LEARNING APPROACHES AND GRIT AS PREDICTORS OF CHEMISTRY ACHIEVEMENT AMONG FORM THREE STUDENTS IN KISII COUNTY, KENYA

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION (EDUCATIONAL PSYCHOLOGY) IN THE SCHOOL OF

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DECLARATION

I confirm that this research project is my original work and has not been presented in any other university or institution for consideration of any certification. The project has been complemented by referenced sources duly acknowledged. Where text, data (including spoken words), graphics, pictures or tables have been borrowed from other sources, including the internet, these are specifically accredited and references cited in accordance and in line with anti-plagiarism regulations.

Signature----------Date----------

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I confirm that the work reported in this project was carried out by the candidate under my supervision as university supervisor.

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DEDICATION

This project is dedicated to my late parents for inspiring me to aim higher in education and my wife Mary and children-Belden, Joan and Elsie for their sacrifices and understanding that enabled me to pursue postgraduate studies.

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ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
CGPA	Cumulative Grade Point Average
CTLA	Contextual Teaching-Learning Approach
ISIM	Inventory on Students' Interest in Mathematics
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
MANOVA	Multivariate Analysis of Variance
MAT	Mathematics Achievement Test
NACOSTI	National Commission of Science, Technology and Innovation
OCAT	Organic Chemistry Achievement Test
OLS	Ordinary Least Square
PLSPQ	Perceptual Learning Style Preference Questionnaire
SPSS	Statistical Package for Social Science
SRLS	Self-Regulated Learning Strategy
SSCE	Secondary School Certificate Examination
UCE	Uganda Certificate of Education
UNESCO	United Nations Educational, Science and Cultural Organization

A BSTRACT

Kenya aims to be an industrialized country by the year 2030. This can be realized by improving achievement in science related subjects chemistry being one of them. The knowledge and practical skills regarding purification, analysis, preparation and separation of chemical substances obtained from the study of chemistry play a critical role in innovations and technological development. Despite the crucial role, majority of secondary school students in Kisii County continue to register below average grades in this subject. A research focusing on grit and learning approaches may provide new ways of improving chemistry. The study's specific objectives were to: establish the relationship between learning approaches and chemistry achievement; find out the relationship between grit and chemistry achievement; test for gender differences in learning approaches and grit in relation to chemistry achievement; determine the predictive weight of learning approaches and grit on chemistry achievement. Framed around the learning approaches model and grit theory, a correlational research design was used with a target population of 3,320 form three students in 27 public secondary schools in Etago Sub-County in the year 2023. Purposive sampling was used to select Etago sub-county and form three class students taking chemistry. Stratified sampling technique was adopted to select the schools while simple random sampling was used to select students who participated in the study. The study was carried out in six public secondary schools using a sample size of 446 students. A pilot study involving 30 students from one of the schools within the Sub-County was conducted to refine the reliability and validity of the research instruments. Data were collected using questionnaires and chemistry pro forma forms and then analyzed using the Statistical Package for Social Science (SPSS version 25). The results revealed a moderate significant positive correlation between learning approaches and chemistry achievement, r (433) = .58, p< .05. There was a significant positive correlation between grit and chemistry achievement, r (433) = .65, p < .05. The result further indicated that there were no statistically significant gender differences in learning approaches and grit in relation to chemistry achievement. Learning approaches and grit significantly predict chemistry achievement, F (2,433) = 133.96, p < .05. The moderation between learning approaches and gender and grit and gender accounted for 5% variance in chemistry achievement .Change in R square was statistically significant $\Delta R^2 = .05$ $p < .05$. Gender does not significantly moderate the prediction of chemistry achievement from learning approaches and grit. Based on the findings, the study recommends that chemistry teachers should enhance the use of effective teaching aids to boost interest and perseverance (grit) and effective learning approaches during chemistry learning for better achievement in the subject.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

In this chapter, the following are presented; background to the study, statement of the problem, purpose and research objectives. The chapter also presents research hypotheses, significance of the study, limitations and delimitations, assumptions, theoretical and conceptual framework and operational definition of terms.

