. Data from the interview schedule was analyzed quantitatively. The findings of this study show that there was a low level of scientific creativity in Biology education in Turkana County. Culture was also found to influence the level of scientific creativity however, scientific creativity was not gender dependent. The findings of this study may provide valuable information to policy makers, curriculum developers and implementers which could be helpful in fostering positive cultural practices by restructuring the curriculum to eliminate cultural blocks to scientific creativity among the students.

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LIST OF ABBREVIATIONS AND ACRONYMNS

BSCT	Biology Scientific Creativity Test
CEO	County Education Officer
GMS	Grams
IS	Interview Schedule
KCPE	Kenya Certificate of Primary Education
KGS	Kilograms
KJ	Kilojoules
KNEC	Kenya National Examinations Council
MOEST	Ministry of Education, Science and Technology
NACCCE	National Advisory Committee on Creative and Cultural Education
NACOSTI	National Commission for Science, Technology and Innovation
SCEQ	Students' Culture Evaluation Questionnaire
TIMSS	Trends in International Mathematics and Sciences Study
UNESCO	United Nations Educational, Scientific and Cultural organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Education is meant to prepare learners to make sense of how the world works; to think critically and independently; and to lead responsible and productive lives in a culture that is increasingly shaped by science and technology (Project 2061 Report, 1990). In Kenya one of the main goals of education is to promote social, economic, technological and industrial skills for national development. Education therefore, should produce citizens with skills, knowledge, expertise and personal qualities that are required to support a growing economy, rapid industrial and technological changes taking place especially in the developed world (Kenya National Examinations Council, 2010).

Biology is a practical subject which equips learners with knowledge and skills that are useful in solving everyday problems of life. The study of Biology aims at providing learners with the necessary knowledge with which to control or change the environment for the benefit of an individual, family or society. It also prepares learners for further studies in applied disciplines like agriculture, medicine, biotechnology, genetic engineering and processing industries especially for beer and milk (Maundu, Sambili, & Muthwii, 1998). School leavers who can think critically and respond creatively will more likely be able to meet the challenges of the 21st Century by contributing positively to the personal, social, technological and economic worlds that they will inhabit as adults (Welle-strand & Tjeldvoll, 2003). However, it has been noted that there is lack of understanding about basic biology concepts and principles such as evolution (Alters & Nelson, 2002) and ecology (Mason, 1992) and even significant chronic misconceptions about key ideas such as the importance of scientific reasoning.

The concept of creativity is used in various fields of study and the meaning attached to it varies from one field to another. According to Boden (2001), creativity is one's ability to come up with new ideas that are surprising yet intelligible, and also valuable in some way.

Therefore novelty and value should be the two conditions or characteristics of scientific creativity. According to these two characteristics, scientific creativity can be identified either with historical creativity (when something, like a new idea, a new theory, a new discovery, is historically new) and/or with personal creativity (when something is new in a personal sense regardless of whether that something is not new to others). Sternberg (1995) also gives the essentials for creativity as intelligence, knowledge, thinking styles, personalities, motivation and environment. Treffinger (2001) and Loehle (1990) argue that many characteristics associated with creativity are not innate but can in fact be taught and nurtured. They further point out that creative behaviour is influenced by motivational as well as situational factors.

Okere (1986) gives indicators of creativity in science education as sensitivity to problems, flexibility in reasoning, recognition of relationships and planning for scientific investigations. Therefore the notion of creativity in the context of science education should take into account all these ideas. Science educators and teachers should provide an environment that increases the possibilities for creativity to emerge and opportunities for divergent thinking among learners. Creativity is increasingly considered a crucial ability for the future. Creativity is not just becoming increasingly important (Pink, 2005), but it seems that our future is now closely tied to human creativity (Csikszentmihalyi, 1996). Gardner (2010), in his work titled *Five Minds for the Future*, argued for the crucial role of creativity, as one of the five cognitive abilities that leaders of the future should seek to cultivate. However, there is empirical evidence sugesting that students do not appreciate the creative thinking required in doing science, and that they do not view science in general as a creative endeavour (Schmidt, 2011).

Further, despite its importance, creativity is not yet fully established as a mainstream topic in psychology and/or education research; neither does it hold a significant position in educational practice (Boden, 2001). This is somehow paradoxical , given that creativity is inextricably tied to the nature of science itself (McCo-mas, 1998), and also the consensus among scientists and science educators that scientific knowledge is indeed the product of creative thinking (Osborne, Collins, Ratcliffe, Millar & Duschl, 2003).

Educational systems worldwide are being reformed to adapt to rapid societal changes, due to global economic restructuring and technological development (Bellofiore, 1999). Students need to be prepared for life in a world about which we know very little, except that it will be characterized by substantial and rapid change, and is likely to be more complex and uncertain than today's world (Hodson, 2003). National Advisory Committee on Creative and Cultural Education (1999) pointed out that creativity in education has a part to play in helping students meet the unpredictable demands of the future. Training students in creative skills may contribute significantly to their flexibility, and their ability to handle changes in their working lives. The study on the level of scientific creativity in Biology education among form three students had not been carried in Turkana County hence the need for this study.

Culture is the label that anthropologists give to the structured customs and underlying worldview assumptions that govern people's lives (Kraft, 1998). It can also be interpreted as people's way of life, their design for living, and their way of coping with their biological, physical and social environment. The attributes that define culture include language, social structures, skills, customs, norms, values, beliefs, attitudes, expectations, cognitions, conventional artifacts, technological know- how and worldview of a group (Cobern & Aikenhead, 1998). Ausubel, Novak and Hensian (1978), argued that the construction of new knowledge in science is strongly influenced by prior knowledge, which is conception gained prior to new learning.

Studies on the influence of culture on scientific creativity in physics have shown that the levels of scientific creativity are low among the students. This has been attributed to many factors including inappropriate teaching strategies, lack of appropriate teaching and learning resources. Empirical evidence now strongly suggests that culture is indeed, one of these factors (Shumba, 1995; Anmuah- Mensah, 1998; Okere & Keraro, 2002). Very few studies have been done on the influence of culture on scientific creativity, however no such studies had been conducted in Turkana County.

According to Ai (1999) past research has usually concentrated simply on whether there is a relationship between creativity and academic achievement without taking into consideration whether the relationship could be dissimilar for the two groups, male and female. While there are research results pointing in various, and often contradictory directions, the evidence does not clearly support gender differences in creativity based on test results. However to the extent that a case for such gender differences can be made available evidence suggests that women and girls tend to score higher on creativity tests than men and boys.

Kogan (1974), Tegano and Moran (1989) found a tendency for girls to score higher than boys. However, boys scored higher on originality in grade three. Coone (1969) and Warren and Luria (1972) found higher scores for girls in early adolescence on figural creativity. Torrance (1983) found that gender differences in divergent thinking ability have changed over time. In the 1950's and 1960's boys outperformed girls on measures of originality, whereas girls surpassed boys on elaboration and most measures of verbal creativity (Torrance, 1962, 1965). A study conducted in Kenya by Ndeke (2012) found that scientific creativity in biology was gender dependent. The indications were that creativity skills of sensitivity, flexibility and recognition of relationships were gender dependent but planning was not. The largest inconsistency was between scores of tests designed to predict creativity and actual accomplishments. Such studies on the influence of gender on scientific creativity, however had not been conducted in Turkana County.

1.2 Statement of the problem

One of the general objectives of the Kenyan Secondary School Biology syllabus is to enable learners to demonstrate resourcefulness, relevant technical skills and scientific thinking necessary for economic development. Learners are also expected to acquire scientific creativity skills required to solve problems in everyday life and for further education and training in related scientific fields. Scientific creativity is needed for industrial and technological development and in the achievement of Vision 2030. Studies carried out in some parts of Kenya show that the level of scientific creativity is low among Kenyan secondary school students, however no such studies have been conducted in Turkana County. The level of scientific creativity may be influenced by a person's culture and gender, however, it is not known how the level of scientific creativity in Biology Education is influenced by a student's culture and gender in Turkana County. This study investigated the influence of culture and gender on the level of scientific creativity in Biology education in Turkana County.

1.3 Purpose of the Study

This study sought to investigate the influence of students' culture and gender on the level of scientific creativity in Biology Education among Form Three Secondary School Students in Turkana County.

1.4 Objectives of the Study

The following were the objectives of this study;

i. To investigate Turkana Cultural Beliefs, Practices and Values that relate to Scientific Creativity in Biology Education in Turkana County.
ii. To determine the Level of Scientific Creativity in Biology among Form Three Students in Turkana County.
iii. To determine the influence of Culture on Students' level of Scientific Creativity in Biology Education in Turkana County.
iv. To investigate if Scientific Creativity Skills in Biology is Gender Dependent in Turkana County.

1.5 Hypotheses of the Study

To following null hypotheses were tested.

H_o1 There is no statistically significant relationship between culture and scientific creativity in Biology education amongst Form Three students.

H_o2 There is no statistically significant difference in performance in scientific creativity in Biology education among Form Three boys and girls.

1.6 Research Questions

To cover objectives i and ii the following research questions were derived;

i. What are some of the Cultural Practices, Beliefs and Values that affect Scientific

Creativity in Biology Education in Turkana County?

ii. What is the Level of Scientific Creativity in Biology among Form Three Students in Turkana County?

1.7 Significance of the Study

The findings of this study may provide valuable information to policy makers, curriculum developers and implementers that will be helpful in fostering positive cultural practices that enhance scientific creativity in learners and address cultural blocks that may stifle scientific creativity in the curriculum.

1.8 Scope of the Study

The study was carried out in 4 sub county coeducational schools in Turkana County in Kenya. The study investigated the level of scientific creativity amongst Form Three Biology students and the influence of culture and gender on scientific creativity. There are several measures of creativity but this study concentrated only on four of them namely; Sensitivity to problems, flexibility in reasoning, recognition of relationships and planning for scientific investigation. Biology topics covered in this study were reproduction, ecology, the cell and respiration.

1.9 Limitations of the Study

i. The study was conducted in Turkana County and therefore generalization of the findings was confined to Turkana County only.

ii. The subject content covered was limited to specific questions from topics such as reproduction, ecology, the cell and respiration thus generalization to other topics in Biology should be done with caution.

1.10 Assumptions of the Study

The study was carried out with the following assumption;

i. The participants provided honest responses.

1.11 Operational Definition of Terms

The terms used in this study were defined constructively and operationally as follows

Cultural Beliefs: Refer to the psychological state in which an individual holds a conjecture or premise to be true. In this study, cultural beliefs refer to those suppositions believed to be true by the Turkana ethnic group.