1.2 Background to the Study

Chemistry is one of the science subjects taught in secondary schools in different countries around the world. It entails the study of chemical composition, structures and properties of both natural and manufactured substances. The knowledge and skills acquired in studying the subject is of great value in this era of technology and innovation. The principles of chemical analysis, measurement and instrumentation prepare the learners with problem solving skills required to address pressing societal issues (Ali et al., 2020). As such, it forms a basis for development in technology that has become central in every aspect of human life. The world of business, education and medicine have all embraced the use of technological skills founded on the principles and concepts of chemistry as a science subject. The knowledge gained through the study of this subject is applicable in the manufacture of drugs, plastics, food substances, clothes and industrial chemicals (Wangui, 2017).

The social and economic development of any nation has been associated with greater innovations brought by science and technology (Adikwu, 2012). The improvement of science and technology has a strong correlation with science education and therefore, a

country's development largely depends on its commitment to improve the quality of science education and achievement. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), quality science education prepares the learners with required skills of finding solutions towards different challenges that face the nation (UNESCO, 2016).

Despite the importance of learning chemistry and the wide application of its knowledge in society, a substantial number of secondary school students in different countries across the world continue to achieve unsatisfactorily in the subject. In the United States of America (U.S.A), Trends in International Mathematics and Science Study (TIMSS, 2019) reported a dismal achievement in science assessment as compared to other countries like Singapore. The report further revealed that the science assessment score among the grade four learners was 539 compared to 500 average scale in TIMSS internationally.

A report by Nkiko (2021) revealed that science subjects were achieved below average among University students in Nigeria. The researcher established that the negative attitude and low level of interest and perseverance towards sciences contributed to below average achievement in science subjects. The study pointed out that this worrying trend of achievement threatened the availability of human resources and effectiveness in science related industries particularly chemistry.

A study conducted by Ojukwu (2016) established that the achievement level of chemistry in Nigeria remained consistently low in senior Secondary School Certificate Examination (SSCE). The ineffective learning strategies in chemistry by majority of students was observed as the main factor that affects the achievement of the subject hence need for the current students. A study by Alfred (2023), revealed below average

achievement in science subjects despite an increased effort by the Ugandan government to foster the achievement. The national examination conducted under the Uganda certificate of Education body (UCE) indicated that science subjects were achieved below the expectations compared to the art subjects.

In Kenya, Malala et al. (2021) study in Bondo sub-county observed that there is dwindling achievement in chemistry. According to the research, the results of chemistry in the national examinations over years have been continuously decreasing in most counties within the country. The research pointed out that inadequate resources and unconducive learning environment were among the factors that contributed to such declining achievement in chemistry.

In Kisii County, there are also concerns about below average achievement in chemistry. The study by Mochire and Sabellah (2018) showed that majority of the secondary school students were achieving dismally with many of the students getting low grades in the KCSE examinations. The Table 1.1 below shows the KCSE mean scores of science subjects for the year 2018, 2019, 2020, 2021 and 2022.

Table 1.1

Students' KCSE Mean Scores in Physics, Biology and Chemistry in Etago Sub-County.

	Year				
Subject	2018	2019	2020	2021	2022
Physics	2.27	2.66	2.55	2.80	3.06

Biology	2.27	2.05	2.11	2.40	2.68
Chemistry	1.82	1.94	1.92	1.91	1.80

Source. Etago Sub- County Education Office Examination Report (2022)

The Table 1.1 above demonstrates that the KCSE mean scores in chemistry for the last five consecutive years have been below average. The report similarly indicated that chemistry was the worst performed science subject among the three science subjects. Numerous factors that have contributed to such below average achievement in chemistry among students have been identified. They include; inadequate learning resources, learning strategies, attitudes among other factors (Ojukwu, 2016; Oluoch et al., 2018; Malala et al., 2021). However, there is a scarcity of the literature on the relationship between learning approaches, grit and chemistry achievement.

Chemistry achievement has also been associated with the learning approaches employed by students. Learning approaches refers to different strategies applied by students during their learning process. These strategies have a great influence towards academic achievement of learners. Diseth (2007) defined the learning approaches as objectives, intention or motive of a learner towards undertaking a task in academics and the policies involved in fulfilling the set objectives. Two domains of learning approaches exist; surface learning approaches and deep learning approaches (Marton & Saljo, 1997). Deep approach is guided by the desire to carry out a work in a suitable and effective manner while the surface approach works on the principle of completing task regardless on the level of achievement attained by the student at the end of the task.

A study by Ardura and Galan (2019) revealed that surface approach influenced achievement in chemistry more than deep approach mode of learning. Learners who adopted surface learning approach scored better grades compared to those who embraced deep learning approach. Olic et al. (2019) conducted a study, which established discrepancies in the relationship between surface and deep learning approaches in academic achievement. The study indicated a strong association between academic achievement and deep learning approaches. The researcher further revealed that the majority of students used deep learning approaches compared to surface learning approaches. The current study sought to explore the relationship between both subscales of learning approaches and chemistry achievement.

The concept of grit is significant in educational research. It is defined as the power of passion and perseverance (Duckworth, 2007). According to Duckworth, grit was categorized into two subscales; interest and perseverance. Students with both domains of grit develop strong motivational beliefs in enhancing skills and acquiring new knowledge (Oluoch, 2018). Such learners perceive are positively motivated and willing to undertake activities to achieve academic goals. On the other hand, perseverance is based on demonstration of ability and hard work to attain set objectives. Students with persevering trait perceive failure positively and regard ability as fixed. They go for challenging tasks that can make them think critically during learning process. Sibarani and Meilani (2020) study showed a positive relationship between grit and academic achievement among the college students.

The study also examined the prediction of gender as a moderator variable in chemistry achievement from both learning approaches and grit. Previous studies have shown that male and female students adopt different learning approaches. A study by Zhonggen Yu (2021) on the impact of gender, educational attainment, and personality on online

learning in China, confirmed that female students preferred a consistent face-to-face learning method as compared to the male students who preferred online method. Different scholars have also carried studies on the relationship between grit and gender among learners. Frontini et al. (2021) study on gender differences in grit and mindset among the undergraduate students in Norwegian university reported a significant gender difference in passion, grit and growth mind set. Past studies have indicated that chemistry achievement can be predicted by learning approaches and grit, though; the variables have been studied independently. Ibitham (2020) established that students learning approaches correlates positively with academic achievement in chemistry in Nigeria. Furthermore, Irine and Aloysius (2023) revealed that grit predicts students' academic achievement particularly in science subjects. The findings indicate that learning approaches and grit may be used to predict chemistry achievement among learners. Therefore, in the present study, the researcher examined how learning approaches and grit predict chemistry achievement among form three students in Kisii County, Kenya.

1.3 Statement of the Problem

The Students' achievement in chemistry in the majority of schools within Kenya has constantly remained below average. In Etago Sub-County, for the last five consecutive years (2018 to 2022), approximately 90% of the candidates who sat for the KCSE examination scored a ranking of D or lower in chemistry.

In addition, the national examination chemistry average scores of the Sub-County in the year 2018, 2019, 2020, 2021 and 2022 were 1.82(D-),1.94(D-), 1.92(D-), 1.91(D-) and 1.80(D-) respectively, all these were below average. This is upsetting achievement to the society, which expects a lot of innovative skills and knowledge through the study of chemistry. The below average achievement has raised concern among education

stakeholders. This is because the school system is producing majority of the graduates who are inadequately equipped with practical skills that are required in the world of work and problem solving in everyday life. These students may miss opportunities to contribute optimally towards social and economic development. This may lead to a cycle of poverty and low quality of life. If this problem continues unaddressed, the country may have a shortage of skilled professionals in chemistry and related fields.

Educational researchers have made efforts to address the problem and several factors from different studies have been identified. Such factors include negative attitude, low level of motivation, low ability, ineffective instructional methods, and inadequate learning resources among others. Due to persistency dismal achievement in chemistry among the learners in Kisii county and more particular Etago sub-county, there is need to dwell more in research on how various psychological variables contribute to achievement in chemistry. There is scarcity of studies on extent to which learning approaches and grit contribute to chemistry achievement. This prompted the need for the present study that focused on the extent to which learning approaches and grit predicted chemistry achievement among secondary students in Etago sub-county, Kisii County.

1.4 Purpose of the Study

The aim of this study was to establish the predictive power of learning approaches and grit towards chemistry achievement among secondary school students in Etago Sub-County, Kenya.