Culture: Customs, values, rules, beliefs or rituals, symbols, behaviors and cognitions concerning the manner in which a group of people interact with their social and physical environment. In this study, culture refers to traditions, beliefs, values, practices and way of life of a certain ethnic group. In this case the Turkana.

Cultural Practices: Refer to the manifestation of a culture or sub culture, especially in regard to the tradition and customary practices of a particular ethnic group or other cultural group. In this study, cultural practices refer to traditional and customary practices of the Turkana community.

Cultural Traditions: Refer to beliefs, objects or customs performed or believed in the past, originating in it transmitted through time by being taught by one generation to the next and are performed or believed in the present. In this study, cultural traditions refer to beliefs, objects or customs of the Turkana community.

Cultural Values: Refer to commonly held standards of what is acceptable or unacceptable, important or unimportant, right or wrong, workable or unworkable in a community or society. In this study cultural values refer to the standards held by the Turkana community.

Form Three: The third level in Secondary School in Kenyan Education System. In this study Form Three refer to students in the third level in Turkana County in the selected schools for the study.

Gender: Socially determined personal and psychological characteristics associated with being male or female 'masculinity' and 'femininity'. In this study gender refers to being male or female and their learned behaviors and responsibilities associated with one's sex.

School category: classification of the schools based on whether it is single sex (girl or boy school) or co-educational school (girls and boys together)

School Environment: refers to general school atmosphere that promotes perceptions of human relationships in a school, facilities and resources available for use in teaching and learning in the school.

School Type: refers to categorization of schools depending on whether they are National, County or sub county schools.

School Tradition: Rules, structures and values upheld in the school.

Scientific Creativity: refers to one's ability to come up with new ideas that are surprising yet intelligible, and also valuable in some way.

Level of Scientific Creativity**:** described as high or low based on a criteria reference of 40% of the total scores obtained by the students on scientific creativity test. In this study the level of scientific creativity will be measured based on the dimensions of;

- **Sensitivity to problems:** refers to the ability of a student to be able to identify sources of errors in designs of scientific investigations and rephrase them to be scientifically testable.
- **Flexibility in reasoning:** refers to the ability of a student to generate a variety of ideas or as many solutions to a problem as possible.
- **Recognition of Relationships:** refers to the ability of a student to generate hypotheses or give explanations regarding the causes of a given phenomenon or observation.
- **Planning for Investigations:** this refers to the ability of a student to devise experiments to test hypotheses.

Sub County Secondary School: A secondary school in Kenya that admits average performers (290 marks and below for girls, 340 marks and below for boys) based on MOEST criteria and policy. 100% of the students admitted are from the sub county where the school is situated.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature related to the meaning of creativity, culture and science learning, culture and scientific creativity, gender and achievement in science, gender and creativity. It also discusses theoretical and conceptual framework that was used to guide this study.

2.2 Meaning of Creativity, Culture and science learning

Creativity is a powerful catch phrase. In Western societies it epitomizes success, the modern trends for novelty and excitement. It is a positive word in any society that is constantly aspiring to innovation and progress and is outlined by Draeger (1991) as a pre-requisite for innovation, invention and discovery. Creativity means different things to different people and can be defined in a number of ways. Beghetto (2007) defined creativity as the ability to offer new perspectives, generate novel and meaningful ideas, raise new questions, and come up with solutions to ill-defined problems. Adam-Price (1998) defined Creativity as a complex of traits, skills and capacities, including the ability to work autonomously, curiosity, and unconventional thinking, openness to experience, and tolerance to ambiguity.

Trautmann (2012) defined creativity as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others. Cropley (1999) adds that creativity can be defined as a social phenomenon that is facilitated by some social factors and inhibited by others. It can be argued that the central component to all these definitions is novelty. In a summary of scientific research into creativity, Mumford (2003) suggested that a general agreement had been reached that creativity involves production of novel and useful products.

Culture has received considerable attention in the global world with its varying definitions. Culture depicts people's peculiar patterns of values, attitudes, knowledge, skills, behaviors, language and technology (Akinwale, 2004). It is the sum total of learned behavior of a group of people that are generally considered as their tradition and are transmitted from generation to generation and in various forms (Ogunleye, 2009). Each child goes through a process of enculturation when they grow up in a culture. Culture envelopes each of us, and touches every aspect of our lives. United Nations Educational, Scientific and Cultural Organization (2002) general definition of culture refers to domains of culture as spirituality, material, intellectual and emotional features of a society, in addition to its art and literature, lifestyles, way of living together, value system, traditions and beliefs.

The future of Kenya and the rest of the world lies in knowledge. But our ability to generate new knowledge and use it innovatively depends upon having a scientifically literate population. There is widespread concern about the outcomes of science education at school. Finding meaning in science refers to going beyond knowing facts and definitions, to knowing what something represents, feels like, to having it shape and colour our perceptions and understanding. Such a sense of meaning suggests learning of science as a way of knowing that enables individuals to enter into the social and intellectual life of their community in a new and different way. It carries a sense of reconstruction of self through a newly articulated engagement with the world and society (Richard & Osborne, 2004).

Using the phenomenological sense of lifeworld as our "being in the world", Questions of meaning in the teaching and learning of science are explored (Heidegger, 1962). Considering students' everyday experiences and the possible connections to science they might construct, we need to consider that children become situated within a system of values and experiences that define ways of acting.

In other words, lifeworlds guide interpretations for both the individual and shared social world thereby interconnecting these experiences and values that allow our identities, personalities and social roles to materialize from within lifeworld knowledge (Habermas, 1987). Within science education, the question of how learners find meaning or sense of value in science so that they choose to engage in science studies would seem to be answered by current concepts of "best practice" in the field.

For example, constructivist and situated learning theories hold that establishing connections between science concepts and students' lives promote personally meaningful, worthwhile understanding (Witz, 2000). This study investigated the influence of culture on scientific creativity in biology education among form three students in Turkana County.

2.3 Culture and scientific creativity

Creativity is central to human activity and thought, and has been the driving force for all innovations throughout human history. However, it has eluded precise definition and scientific study, although the literature abounds with explanations ranging from the mundane to the highly complex (Taylor, 1988). According to Hu and Adey (2002), scientific creativity is different from other forms of creativity since it is mainly concerned with creative science experiments, creative scientific problem solving and creative science activity.

Scientific research into creativity suggested that there is a general agreement that creativity involves production of novel, useful products (Mumford, 2003). Creativity can also be defined as the process of producing something that is both original and worthwhile, or characterized by originality, expressiveness and imaginativeness (Sternberg & Lubart, 1996).

One of the most useful definitions states that a creative idea cannot be produced by the same set of generic rules as a familiar idea, thus indicating that creativity depends on a conceptual shift in thinking, (Boden, 2004). According to Amabile (1996), creativity in science not only generates novel ideas but aspires to produce a verifiable representation of an objective truth. Most studies on creativity have focused on the individual, such as the many studies on personality traits of highly creative persons (Barron & Harrington, 1981). However, more recently studies suggested that creativity also depend on the social and cultural context (Montuori & Purser, 1999, Paulus & Nijstads, 2003).

Culture refers to that whole complex which includes knowledge, belief, art, law, morals, custom, and any other capabilities and habits acquired by man as a member of society (Tylor, 1974). In a most anthropological sense, culture is regarded as that complex whole and a compound phenomenon that includes all aspects of life that give definition to human membership in society. Since culture refers to values and norms people have which make them live in a particular way (Obioha, 2010), it follows that culture is fundamental to any form of human creativity.

That is human beings must exist first in a cultural setting as a culturally enclosed being before they can begin to explore the possibilities within their environment and the productivity of the human mental capabilities. This is perhaps why culture is regarded as the ground norm of technological and scientific development (Williams, 2006).

A given culture may contain some elements that foster creativity and others that stifle it, yielding an overall influence that may be positive, negative, or neutral (Sternberg, 1999). Creativity is viewed differently in different countries (Sternberg, 2006). For example, cross cultural research conducted in Hong Kong found that Westerners view creativity more in terms of the individual attributes of a creative person, such as their aesthetic taste while Chinese people view creativity more in terms of the social influence of creative people that is what they can contribute to society (Niu, 2006). Mpofu et al., (2006) surveyed 28 African languages and found that 27 had no word which directly translated to creativity (the exception being Arabic).

Creativity may be fostered or hindered by cultural features such as individualism or collectivism and the value placed on conformity or tradition (William et al., 1995). Triandis et al., (1993), suggested that individualist cultures value independence and self-reliance, which are important factors that foster creativity, whereas collectivist cultures emphasize obedience, cooperation, duty and acceptance of an in- group authority which stifle creativity. Ng (2001) proposed that the individualism – collectivism dimension can explain to a large extent differences in creative abilities levels for Westerners and Asians.

The worldview and values of a culture can affect the overall level of creativity. A culture can influence the amount of creativity through its emphasis on individuality as opposed to collective interest, through its tolerance of deviance as opposed to emphases on conformity (Lubart & Georgsdottir, 2004). According to Berry et al., (1992) cultural values that foster creativity are perseverance, tolerance to ambiguity, and risk taking. Adams (1986) on the other hand gave several factors that may hinder creativity as “Fantasy and reflection are a waste of time”, “Playfulness is for children only”, “There is a right answer”, and “Reason, logic, numbers, utility, and success are good while intuition, emotions, qualitative thinking, and failure are bad”.

Creativity is more than a purely a cognitive phenomenon. Certain personality traits are particularly relevant for original, adaptive thinking development during childhood (Lubart & Georgsdottir (2004). Traits of risk taking, openness, individuality, perseverance and tolerance to ambiguity seem to play a role in creativity (Sternberg & Lubart, 1995).

Therefore a culture that promotes these traits in children is likely to foster creativity unlike the one that does not. Gardner (1999) stated that people are creative when they can solve problems, create products, or raise issues in a domain in a way that is initially novel but is eventually accepted in one or more cultural settings. Gardner's views seem to support the idea that creativity can take different forms in different domains. Thus it may be conceptually and practically important to know about the differences as well as similarities of creativity in different cultures.

Science is usually seen as a precise enterprise that relies on observation, reproducible experiments and critical analysis. Several studies have shown that cultural beliefs do influence students' conceptualization of scientific phenomena. Therefore children growing up in traditional communities gain experiences, knowledge, values and ways of thinking that might differ in varying degrees with those inherent in or arising from the conventional science. These socio-cultural predispositions, therefore, make a significant contribution to the learning of conventional science. Odhiambo (1972) and Ogunninyi (1988) asserted that since modern science is a product of western cultures it may not be easily amenable to the African worldview.

Education throughout the world faces unprecedented challenges: economic, technological, social, and personal. Policy makers everywhere emphasize the urgent need to develop human resources, and in particular to promote creativity, adaptability and better powers of communication. This means that there is need to review some basic assumptions of our education system. A major challenge for the education system is to equip young people with the knowledge and skills they need to make their ways in the increasingly complex world of financial interdependence and competition (National Advisory Committee on Creative and Cultural Education, 1999)

Today we live in a highly complex, largely science and technology-driven world. However, the enormous changes of the last two decades seem to be merely a foretaste to the challenges ahead.

Science based innovation remains at the heart and center of humanity's endeavour to take on the present and future challenges. Nevertheless, it is true that there has been very little research of creativity in Africa (Mpofu et al, 2006). In Kenya few studies on creativity have been done. However such studies have not been conducted in Turkana County. This study investigated the influence of Turkana culture on scientific creativity in Biology education amongst form three students in Turkana County.

2.4 Gender and Achievement in Science

The issue of gender difference in achievement in school science is far from resolved, and the inconclusiveness of studies conducted to date provides no solid basis on which changes can be made in teaching and learning. As Tobin (1988), suggested, it is unlikely that teachers will respond until this basis exists. The gender gap in interest, participation and performance in science is well known and the subject of intense scrutiny worldwide (Gonzales, Noll, & Amanti 2005). In America national trends reveal mixed results with regard to gender gap in science achievement. In some instances, such as coursework completed, females perform equal to male peers; however, assessments geared to measuring mastery of content, reveal that differences between males and females in K-12 education surface in elementary school continue at the high school level (Ingels & Dalton, 2008). Differences in science achievement at the K-12 level are attributed in part to fewer females attaining degrees in science, technology, engineering and mathematics fields (Hazari, Tai, & Sadler, 2007).

In 2003 Trends in International Mathematics and Sciences Study (TIMSS) among 34 nations, showed that there was substantial variability in the size of the sex differences, and the 8^{th} grade girls in 3 nations significantly outperformed boys in science. For the same sample there was overall sex difference in mathematics achievement, with girls significantly outperforming boys in 7 nations and boys significantly outperforming girls in 5 nations. This variability across time and place suggests that sex differences in math and science achievement are shaped by socio-cultural factors (Guiso, Monte, Sapienza & Zingales, 2008).

Stereotypes that men are naturally more talented and interested in math and science are thought to influence the science, technology, engineering and math aspirations and achievements of boys and girls, men and women (Frome & Eccles, 1998). For example, women who endorse such stereotypes also report less interest in math and science and are less likely to pursue a math or science degree (Schmader, Johns, & Barquissau, 2004).

Therefore stereotypes can influence individual performance in math and science domains. This study sought to determine whether scientific creativity in biology education was gender dependent among form three students in Turkana County.

2.5 Gender and Scientific Creativity

Creativity is increasingly being considered a crucial ability for the future. If the world, as we know it today, is a result or product of the creative thinking of a few individuals, and if progress in any human endeavor and field of study is due exclusively to the development of new ideas and new ways of seeing reality, then it makes sense to make creative thinking a curricular goal. Science is one of the disciplines that can make a contribution to the achievement of this goal (Csikszentmihalyi, 1996).

The underrepresentation of women in the mathematically intensive sciences sometimes referred to as the hard sciences has been a concern in many nations of the world and even here in Kenya. Piirto (2004) argues that girls show less creative achievement after high school and college. The study emphasized the role of important decision making saying that men are more likely to make decisions that pull them toward creative endeavours whereas women are more likely to make decisions that result in less creative endeavours.

Research on gender differences in creativity carried out includes those on creativity test scores, creative achievements, and self-reported creativity. Creativity is reviewed, as are the theories that have been offered to explain such differences and available evidence that supports or refutes such theories.

This is a difficult area to conduct research because of the consistent lack of gender differences both in creativity test scores and in the creative accomplishments of boys and girls, (Baer, 2006) As a result it is difficult to show how innate gender difference in creativity could possibly explain later differences in creative accomplishments. At the same time the large difference in the creative achievement of men and women in many fields make blanket environmental explanations that have been proposed thus far are at best incomplete.

There are many new studies on gender differences, some using very different methodologies, techniques and populations. However, we find that we share relief that although there is considerable evidence of differences in patterns and areas of strengths between genders, there is still relative equality in creative ability (Kogan, 1974). There has clearly been a greater openness to investigating gender differences in recent years. Piirto (2004), made powerful arguments to explain the observed differences. Yet despite the many studies that have been done, gender differences in creativity have not become an important focus in either the creativity or psychology of women literatures. This study sought to find out whether scientific creativity in Biology education among form three students in Turkana County was gender dependent.

Sternberg (1999) handbook of creativity cited only once gender difference. This is partly attributed to the inconsistent findings on gender differences in creativity. The largest inconsistency is between scores of tests designed to predict creativity and actual creative accomplishment. Most studies relating to gender differences in creativity have focused on divergent thinking, and these have not produced clear or consistent gender differences. The differences in real world creative accomplishment are large and significant (Simonton, 1994); it is here that explanations are most needed. Several of these differences have been provided, but none with enough power to push the issue into the mainstream of creativity research.

This study may extend the ideas and findings reported in ways that will enrich our understanding of why there have been so many prominent men than women among those of the highest creative accomplishment. This will go a long way in helping in restructuring our schools and curriculum which will lead to less waste of human creative talent. There are also limitations that vary from field to field and domain to domain which explain differences in creative achievement by women in different domains (Helson, 2004, Simonton, 1994).

While there are research results pointing in various and often contradictory directions, the evidence does not clearly support gender differences in creativity based on test results; however, to the extent, that a case for such gender differences can be made, the available evidence suggests that women and girls tend to score higher on creativity tests than men and boys.

Torrance tests of creative thinking (Torrance, 1974) have suggested that these divergent thinking tests are more predictive of creative behaviour in males than females. Although a great many studies have looked for gender differences in test scores designed to measure and predict creativity, few have found such differences and no consistent pattern has emerged from this research. Goldsmith and Matherly (1988) gave 118 college students three self-report measures of creativity and found no gender differences. Forisha (1978) in her study of the relationship between creativity, imagery and sex-role orientation in men and women, found that creative production in women was associated with sex role, masculinity (a construct that includes the personality traits of competence and self-reliance). Chan (2005), on assessing 212 gifted Chinese students on their creativity, family hardiness and emotional intelligence found no significant gender differences for all the constructs.

Henderson (2003), found no gender differences in self-reported creative achievement of inventors working in multinational firms who responded to an online survey. Women in this study did report more publications and conference presentations than men. Early environments were important; subjects cited many instances of early family, school, community and higher education experiences that had influenced their ability to invent. Costa, Terracciano, McCrae, and Pers Soc Psychol (2001), analyzed gender differences in openness to experience based on a secondary analysis of people from different cultures and found out that women scored higher than men on openness to aesthetics, feelings and actions while men scored higher on openness to ideas.

According to Kaufman and Baer (2006) findings, the differences may be related to gender stereotypes as much as individual beliefs. Abra and Valentine-French (1991), on surveying available explanations for gender difference in creative achievement argued that nature and nurture were responsible for observed differences in creative accomplishments.

They argued that possible explanations range from differences in specific cognitive abilities and in educational opportunities to differences in selfishness and competitiveness and they considered possible genetic and environmental sources of such differences.

Vernon (1989), argued that although social- environmental influences are certainly major causes of the differences in numbers of highly creative men and women in various fields, these factors are not sufficient explanation for the patterns of achievement that have been observed. Simonton (1994), at least partially refuted this argument by pointing out that active sex discrimination has often prevented women from acquiring the resources necessary for achievement. A research carried out in Kenya by Ndeke (2012), noted that boys scored significantly higher than girls on all aspects of scientific creativity skills that were considered in the study. These findings were in agreement with earlier findings by Okere (1991) and Okere, Illa and Changeiywo (2010).

Several theorists have tried to explain why there are many more creatively accomplished men than women. Helson (1990) argued that cultural values, social roles and sexist thinking are now recognized as key reasons for the comparative lack of creative accomplishment by women. According to him differences between men and women in biology and early socialization experience are exaggerated by culture. This includes the ways in which parents perceive and interact with their daughters and sons.

There continues to be large gender differences in creative productivity and these differences represent the most significant unanswered questions about gender and creativity. It is clear that a large part of these differences are environmental, including differences in adult expectations of girls and boys, differences in opportunities available to males and female children and the kind of experiences men and women are likely to have. Studies on the influence of gender on scientific creativity have been carried out in Kenya, however such studies have never been conducted in Turkana County. This study has given some insight on the influence of gender and culture on scientific creativity in biology education among form three students in Turkana County.

2.6 Theoretical framework

The theoretical framework for this study was guided by Guilford (1950) model of intellect derived from his work in the field of education the Cognitive Process Creativity. According to Guilford (1950), creativity is a function of a cognitive process which means a volitional mental operation that can be learned in much the same way as solving a mathematical equation or speaking another language. Guilford's model describes several types of thinking functions with certain combinations of those functions underlying creativity. He felt that creativity is part of the divergent, convergent and evaluative thinking operations. Creativity was measured by the flexibility, fluency and originality of responses to a given problem situation. It is also measured by the sensitivity of an individual to a problem and the ability to redefine information. Originality is the ability to generate a variety of transformations. Flexibility, fluency and originality are part of divergent thinking model. Sensitivity to the problem is in the evaluative mode. The individual must be able to evaluate situations for unmet needs in order to bring about improvement. The convergent thinking mode is used to redefine information. The product is a transformation. A lot of creative effort is in the form of transforming something known into something not previously known.

From Guilford model of divergent thinking, a creative individual should be divergent in thinking which can be measured by flexibility, fluency, originality and sensitivity of an individual response to a problem situation. This is for general creativity. This study was aimed at investigating the level of some of these creativity aspects such as sensitivity to problems and flexibility in reasoning among Form Three Students in Biology Education.

Okere's model (1986) which maps psychological definitions of creativity onto scientific meanings also guided this study. This model gives the scientific meanings as sensitivity to problems, flexibility in reasoning, recognition of relationships and planning for scientific investigations. All the four scientific meanings were tested in BSCT, an instrument formulated to measure scientific creativity level among Form Three Students in this study. Both theoretical models were used in this study.

2.7 Conceptual Framework

The following is a figure showing the interaction among different variables in this study.