1.5 Research Objectives

The following research objectives guided the study:

i. To establish the relationship between learning approaches and chemistry achievement among form three students in Etago sub-county.

ii. To find out the relationship between grit and chemistry achievement among form three students in Etago sub-county.

iii. To test for gender differences in learning approaches and grit among the form three students in Etago sub-county.

iv. To determine the predictive equation of chemistry achievement from learning approaches and grit among the form three students in Etago sub-county.

1.6 Research Hypotheses

The research alternative hypotheses, which guided the study, were:

H_{a1} There is a relationship between learning approaches and achievement in chemistry among the form three students in Etago sub-county.

H_{a2} There is a relationship between grit and achievement in chemistry among the form three students in Etago sub-county.

H_{a3} There are gender differences in learning approaches and grit among form three students in Etago sub-county.

Ha_4 Learning approaches and grit predict achievement in chemistry among the form three students in Etago sub-county.

1.7 Significance of the Study

The results obtained from the survey may aid teachers and students in identifying most appropriate learning approaches that will stimulate the students' interest in learning chemistry. This will advance the achievement in chemistry in schools. The study may also be beneficial to the guidance and counseling teachers in school, parents and teachers on the best ways to design the learning environment with academic activities both at home and in school to effect learning in chemistry. The outcome would be crucial to the school management and other administrative bodies on the level of chemistry in schools, grit and learning methods applied by students. This may help in decision making towards the chemistry achievement in schools. In addition, the study findings may contribute to the academic literature gap on predictors of achievement in chemistry among students. This may be useful to other researchers conducting related study.

1.8 Limitations and Delimitations of the Study

1.8.1 Limitations of the Study

The study used self-report questionnaires to collect data, which might have resulted to subjective responses. In order to address this issue, to boost the trustworthiness of the respondents, the researcher explained the study's purpose to the participants. Secondly, a few public secondary schools within Etago sub-county were involved in the study. The fact that secondary schools adopt different learning cultures, then the findings obtained from the study may not be generalized to other public secondary schools. The correlation design was used during the study, which could not show the cause effect relationship between grit and learning approaches in the chemistry achievement.

1.8.2 Delimitations of the Study

The study only focused on learning approaches and grit as the psychological variables predicting chemistry achievement among students. This was due to the absence of local studies on how the two variables influence the achievement of chemistry. The study was delimited to form three students in Etago sub-county. This was because the sub-county has been performing below average in K.C.S.E for the last five consecutive years. Additionally, the study considered sex of the participants as the only moderator variable.

1.9 Assumptions of the Study

The study's underlying presumption was that the participants provided honest self-report data regarding their learning approaches and grit. It was also assumed that variations in chemistry achievement among learners was due to different levels of grit and learning approaches. Furthermore, it was deemed that the measuring instruments used were valid in measuring learners learning approaches, grit and chemistry achievement.

1.10 **Theoretical and Conceptual Framework**

1.10.1 Theoretical Framework

The learning approach model by Marton and Saljo (1976) and grit theory by Duckworth (2007) guided the study.

1.10.1.1 Learning Approaches Model (Marton & Saljo, 1976)

Learning approaches are methods or guidelines designed to link the learning environment and the styles in which the learning process take place. It deals with the motivational level of the learner and the strategies used during learning process. Marton

and Saljo (1976) proposed the concept of learning approaches and its model. According to the model, two major categories of instructional approaches exist; surface approach and deep approach. The proponents further argued that the type of learning approach depends on th e characteristic of the learners, the learning environment and the learning outcome among other variables. Deep learning approach students tend to be self-driven as compared to those who embrace surface learning approach. They score highly in academics than those who adopt surface approach style of learning. Learners who adopt deep learning approaches, have intellectual curiosity towards new knowledge. These learners associate academic work to personal experience and view it as part of personal development. Those who adopt surface learning approach memorize most of the learning facts and accept them without questioning. Deep learning approach learners are generally intrinsically motivated compared to those embracing surface learning approach.

Deep learning approach has been further classified into two categories; active deep and practical deep learning approaches. Active learning approach entails the interaction with the course materials, through discussions in class and problem solving as part of engagement methods. Most learners who perform above average in chemistry and gain knowledge that help them to pursue science courses are those who engage themselves in deep learning approaches that help them to explore much of the chemistry learning concepts and practical skills by their own (Ozgur & Yilmaz, 2018). Similarly, there are two types of surface learning approaches: the technical surface approach and the submissive surface method. Submissive surface approach learners memorize most of the information learnt in school. Such learners are neither willing to learn the subject nor putting effort that is required in learning process.