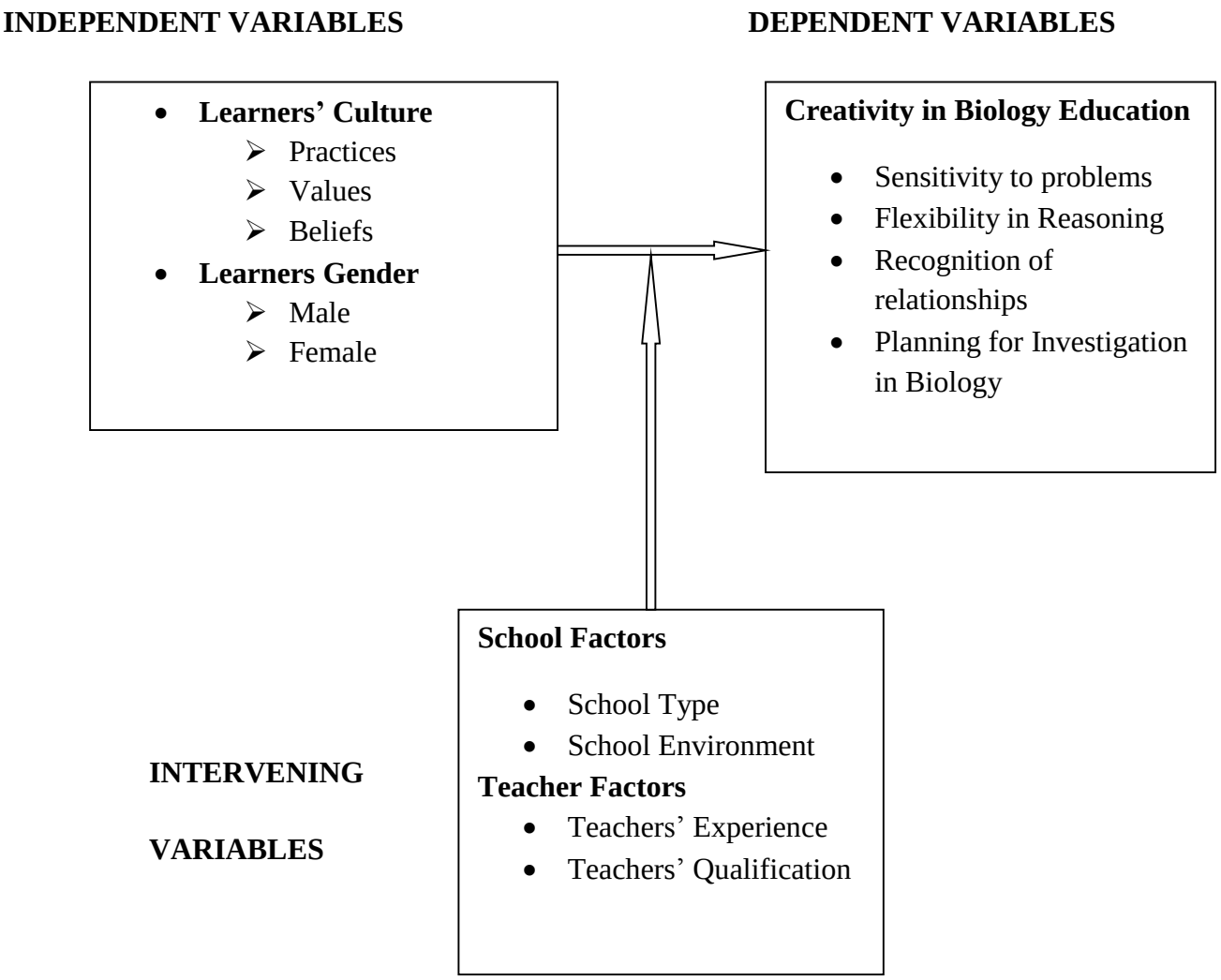

Figure 1: Diagrammatic representation of the interaction of the various variables in the study.

This study focused on the influence of learners' culture and gender on scientific creativity in Biology education. Scientific creativity may be influenced by many factors. These factors constituted the independent variables but only two were investigated that is learners' culture and gender. Scientific creativity may also be influenced by intervening variables such as teachers' factors; teacher experience and teacher qualification as well as school factors such as; school type and school environment. Teacher experience was controlled by involving only classes taught by biology teachers with at least 3 years teaching experience. Teacher qualification was controlled by involving only classes taught by trained (Diploma or Graduate) biology teachers.

Other intervening variables were school factors and these were controlled through involving sub county schools with similar characteristics. The single directional arrow from independent variable towards dependent variables indicates that student's scientific creativity in biology may be influenced by the student's factors (learners 'culture and gender). The arrow from intervening variable indicates that both the dependent and independent variables are affected by the intervening variables.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter gives a description of the research design that was used in this study, of the study, sampling procedures and sample size and the instruments used for data collection, validation and reliability of the instruments and data collection procedures and statistical methods of data analysis are also discussed.

3.2 Research Design

Descriptive research design was used in this study because it defines characteristics of a population or phenomena under study (Shields et al, 2013). The research method was cross-sectional survey since information to be collected was drawn for predetermined population (Borg & Gall, 1989). Cross-sectional survey is appropriate for this study since it was used to determine the nature of prevailing conditions or relationships and practices that exist (Cohen, Manion & Keith, 2007). It also explores and describes the variable under the study (Kathuri & Pals, 1993). Survey method has the advantage of collecting a lot of information in a relatively short time. In this study the variables were the level of scientific creativity in Biology, students' culture and gender.

3.3 Population of the Study

The target population for this study was Form Three Students in Sub County Coeducational Secondary Schools and Turkana men and women of 55 years of age and above since they are well versed with the culture. The accessible population was Form three students in Sub County coeducational Schools from Turkana Central (110 boys, 84 girls), South (85 boys, 50 girls) and West (54 boys, 44 girls) Sub Counties giving a total of 427 students. The adults from Turkana South Sub County were 9 men and 6 women.

3.4 Sampling Procedure and Sample Size

A list of all Sub County Secondary Schools in Turkana County was obtained from the County's Education Office. Four Sub County Secondary Schools were selected using purposive sampling because the schools were few and scattered throughout Turkana County and also to ensure that majority of the students were from the Turkana Tribe. Many schools had more than one Form Three Class and more than 40 students per class, 80 students were chosen randomly per school (40 girls and 40 boys). This gave a sample size of 320 for this study for the four Sub County Coeducational Secondary Schools. Students and adults that participated in the study were chosen through purposive sampling to ensure they were from the Turkana culture under study. A sample size of 10 adults participated in this study. The guideline given by Gall, Borg & Gall (2007) was adapted in determining the sample size in this study. The general rule in quantitative research is to use the largest sample possible. The larger the sample, the more likely the research participants scores on the measured variables was representative of the population scores.

3.5 Instrumentation

In this study three instruments were used to collect data, these included;

i. Students' Culture Evaluation Questionnaire (SCEQ)
ii. Biology Scientific Creativity Test (BSCT)
iii. Interview Schedule (IS) for adults

3.5.1 Students Culture Evaluation Questionnaire (SCEQ)

The SCEQ contained 9 questions, one was open ended while eight required students to give yes or no answers and explain them briefly. This was used to evaluate cultural values, rules and regulations and practices of the Turkana tribe that either stifles creativity such as strict cultural practices William, et al (1995), or those that foster creativity in children such as perseverance (Sternberg & Lubart, 1999). The items were scored based on the relevance of the points given by the respondent in which a maximum of 2 marks were awarded for every relevant answer or response.

3.5.2 Biology Scientific Creativity Test (BSCT)

The Biology Scientific Creativity Test had four sections namely; A, B, C and D each representing the various aspects of scientific creativity in Biology Education as outlined below. All the items in BSCT were open ended with each question testing different aspects of scientific creativity. The test was aimed at assessing Form Three learners' competence in scientific creativity abilities which included;

- Sensitivity to problems – The items required students to identify whether the statements were scientifically testable and give an explanation which involved rephrasing the statements. The items in this section were five and they were scored in such a way that a maximum of 1 mark was awarded for stating whether the statement was correct or incorrect and 2 marks were awarded for correctly rephrased statement.
- Flexibility in reasoning – The items required students to suggest various methods of solving a given problem or approaches to an investigation. This section had 2 items and each question had a maximum of 4 marks where 1 mark was awarded for each correct response.
- Recognition of relationships – This skill required students to recognize relationships between observations and scientific knowledge acquired from science lessons. There were four items in this section. A maximum score of 2 marks was awarded for every correct explanation.
- Planning for investigation in Biology – This skill required students to plan for an investigation. This involves suggesting the equipment to be used, experimental procedure and method of data analysis. This section had only one item which carried 10 marks. A maximum score of 2 marks was awarded for every step correctly explained.

3.5.3 Interview Schedule for the Adults

The interview schedule in appendix C contained ten questions which were used to determine cultural practices, beliefs, values and taboos by the Turkana community. The adult chosen for the study were 55 years and above. This age bracket was considered because these adults understood the culture well and were also brought up in the Turkana culture under study. The results obtained corroborated findings from Students Evaluation Questionnaire.

3.5.4 Validity of the Instruments

For content validity and scoring key for the SCEQ, BSCT and Interview instruments, the researcher sought the opinion of five experts from the faculty of education and community studies at Egerton University. The instruments were pilot tested in one sub county secondary school in Turkana County.

3.5.5 Reliability of the SCEQ and BSCT Items

To estimate the reliability of the instruments, the instruments were administered to forty (40) students selected from a school that did not participate in the study. Pilot testing was carried out in a Sub County Secondary School located at Loima Sub County which had similar characteristics to those to be used in the study. Cronbach coefficient alpha was used to measure the reliability of the instruments. Gall, Borg and Gall (2007) suggested that Cronbach coefficient alpha can be used when items are not scored dichotomously. Also the test items had a range of scores. This is a measure of internal consistency among the items. It provides a coefficient of inter-item correlation and was used for multi-item scales, (Cohen, Manion and Keith, 2007).

This study obtained a reliability coefficient of 0.74 for SCEQ and 0.70 for BSCT which was considered appropriate since it was within acceptable limits (Fraenkel & Wallen, 2000).

3.6 Data Collection Procedures

The researcher sought for an introductory letter from the graduate school of Egerton University to help in obtaining a research permit from the National Commission for Science, Technology and Innovation (NACOSTI) before the commencement of the study. The researcher then visited the Turkana county education offices to notify them of the intention to collect data. The researcher then visited the sampled schools to introduce herself to the heads of the schools and inform them of the intended study. During the study the researcher with the assistance of the Biology teachers administered the BSCT and SCEQ to the sampled streams. Structured focused group interview was used to collect data from the adults, where the researcher guided them in answering already predetermined questions. A total of 320 students took the BSCT and filled the SCEQ, 10 adults were interviewed. The researcher then scored the instruments and generated quantitative data which was then analyzed.

3.7 Data Analysis

Both qualitative and quantitative data were generated in this study. Quantitative methods used involved both descriptive and inferential statistics. The inferential statistics used were the chi-square and t-test. Descriptive statistics used were means, standard deviations and percentages. Qualitative approaches were used to describe cultural practices, beliefs and values, of the Turkana community. The hypotheses were tested at α=0.05 significance level. The statistical package for social sciences (SPSS) program was used to analyze data. Table 1 summarizes the variables and statistical techniques which were used in this study.