Lastusaari et al. (2016) further argues that technical surface learning is an active mode of learning that involves learner's abilities in memorizing learning information by actively using different memorization techniques. Many studies have been conducted using learning approach model. Puteh et al. (2018) explored the relationship between learning strategies and academic achievement among students. Result showed that learning approaches significantly influence the academic achievement of learners. This model is appropriate to the study because it explains how the social environment influences the learning approaches that students adopt while learning chemistry. It also further asserts that all students are able to understanding chemistry concepts when exposed to appropriate learning approach model.

1.10.1.2 Grit Theory (Duckworth, 2007)

Duckworth defined grit as the passion and sustained persistence towards the achievement of long-term goals without any attachment for rewards or recognition. It comprises of resilience, ambition and self-control in the pursuit of long-term achievements in life. Grit was also perceived as the inner drive that guides a person towards achieving a goal that an individual cares about so much. The proponent of the theory posited that students' academic success was majorly guided by interest and perseverance. Duckworth et al. (2007) investigated the importance of intellectual talents, perseverance and interest towards professional achievement among the adults. The result obtained suggested that the achievement attainment of challenging tasks requires the persistent, careful utilization of talents throughout time. The study further showed that, student's interest and perseverance was directly related to learning outcomes. Krap (1992) study indicated that interest-based motivation had a positive relationship in both learning process and the outcome of learning. Student's interest in

learning determines the amount of time invested in understand learning content and the kind of resources mobilized to enhance learning.

Perseverance on the other hand is described as the ongoing desire to accomplish objectives and enhance abilities in achievements through steadfast efforts (Dweck, 2017). According to Duckworth et al. (2010), perseverance is perceived as a capacity to stick in the face of diverse difficulties. Studies conducted have shown that perseverance is a crucial component required for the success of academics. A study by Caroyn (2014) indicated that learners who persevere in their studies engage in learning complex tasks, explore new ideas in their educational endeavors and enhance competence in academics. This is because they believe that competence and success are achieved over time through consistence practice and effort.

Silvervarg et al. (2018) also carried out a study anchored on perseverance towards learning and established that high-persevering students completed noticeably more tasks as compared to low-persevering learners. It therefore suggest that learners who are persevering adopt self-regulated learning strategies that enhances their academic achievement. This theory is appropriate to the proposed study for it provides a theoretical underpinning on the purpose why students engage in chemistry learning tasks. It also provide an explanation as to why students double their efforts and stick with tasks even if they are challenging in the course of studying chemistry. Students with both interest and perseverance domains towards learning of chemistry view errors made in learning as normal and uses them as motivators to improve academically. Those who lack interest and perseverance perceive mistakes committed during learning as a sign of failure and incompetence.

1.10.2 Conceptual Frame Work

Figure 1.1 shows the conceptual framework.