Table 1

Summary of Data Analysis Procedures

Hypothesis/ Research Questions	Independent Variable	Dependent Variable	Statistical Test
$H_0$1 There is no statistically significant relationship between culture and scientific creativity	Learners' culture	Scientific Creativity	Chi-square
$H_0$2 There is no statistically significant difference in scientific creativity among form three boys and girls	Learners' gender	Scientific Creativity	t-test
(i) What are the cultural practices beliefs and values that affect creativity in Biology education in Turkana County?	Learners' culture	Scientific Creativity	Means
(ii) What is the level of scientific in Biology among Form Three students in Turkana County?	Learners' gender	Scientific Creativity	Percentage

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study and the discussions. Both qualitative and quantitative data were obtained and the results are presented in various sections in this chapter. The results are presented according to the objectives, research questions and the hypotheses of the study.

4.2 Results on Cultural Practices, Beliefs and Values of the Turkana

The first research question is on the cultural practices, beliefs and values that affect scientific creativity in Biology education. This was measured using the students' culture evaluation questionnaire (SCEQ) and an interview schedule which corroborated the findings as shown. The following cultural practices, beliefs and values were identified in the Turkana culture and the results were analyzed qualitatively.

Sample cultural practices of Turkana culture

- Removal of the lower teeth.
- Traditional marriage.
- Eloping with girls.
- Story telling.
- Singing and dancing.
- Naming of newborns.

Sample cultural beliefs of Turkana culture

- Disrespecting elders attract a curse.
- Boys are supposed to take care of the family's animals therefore are not allowed to go to school.
- A child found doing wrong could be punished by any adult.
- Girls should never visit boys houses.
- Boys are not allowed in the kitchen or do any house chores.
- Believed in ancestral spirits.
- Young people must respect elders.

Sample cultural values of Turkana culture

- Older men and women guide the young people into adulthood.
- Children are taught to respect elders.
- Sharing is encouraged.
- Children are taught to obey elders without questioning.
- Children should perform any duty allocated by elders.
- Children are taught to be morally upright by the elders and their parents.
- Being greedy was discouraged.
- Honesty was encouraged.
- Theft is punishable.

Some of the values and beliefs generated by the students may hinder the children from discovering things on their own hence affect their scientific creativity. For instance, insistence on obedience may stifle scientific creativity in biology education because children may not explore and try new things on their own.

4.2.1 Handling of samples such as blood in determining health of people and livestock

Table 2 shows the responses given by students on whether it is acceptable to handle samples such as blood in determining the health of people and livestock in Turkana culture. The Students' responses were YES or NO with a brief explanation.

Table 2

Response on Handling of Samples

Culture	Response	Number N	Percentage %
Handling of Samples	YES	186	58.1%
	NO	134	41.9%
Total		320	100%

From the above results 58.1% of students agreed that handling of sample such as blood is allowed in determining health of people and livestock. This is because it is the only way to check the health of people and livestock since there are no health facilities and specialists. 41.9% disagreed with handling of these samples because it is considered dirty and it is believed that one could contract contagious diseases. Failure to handle samples may stifle creativity in Biology since it is a practical subject and this will interfere with discovering of scientific facts.

4.2.2 Discussion of matters of reproduction and family planning

Table 3 shows the responses given by students on whether matters of reproduction and family planning are discussed openly in the presence of children. Students' responses were YES or NO with a brief explanation.

Table 3

Response on Discussions of Matters of Reproduction and Family Planning

Culture	Response	Number N	Percentage %
Matters of Reproduction and family planning	NO	320	100%
	YES	0	0%
Total		320	100%

The results in table 3 indicate that 100% of the students indicated that the matters of reproduction and family planning are not openly discussed in the presence of children. This is because family planning is prohibited in the Turkana culture. It is also considered a taboo to talk about reproduction to children. Matters of reproduction are adult affairs and if the children are exposed to them it may encourage immoral behavior among the children. This may stifle creativity by conflicting with biology knowledge especially reproduction and family planning topics. Creativity is knowledge dependent and this may explain the low levels of creativity in Biology Education.

4.2.3 Traditional Medicine versus Modern Medicine

Table 4 shows the responses given by students on whether the Turkana community prefers the use of traditional medicine to modern medicine. Students' responses are YES or NO with a brief explanation.

Table 4

Response on Use of Traditional Medicine versus Modern Medicine

Culture	Response	Number N	Percentage %
Traditional medicine Versus modern medicine	YES	302	94.4%
	NO	18	5.6%
Total		320	100%

The results in table 4 indicate that 94.4% of the students agreed that the Turkana people prefer the use of traditional medicine to modern medicine. This is based on the belief that modern medicine is harmful and expensive. They also believe that traditional medicine cures all diseases. This may stifle creativity because biology is the important for the study and research in medicine leading to low levels of creativity in biology education.

4.2.4 Children questioning instruction by adults

Table 5 shows the responses given by students on whether children were allowed to question instructions by adults. Students' responses are YES or NO with a brief explanation.

Table 5

Response on Questioning of Adults Instruction by Children

Culture	Response	Number N	Percentage %
Children questioning Instructions given by adults	YES	16	5.0%
	NO	304	95%
Total		320	100%

The results in table 5 indicate that 95% of the students agreed that children are not allowed to question instructions given by adults. This is because it is believed that what older people say is right and if children questioned they would be punished. It is also considered disrespectful to question adults. Questioning is important in fostering creativity. Lack of this hinders creativity in the children. This may be the reason for the low levels of creativity in biology education.

4.2.5 Rules, Practices and Beliefs that conflict with biology knowledge

Table 6 shows the responses given by students on whether some rules, practices and beliefs in the Turkana culture conflicted with biology knowledge. Students' responses are YES or NO with a brief explanation.

Table 6

Response on Rules, Practices and Beliefs that Conflict with Biology Knowledge

Culture	Response	Number N	Percentage %
Rules, practices and beliefs that conflict with biology knowledge	YES	142	44.4%
	NO	174	54.4%
	NO RESPONSE	4	1.2%
Total		320	100%

The results in table 6 indicate that 54.4% of students gave a NO response meaning that there is no conflict between Turkana cultural rules, practices, beliefs and biology knowledge. This could mean that students may not have knowledge of biological concepts so that they cannot explain whether there is a conflict or not. This is likely to hinder creativity which is knowledge dependent. This may explain the low levels of creativity in biology education.

4.2.6 Learning through exploration

Table 7 shows the responses given by students on whether children were allowed to learn by exploration in the Turkana community.

Table 7

Response on Children Learning by Exploration

Culture	Response	Number N	Percentage %
Learning through Exploration	YES	122	38.1%
	NO	194	60.6%
	NO RESPONSE	4	1.3%
Total		320	100%

The results in table 7 indicate that 60.6% of the learners agreed that the children were not allowed to learn by exploration due to different reasons ranging from being exposed to unforeseen dangers, fear of them leaving their traditions and culture. Exploration fosters creativity and if not allowed it could hinder creativity. This therefore could explain the low levels of creativity in biology education.

4.2.7 Teachings reserved for boys or girls only

Table 8 shows the responses given by students on whether some specific teachings were reserved for boys and girls in the Turkana community. Students' responses were YES or NO with a brief explanation.

Table 8

Response on Teachings Reserved for Boys or Girls only

Culture	Response	Number N	Percentage %
Teachings reserved for boys or girls only	YES	310	96.6%
	NO	8	2.5%
	NO RESPONSE	2	0.6%
Total		320	100%

The results in table 8 indicate that 96.9% said YES that is they agreed that specific teachings were reserved for boys and girls because of their different roles. This may be the cause of low levels of different creativity aspects amongst genders.

4.2.8 Education and instruction by men or women

Table 9 shows the responses given by students on whether instruction and education was offered by both men and women in the Turkana community.

Table 9

Response on Instruction being done by Men or Women only

Culture	Response	Number N	Percentage %
Education and instruction by men or women	YES	222	69.4%
	NO	96	30.0%
	NO RESPONSES	1	0.6%
Total		320	100%

The results in table 9 indicate that 69.4% of students gave a YES response agreeing that education and instruction of the children is handled by men and women differently because of the different roles of girls and boys. This may stifle scientific creativity especially in girls who may develop negative attitudes towards science subjects believing they are meant for boys only.

4.2.9 Summary of the Responses on the Students Culture Analysis Questionnaire

Table 10 shows a summary of the students' responses on various cultural aspects that influenced scientific creativity. The Students gave YES or NO responses that indicated if they agreed or disagreed with the statements respectively explaining briefly.

Table 10

Percentages and Frequencies of Agreements and Disagreement in some Cultural Aspects of the Turkana Culture

Culture Aspects	Response	Number	Percentage
HANDLING OF SAMPLES	YES	186	58.1%
	NO	134	41.9%
DISCUSSION OF MATTERS OF REPRODUCTION & FAMILY PLANNING	NO	320	100%
	YES	0	0%
TRADITIONAL VERSUS MODERN MEDICINE	YES	302	94.4%
	NO	18	5.6%
QUESTIONING ADULT INSTRUCTION	YES	16	5.0%
	NO	304	95%
RULES, PRACTICES, BELIEFS CONFLICTING BIOLOGY KNOWLEDGE	YES	142	44.4%
	NO	174	54.4%
LEARNING THROUGH EXPLORATION	YES	122	38.1%
	NO	194	60.6%
TEACHING FOR BOYS OR GIRLS	YES	310	96.9%
	NO	8	2.5%
EDUCATION AND INSTRUCTION BY	YES	222	69.4%
	NO	96	30.0%

The results in table 10 show that majority of the learners believed their cultural practices, beliefs, rules and values which could lead to low scientific creativity in biology education.

4.2.10 Focused Interview for Adults

Objective one sought to investigate cultural practices, beliefs, and values of the Turkana community that related to scientific creativity in biology education. The focused interview comprised 10 questions and it involved 10 respondents of which 5 were women and 5 men aged 55 years and above of the Turkana community. The findings were used to corroborate findings from the students' culture evaluation questionnaire. The researcher analyzed the data from the focused group interview and noted several major themes. These were discussed under the following sub headings;

Cultural practices, beliefs and values that are related to children education and instruction

To determine these, respondents were asked to state some of the cultural practices, beliefs and values in the Turkana community that related to children education and instruction guided by the following questions. The adults' responses were as indicated.

Cultural practices

What cultural practices are used in teaching children traditionally? The responses given by adults' were as follows;

- Story telling.
- Singing and dancing.
- Traditional marriage.
- Training girls and boys to perform various duties.

Cultural beliefs

What are some of the cultural beliefs that children are expected to learn? The responses given were as follows;

- Girls are expected to dress properly.
- Girls are not allowed to visit boys' houses.

- Disrespect to elders is punishable.
- Boys are not allowed anywhere near the kitchen.

Cultural values

What cultural values are imparted to children? The adults' responses were as follows;

- Girls are not allowed to have affairs before marriage.
- Stealing is prohibited.
- Sharing is encouraged.
- Greediness is discouraged.

Discussion of matters of reproduction

To determine this, respondents were asked whether matters of reproduction were discussed openly before children. All respondents unanimously said that these matters were considered adult affairs and were therefore not discussed openly especially before the children. In fact children found eavesdropping were punished.

Questioning of rules and instructions given by adults

The respondents were asked if children were allowed to question the rules set by adults or the instructions they gave. All the respondents agreed that no questioning was allowed whatsoever. It was considered disrespectful to the elders and was also punishable. Obedience was demanded at all times.

Roles for boys and girls

To determine this, respondents were asked if there were specialized roles for boys and girls. All the respondents said that there were specialized roles for boys and girls. Boys were mainly involved in herding of the family animals and provision of security for the home while girls took care of the house work such as cooking, cleaning, building the houses and taking care of the younger children.

Training of children on various duties and Skills acquired

To determine this, the respondents were asked if the children were trained on various duties and to state the skills that they acquired.

All the respondents agreed that the children were trained on various duties mainly through observation and apprenticeship. For instance boys were trained on how to take care of animals by following the father at a very early age and also being allowed to take of the young animals. The girls also remained home with the mother and they learnt by observation and in the process of assisting the mother they would learn. Some of the skills acquired included making clothes through use of hides and skins, beading, making bows and arrows, shields and spears, preparing sour milk and building houses for the girls.

Planning for daily activities

The respondents were asked whether they ever plan before embarking for the daily activities and all of them said they never plan for daily activities. Children would just wake up and they are directed on what they are to do for the day. They were expected to follow without questioning.

Medicine preferred

To determine this, the respondents were asked to state the type of medicine they preferred to use. They unanimously said the members of the Turkana community preferred the use of traditional medicine because they believe it was more effective than modern medicine. They also said it was cheap and harmless compared to the modern medicine.

Learning by discovery

To determine whether the children were allowed to learn by discovery this question was asked to the respondents. Are children allowed to learn through discovery? They all said that children were not allowed to learn by discovery. They would always be threatened with punishment whenever they veered away from the parents' sight when playing. They were only allowed to play under observation.

4.3 The Level of Scientific Creativity in Biology Education

The second research question was to determine the level of scientific creativity in biology education amongst form three students in Turkana County. This was measured using Biology Scientific Creativity Test (BSCT). Students' raw scores on biology creativity test were expressed in percentages. The scores were then categorized into two, high and low with the criterion reference of 40%. Those who scored 40% and above were categorized as highly creative, while those who scored less than 40% were categorized as having low scientific creativity.

Table 11 shows the results of the level of scientific creativity in biology education among form three students in Turkana County.

Table 11

Number and Percentage of Students and Categories of Creativity

Creativity	Number	%
High	16	5
Low	304	95
Total	320	100

The results in table 11 indicate that the level of scientific creativity in Biology education is low since only 5% of all the students managed to score 40% and above. Majority of the students 95% scored below 40% which was categorized as a low level of scientific creativity. From this results then it was concluded that the level of scientific creativity in Biology education among form three students in Turkana County was low. These results are in agreement with the findings of Ndeke (2003) and Hungi (2009) who found out that the level of scientific creativity in Biology were low and findings of Okere (1986) who found that the level of scientific creativity in Physics were low.

4.4 The Influence of Culture on the Level of Scientific Creativity in Biology Test

Scientific creativity in biology was measured by the Biology Scientific Creativity Test (BSCT) while Student's Culture Evaluation Questionnaire (SCEQ) was used to measure cultural practices, beliefs and values in the Turkana culture. Learners' scores in BSCT and SCEQ were expressed in percentages, means were also calculated. The SPSS programme was used to compute the Chi- Square test for the scores obtained from the two scores. The results are shown in table 12.

Table 12

Chi-Square Tests

	Value	df	Asymp.Sig.(2-sided)
Pearson Chi-square	545.321[a]	442	0.001
Likelihood Ratio	344.352	442	1.000
Linear by linear association	6.674	1	0.010
N of Valid Cases	320		

The results in table 12 shows that there was statistically significant influence of culture on the level of scientific creativity in biology education among form three students in Turkana County. This is because r = 545.321, p= 0.001. This implies that there is a strong influence of culture on the level of scientific creativity in biology education. The relationship was identified as being statistically significant at 0.05 level. This means that when learners focus on their cultural practices, beliefs, rules and values it leads to low scientific creativity in biology education. Therefore the Ho1 is rejected.

Discussion of Results

The results in Table 12 show that learners' culture (practices, rules, beliefs and values) influenced scientific creativity in biology education among form three students in Turkana County. This means there are some cultural practices that may be hindering or stifling biology scientific creativity in secondary schools. These include lack of freedom to explore in risky activities, lack of questioning, corporal punishment, and lack of motivation, strict rules and demand for obedience.

These findings are in agreement with other researchers. A given culture may contain some elements that foster creativity and others that stifle it, yielding an overall influence that may be positive, negative, or neutral. (Sternberg, 1999).

Creativity may be fostered or hindered by cultural features such as individualism or collectivism and the value placed on conformity or tradition (William, Saiz, Formyduval, Munick, Fogle, Adom, Hague, & Yu, 1995). Triandis, McCusker, Bentancourt, Sumiko, Leung, Salazar, Setiadi, Sinha, Tozard & Zaleski (1993), suggested that individualist cultures value independence and self-reliance, which are important factors that foster creativity, whereas collectivist cultures emphasize obedience, cooperation, duty and acceptance of an in- group authority which stifle creativity. Ng (2001) proposed that the individualism – collectivism dimension can explain to a large extent differences in creative abilities levels for Westerners and Asians.

The worldview and values of a culture can affect the overall level of creativity. A culture can influence the amount of creativity through its emphasis on individuality as opposed to collective interest, through its tolerance of deviance as opposed to emphases on conformity (Lubart & Georgsdottir, 2004). According to Berry, Ype, Seger, Athanasios and David (1992) cultural values that foster creativity are perseverance, tolerance to ambiguity, and risk taking. Adams (1986) on the other hand gave several factors that may hinder creativity as "Fantasy and reflection are a waste of time", "Playfulness is for children only", "There is a right answer", and "Reason, logic, numbers, utility, and success are good while intuition, emotions, qualitative thinking, and failure are bad".

Creativity is more than a purely a cognitive phenomenon. Certain personality traits are particularly relevant for original, adaptive thinking development during childhood (Lubart & Georgsdottir (2004). Traits of risk taking, openness, individuality, perseverance and tolerance to ambiguity seem to play a role in creativity (Sternberg & Lubart, 1995). Therefore a culture that promotes these traits in children is likely to foster creativity unlike the one that does not. Gardner (1999) stated that people are creative when they can solve problems, create products, or raise issues in a domain in a way that is initially novel but is eventually accepted in one or more cultural settings. Gardner's views seem to support the idea that creativity can take different forms in different domains. Thus it may be conceptually and practically important to know about the differences as well as similarities of creativity in different cultures.

4.5 Influence of Gender on Scientific Creativity in Biology Education

Objective four investigated whether scientific creativity in biology education was gender dependent amongst form three students in Turkana County. To determine this, a BSCT test was used to determine the level of creativity in biology education amongst form three students. The findings on the BSCT were as follows.

4.5.1 Students' Responses and Performance on the BSCT

The BSCT comprised 13 questions that were classified into four sections on the basis of the scientific creativity aspects namely; sensitivity to problems, recognition of relationships, flexibility in reasoning and planning for investigations. For each aspect, only one question was discussed as shown.

4.5.2 Sensitivity to Problems Aspect

Study the following statement then answer the questions that follow.

"Fat people lead better lives than thin ones"

(a) State whether the above statement is correct or incorrect.

(b) Rephrase the statement in such a way that it is scientifically testable.

The test question was measuring sensitivity to problems aspect of creativity. Part (a) of the question tested the ability of the learner to be able to identify testable statements which was the starting point in design of investigation and the score was 1 mark, while part (b) tested the ability to rephrase the statement to be scientifically testable and the score was 2 marks.

Expected Correct Responses

Responses

(a) The term better is not measurable scientifically hence the statement is incorrect.

(b) Fat people are more vulnerable to cardiovascular diseases than thin ones.

Correct Responses from the students

(a) Incorrect

(b) Fat people have been identified with dangerous diseases such as breathing problems

Fat people may suffer from heart failure due to accumulation of fat and this leads to death

Incorrect sample responses from the students

Responses

(a) Correct

(b) All people have better lives not necessarily fat or thin

Thin people lives are better because they do not want to be fat and also they have money more than fat people. Fatness depends on an individual

The responses given above show that learners did not have an idea on what it means to have a scientifically testable statement?

Table 13 shows the number and percentage of students' performance by gender on sensitivity to problems aspect of scientific creativity.

Table 13

Students Performance by Gender on Sensitivity to problems

Creativity Aspect		Gender			
		Girls		Boys	
	Scores	No.	%	No.	%
Sensitivity to Problems	0.00	32	20%	22	13.8%
	1.00	128	80%	138	86.2%
Rephrasing the Statements	0.00	64	40%	52	32.5%
	2.00	96	60%	108	67.5%

The results in Table 13 indicate that 86.2% of boys and 80% of girls scored 1 mark meaning that the learners performed well in the first part of this item where they were to identify whether the statement was correct or incorrect meaning scientifically testable or not respectively.

Boys performed better than girls in sensitivity to problems. On the second part of this question where the learners were to rephrase the statement to be scientifically testable. Boys who scored 2 marks were 67.5% while the girls 60%. Boys performed better than the girls.

4.5.3 Recognition of relationships aspect

Question 1: It has been observed that a dog weighing 15.2kg requires 216KJ while a mouse weighing 50g requires 2736 KJ per day. Explain

This item tested recognition of relationship aspect of scientific creativity. The scientific aspect tested is surface area to volume ratio. For every correct response and fully explained relationship among concepts the learner scored 2 marks.

Expected correct responses

Responses

A dog which is heavier than the mouse requires less energy per day because it has a smaller surface area to volume ratio which is exposed to the environment. The mouse has a larger surface area to volume ratio hence loses more heat to the environment.

Correct Sample Responses from the Learners

Responses

- A mouse has a larger surface area to volume ratio thus requires more energy than a dog.
- The mouse has a larger surface area to volume ratio compared to the dog so respiration rate in the mouse is higher.

Incorrect Sample Responses from Learners

Responses

- A dog has a larger surface area to volume ratio while the rat has a smaller surface area to volume ratio hence requires a lot of energy
- The smaller the organism the higher the number of food intake compared to big organisms which require less energy.

Table 14 shows the number and percentage of students' performance by gender on recognition of relationships aspect of scientific creativity.

Table 14

Students Performance by Gender on Recognition of Relationships

Creativity Aspect		Gender			
		Girls		Boys	
	Scores	No.	%	No.	%
Recognition of Relationships	0.00	72	45%	94	58.8%
	2.00	88	55%	66	41.2%

The results in table 14 indicate that 55% of girls and 41.2% of the boys scored 2 marks in recognition of relationships creativity aspect. This indicates that the girls are better than boys in recognizing relationships based on this item.

4.5.4 Flexibility in reasoning aspect

Question 1: A rabbit escapes from predators by leaping left and right in a zigzag pattern while a honeybee stings the predators. Suggest four possible reasons why the rabbit runs in that manner rather than sting to escape predation like the honeybee.

This item tested flexibility in reasoning scientific creativity aspect. Flexibility in reasoning is giving more than one correct response. Maximum score was 4 marks, one for each correct response.

Expected Correct Responses

Responses

- Rabbits have excellent sense of smell, hearing and vision allowing them to detect predators from all directions.
- Rabbits have strong hind limbs which allow them to leap great distances.
- Rabbits can run very fast.
- Rabbits leap in a zigzag pattern to confuse their predators.

Correct Sample responses from Learners

Responses

- The manner helps it to trick the predator.
- The manner helps it to run faster.
- The zigzag pattern is to confuse the predator.
- It has no sting like the honeybee.

Incorrect Sample Responses from Learners

- It is not adapted to stinging like the bee.
- It can’t fly like a bee hence opts to running as an alternative method.

Table 15 shows the number and percentage of students' performance by gender in flexibility in reasoning aspect of scientific creativity.

Table 15

Students Performance by Gender on Flexibility in reasoning

Creativity Aspect		Gender			
		Girls		Boys	
	Scores	No.	%	No.	%
Flexibility in Reasoning	0.00	115	71.88%	120	75%
	1.00	32	20%	42	26.25%
	2.00	7	4.37%	3	1.88%
	3.00	1	0.63%	0	0.00%
	4.00	0	0.00%	0	0.00%

The results in table 15 show that boys who scored 2 marks were 1.88% while girls were 4.37%. This indicates that girls performed better in flexibility in reasoning than the boys. Generally the students performed poorly in this aspect of creativity.

4.5.5 Planning for Investigation Aspect

Question 1: A group of students were investigating the number of Tilapia fish in a shallow pond using the capture recapture method. Describe how the students would go about this.

This item tested planning for investigations whereby the learner was to answer several questions where each consisted of 2 marks and the maximum score was 10 marks.

These questions included;

(i) What would you use?

(ii) What would you measure?

(iii) How would you measure it?

(iv) How would you use the results to arrive at a conclusion?

(v) What do you think would make the results inaccurate apart from careless mistakes?

Expected Correct Responses

Responses

Equipment/ Apparatus

- Fishing net
- Water proof dye
- Writing material
- Pen
- Container
- Pond

What to measure

- Tilapia population in the fish pond

How to measure/ Procedure

- Select the study area/shallow pond
- Capture the fish using a fishing net
- Count and record the number of Tilapia fish collected
- Mark individual tilapia fish using a water proof dye
- Release the marked ones back to the fish pond
- After 24 hours capture as many more fish as possible including the already marked ones

- Record the number of the fish collected and the number of those that were marked

Results and Conclusion

Use the following formula to determine the population of Tilapia fish in the pond

$$P = \frac{FM*SC}{MR}$$

KEY

P - Total population of Tilapia Fish

FM - Number of the first capture that was marked

SC - Number of Tilapia fish in the second capture

MR - Number of the marked Tilapia fish that were recaptured

Use the answer to give a conclusion on the population of tilapia fish in the pond.

Things that would make the results inaccurate

- If the mark alters the behavior of the fish
- Predation which results to death of some of the fish

Correct Sample Responses from the Learner

Responses

- They would capture the animals and record the first count then release them. After 24 hours capture them again
- They would use a fish net and the first catch is marked by Indian mark pen. After two days they should come back and catch the second time and those caught will make the second capture

Incorrect Responses from Learner

Responses

- Use of a bait hook to capture the tilapia fish
- I will measure the size of the tilapia I have caught
- I will use estimation method to measure it using a centimeter ruler
- I will mark each of them using alluminium foil and release again
- Severally would then use the calculation to arrive to the conclusion
- May be the alluminium foil will be released and this will result in repeating the calculations causing an error

Table 16 below shows the number and Percentage of students' performance by gender on planning for investigation aspect of scientific creativity.

Table 16

Students Performance by Gender on planning for investigation

Creativity Aspect		Gender			
		Boys		Girls	
	Scores	No.	%	No.	%
Planning	0.00	60	37.5%	96	60%
For investigations	2.00	95	59.38%	52	32.5%
	4.00	5	3.12%	4	2.5%
	6.00	0	0.00%	8	5.0%
	8.00	0	0.00%	0	0.00%
	10.00	0	0.00%	0	0.00%

The results in table 16 shows that 59.38% of boys scored 2 marks while 32.5% of girls scored 2 marks. This means that boys performed better than girls in planning for investigations.

4.5.6 Means and Standard Deviation by Gender on all Aspects of Scientific Creativity and Overall Scientific Creativity Test

For the purpose of determining the performance of students by gender in BSCT and in the four aspects of scientific creativity, raw scores in the BSCT and on each aspect of scientific creativity were used to compute the means.

Table 17 shows the means and standard deviations by gender on all aspects of scientific creativity and overall scientific creativity test.

Table 17

Means and Standard deviation by Gender on all Aspects of Scientific Creativity and Overall Scientific Creativity Test

Scientific Creativity	Gender	Mean	Std deviation
Sensitivity to Problems	Boys	1.93	0.48
	Girls	1.76	0.74
Recognition of Relationships	Boys	0.76	0.59
	Girls	0.77	0.75
Flexibility in Reasoning	Boys	0.92	0.83
	Girls	0.96	0.88
Planning for Investigation	Boys	0.53	1.25
	Girls	0.49	1.17
Overall Scientific Creativity	Boys	4.14	3.15
	Girls	3.98	3.54
Total Scientific Creativity		8.12	6.69

The results in table 17 show that the mean for boys is higher than that of girls in sensitivity to problems and planning for investigations aspects of creativity.

Boys also scored a higher mean score of 4.14 in the overall creativity than girls whose mean score was 3.98. Generally the total scientific creativity in Biology education for both boys and girls is low that is 8.12 compared to the expected 40% and above mark. Recognition of relationships and planning for investigations aspects of creativity had the lowest mean scores. This shows that learners have poor mastery of biology concepts which may hinder creativity. Creativity is knowledge dependent and this resulted to low levels of creativity shown by the poor performance in BSCT. Sensitivity to problems aspect of creativity had the highest mean score implying that learners were able to identify the gaps in knowledge that exist but they were not able to devise experiments to test for hypotheses. This is because this aspect of creativity that is planning for investigations is not taught in schools.

4.5.7 Independent Sample t-test Results of the difference between Girls and Boys for various Aspects of Biology Scientific Creativity

Table 18 gives the results by gender on each aspect of scientific creativity.

Table 18

Independent Sample t-test Results of the difference between Girls and Boys for various Aspects of Biology Scientific Creativity

Creativity Aspect		Levene's Test for Equality of variances		t-test for equality of means		
		F	Sig.	t-value	df	Sig (2- tailed)
Sensitivity	Equal variances assumed	47.51	.000	2.359	318	.019
	Equal variances not assumed			2.359	273.672	.019
Recognition	Equal variances assumed	22.14	.000	-.062	318	.951
	Equal variance not assumed			-.062	299.959	.951
Flexibility	Equal variances assumed	.067	.796	-.394	318	.694
	Equal variance not assumed			-.394	316.961	.694
Planning	Equal variances assumed	.363	.547	.323	318	.747
	Equal variances not assumed			.323	316.698	.747

Table 18 shows that the difference in the means scores of performance in sensitivity to problems aspect of girls and boys were statistically significant at 0.05 level of significance. This is because the p-value of .019 is less than 0.05. therefore equal variances not assumed were considered at $t(320) = 2.359$, $p<0.05$. On the other hand the difference in the means scores of performance in recognition, flexibility and planning aspects of scientific creativity of girls and boys were not statistically significant at 0.05 level of significance. This is because their p-value are greater than 0.05. Therefore equal variances assumed were considered.

4.5.8 Difference in performance in Biology Scientific Creativity Test by Gender

To determine if the performances in BSCT by gender were significantly different, raw scores in the test were used to calculate the mean score. Table 19 shows the results of the differences in performance in biology scientific creativity test by gender.

Table 19

Means and Standard Deviations of the Scores Obtained by Boys and Girls in the Biology Scientific Creativity Test (BSCT)

Gender	N	Mean	Std deviation	Std Error Mean
Boys	160	4.14	3.15	0.249
Girls	160	3.98	3.54	0.281
Total	320	8.12	6.69	0.53

The results in Table 19 show that boys had a higher mean of 4.14 with a corresponding standard deviation of 3.15 than girls who got a mean of 3.98 with corresponding standard deviation of 3.54. This total means score of 8.12 shows that the level of biology scientific creativity is low on the basis of high scientific creativity being 40% and above.

Further analysis of the test for significance (t-test, 2-tailed) for the difference in attainment of boys and girls in the entire sample was done to determine whether the difference in the mean scores of the boys and girls was statistically significant. Results are shown in Table 20.

Table 20

Test of Significance (t-test, 2-Tailed) for the Difference in Performance between Boys and Girls in Biology Scientific Creativity Test (BSCT)

		Levene's Test For Equality Of Variances		t-test for equality of means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Differences
SCIENTIFIC CREATIVITY	Equal variances assumed	18.97	.000	1.230	318	0.220	0.594
	Equal variances not assumed			1.230	284.106	0.220	0.594

The result in Table 20, shows that the t value (320) = 1.230, $p > 0.05$ that is at 0.220 is greater than 0.05 hence there is no statistically significant difference in the scores attained by boys and girls in the biology scientific creativity test. Therefore equal variances not assumed were considered and Ho2 is retained.

Discussion of Results

The findings in Table 20 show that students of neither gender can be said to be better than the other in scientific creativity in biology despite boys having a mean that is slightly higher than that of girls. This implies that scientific creativity in biology education is not gender dependent. The results of this study show that boys had a higher mean score in scientific creativity in biology than girls. These findings are in agreement with studies carried out on biology students by Ndeke (2003) which found that boys had a higher mean score than girls. Likewise, Torrance (1983) found that gender differences in divergent thinking ability have changed over time. In the 1950's and 1960's boys outperformed girls on measures of originality, whereas girls surpassed boys on elaboration and most measures of verbal creativity (Torrance, 1962, 1965).

However the difference in means between boys and girls are not statistically significant meaning that gender has no influence on scientific creativity in biology education. These results are not in agreement with findings by Ndeke (2003) and Hungi (2009) in biology and Okere (1986), (1988) who found that there was a statistically significant relationship between scientific creativity and gender in favour of boys. They found out that in biology and physics scientific creativity was gender dependent. They also found out that the difference in scientific creativity in biology and physics was statistically significant in favour of boys.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMENDATIONS

5.1 Introduction

This study was aimed at determining the level of scientific creativity in biology education among form three students in Turkana County in Kenya. It further investigated the influence of culture and gender on scientific creativity among form three biology students in Turkana County.

Four instruments were used in the study namely; Biology Scientific Creativity Test (BSCT), Students' Culture Evaluation Questionnaire (SCEQ), Interview Schedule (IT) and an Observation Schedule (OS). This section presents a summary of the major findings, the conclusions and implications of the findings of the study. In addition the recommendations and suggestions for further research are also given.

5.2 Summary of Major Findings

The following are the major findings of this study based on the analysis presented in chapter four.

1. The level of scientific creativity in biology education amongst form three students in the study sample was low.
2. Of the four aspects of creativity under study, sensitivity to problems had the highest mean score followed by recognition of relationships, then planning for investigation and flexibility in reasoning had the lowest mean score.
3. Boys performed better than girls in overall scientific creativity test. Girls performed better in recognition and flexibility while boys in sensitivity and planning.
4. There was a statistically significant influence of culture on the level of scientific creativity in biology education.
5. The level of scientific creativity in biology is not gender dependent.

5.3 Conclusions

Specifically, the following conclusions were reached:

1. The level of scientific creativity in Biology education in Kenyan Secondary Students is low.
2. The level of scientific creativity is not gender dependent.
3. Culture influences the level of scientific creativity in Biology Education.

5.4 Implications of the Findings and Recommendations

The findings of this study suggest that the level of scientific creativity in Biology is generally low. This was attributed to some cultural practices, beliefs and values in the Turkana culture such as insistence on obedience to instructions given by adults, and children not allowed to learn by exploration among others. This may stifle scientific creativity in Biology education, Turkana culture being a collectivist culture. Scientific creativity may be fostered or hindered by cultural features such as individualism or collectivism and the value placed on conformity or tradition (William, Saiz, Formyduval, Munick, Fogle, Adom, Hague, & Yu, 1995). According to Triandis, McCusker, Bentancourt, Sumiko, Leung, Salazar, Setiadi, Sinha, Tozard & Zaleski (1993), individualist cultures value independence and self-reliance, which are important factors that foster creativity, whereas collectivist cultures emphasize obedience, cooperation, duty and acceptance of an in- group authority which stifle creativity. Ng (2001), proposed that the individualism – collectivism dimension can explain to a large extent differences in creative abilities levels for Westerners and Asians.

The findings further pointed that there was no statistically significant difference in scientific creativity in Biology education among the genders. The boys were found to be creative than the girls. It is hoped that this study will extend the ideas and findings reported in ways that will enrich our understanding of why there have been so much prominent men than women among those of the highest creative accomplishment. This will go a long way in helping in restructuring our schools and curriculum which will lead to less waste of human creative talent (Helson, 2004; Simonton, 1994). Therefore these findings may help in elimination of cultural blocks that limit creativity thereby leading to greater creative works and ideas in sciences necessary for industrial development and attainment of vision 2030.

5.5 Suggestions for Further Research

Further research is required to corroborate these findings, and more specifically in the following areas of concern.

1. The study should have a larger sample and more schools should be involved.
2. The study should be replicated in other counties and also involve other cultures in Kenya in order to find out whether these findings can be generalized to the whole country.
3. More studies can be carried out to find out other factors that may influence scientific creativity in biology education.

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APPENDICES

APPENDIX A: STUDENTS' CULTURE EVALUATION QUESTIONAIRRE

This questionnaire is about cultural practices, beliefs and values in your community. Read them carefully and give your honest responses. Information given is only for education purposes and will be confidential. Please be honest when providing the information being asked for. Respond to the questions by putting a tick (√) against the appropriate bracket or writing the information in the spaces provided.

NAME: …… CLASS: ……

SCHOOL: …… SEX: MALE ( ) FEMALE ( )

1. (a) List some of the cultural practices in your community used in children education and instruction.

   Cultural practices

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   (b) List some of the cultural beliefs used in your community in children education and instruction.

Cultural beliefs

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(c) List some of the cultural values used in your community in children education and instruction.

Cultural values

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2. In your community, is it acceptable to handle samples such as blood, saliva and other body wastes in determining the health of people and livestock?

YES ( ) NO ( )

Explain.

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3. In your community, are matters of reproduction and family planning discussed openly in the presence of children?

YES ( ) NO ( )

Explain.

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4. In your community do people prefer the use of traditional medicine to modern medicine?

YES ( ) NO ( )

Explain.

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5. In your community, are children allowed to question instructions given by Adults?

YES ( ) NO ( )

Explain.

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6. Some rules, practices and beliefs in your community conflict with biology knowledge taught in schools. Do you agree with this statement?

YES ( ) NO ( )

Explain your answer.

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7. Does your community allow children to learn through exploration?

YES ( ) NO ( )

Explain.

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8. In your community, are there teachings that are a reserve for boys or girls alone?

YES ( ) NO ( )

If YES, explain.

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9. During child development, some areas of education and instruction are handled by men or women alone. Do you agree with this statement?

YES ( ) NO ( )

Explain.

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THANKS AND GOD BLESS YOU

APPENDIX B: BIOLOGY SCIENTIFIC CREATIVITY TEST (BSCT)

SECTION A: Sensitivity to Problem Items

Instructions:

Below are scientific statements some of which cannot be tested scientifically. Study them to see whether or not they are correct. Then suggest how those that are not correct can be rephrased in such a way that they can be testable scientifically. Use the spaces provided after each statement.

1. Ghee is better for you than margarine.

Correct ( ) Incorrect ( )

Explain

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2. Boiled meat is more useful for you than roast meat.

   Correct ( ) Incorrect ( )

   Explain

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3. Fat people lead better lives than thin ones.

   Correct ( ) Incorrect ( )

   Explain

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4. The Normal process of giving birth is better than Caesarian Section.

   Correct ( ) Incorrect ( )

   Explain

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5. Use of Farmyard Manure is better for the soil than the use of Chemical Fertilizers.

   Correct ( ) Incorrect ( )

   Explain

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SECTION B: Recognition of Relationships Items

Instructions:

Answer the questions below in the spaces provided after each question.

1. It has been observed that, a dog weighing 15.2 kg requires 216 KJ while a mouse weighing 50 g requires 2736 KJ per day. Explain.

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2. Studies have shown that when the nucleus of a cell is removed, the cell dies. Explain.

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3. An experiment carried out by a Form one Biology class in Lodwar Boys have shown that when fresh water protozoa like amoeba is placed in distilled water it does not burst. Explain.

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4. Experiments have shown that lactic acid is produced during strenuous activity like running. Give two reasons why accumulation of lactic acid during vigorous activity leads to an increase in heartbeat.

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SECTION C: Flexibility in Reasoning item

Instructions:

Answer the question below in the spaces provided.

1. It has been noted that grasshoppers attract their mates by using sound whereas peacocks attract their mates by using colour.

   Suggest four possible reasons why grasshoppers use sound rather than colour.
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2. A rabbit escapes from predators by leaping left and right in a zigzag pattern while a honeybee stings the predators.

   Suggest three possible reasons why the rabbit runs in that manner rather than sting to escape from predation like the honeybee.
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   ……..

SECTION D: Planning for Investigations Items

Instructions:

In this section you are required to describe experiments that could be used to investigate the problems presented. In your explanations, you must say the following:

i. What would you use?
ii. What would you measure?
iii. How would you measure it?
iv. How would you use the results to arrive at a conclusion?
v. What do you think would make the results inaccurate apart from careless mistakes?

1. A group of students were investigating the number of Tilapia fish in a shallow pond using the capture recapture method. Describe how the students would go about this.

2. Some secondary school students wanted to find out if light is needed for pond weeds to grow. Describe how they would do this investigation.

APPENDIX C: FOCUSED GROUP INTERVIEW SCHEDULE FOR ADULTS

Focused group interviews will be guided by the following questions:

1. What are some of the cultural practices, beliefs and values in your community that are used in children education and instruction?

2. Are matters of reproduction discussed openly in your community?

3. Are children allowed to question rules and instructions given by adults in your community?

4. Are there specific roles that are assigned to boys and girls alone in your community?

5. Are children trained on the duties they are expected to perform in your community?

6. What are some of the skills taught to the youth in your community?

7. Do people in your community plan how to go about their daily activities?

8. What type of medicine do people in your community prefer to use and why?

9. Are children in your community allowed to learn through discovery?

10. What are some of the taboos in your community?

APPENDIX D: RESEARCH AUTHORIZATION

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349,310571,2219420
Fax: +254-20-318245, 318249
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9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI KENYA

Ref: No.

Date:

20th July, 2015

NACOSTI/P/15/9911/7048

Susan Akai Aruan
Egerton University
P.O. Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of culture and gender on secondary school students scientific creativity in biology education in Turkana County Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Turkana County** for a period ending **4th December, 2015.**

You are advised to report to **the County Commissioner and the County Director of Education, Turkana County** before embarking on the research project.

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

DR. S. K. LANGAT, OGW
FOR: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Turkana County.

The County Director of Education
Turkana County.

APPENDIX E: RESEARCH PERMIT

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 5884

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MISS. SUSAN AKAI ARUAN
of EGERTON UNIVERSITY, 3884-20100 nakuru,has been permitted to conduct research in *Turkana County*

on the topic: *INFLUENCE OF CULTURE AND GENDER ON SECONDARY SCHOOL STUDENTS SCIENTIFIC CREATIVITY IN BIOLOGY EDUCATION IN TURKANA COUNTY KENYA*

for the period ending:
4th December,2015

Applicant's Signature

Permit No : NACOSTI/P/15/9911/7048
Date Of Issue : 20th July,2015
Fee Recieved :Ksh 1,000

Director General
National Commission for Science, Technology & Innovation