Figure 1.1

Model for the Link between Grit, Learning Approaches and Chemistry Achievement

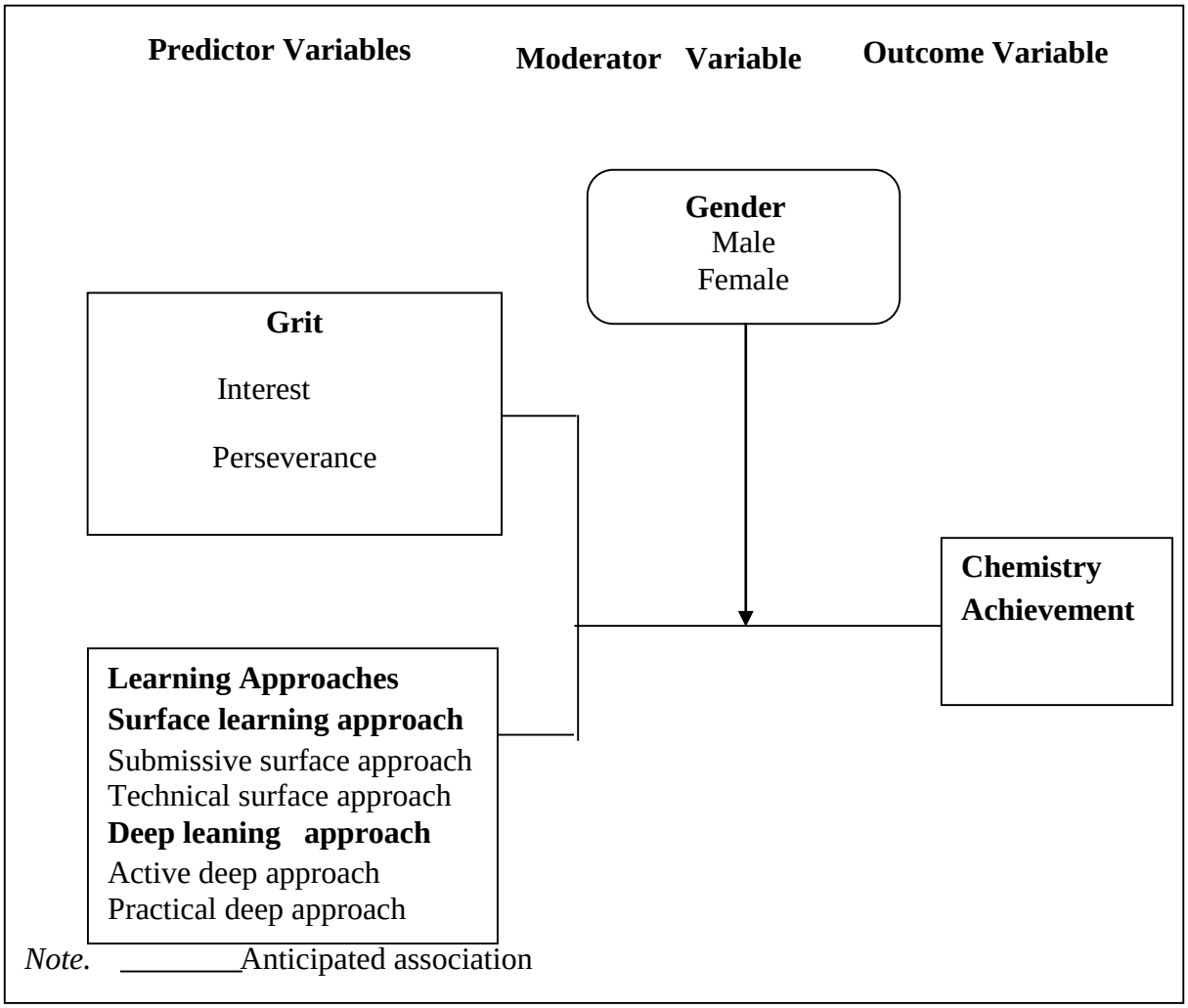

Figure 1.1 shows the relationship between outcome variable and predictor variables. Grit and learning approaches were the predictor variables while chemistry achievement was the outcome variable. Grit was measured at two sub domains; interest and perseverance. Learning approach was also measured at two sub domains; surface and deep learning approaches. The researcher hypothesizes that the two predictor variables;

grit and learning approaches influence chemistry achievement. The student gender was the moderating variable. The researcher further hypothesized that there were gender differences in learning approaches and grit as predictor variables and chemistry achievement as the outcome variable.

1.10 Operational Definition of Terms

Term	Definition
Chemistry Academic Achievement	Refers to the student's proficiency level attained in chemistry knowledge. It is measured in terms of the grades attained in chemistry in K.C.S.E examination. The grades scored by the students range from A of 12 points to E of 1 point.
Grit	Relates to a learner's grade on the passion and perseverance to understand chemistry concepts. Measured through summation of all the scores obtained from the scale of Angela Duckworth (2007).
Learning Approaches	Refers to the students score on the adopted strategies in learning that are based on either reproducing the learnt concepts or understanding the concepts. Measured from the addition of all the scores obtained from Lastusaari et al. (2016) scale.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter presents pertinent literature based on the study objectives of the study. It also includes a review of related literature on learning approaches, grit and students achievement in chemistry. The chapter ends with identification of research gaps.

2.2 Relationship between Learning Approaches and Achievement in Chemistry

Many educational researchers have not conducted the study on the relationship between learning approaches and achievement in chemistry. Majority of the relevant studies have concentrated on the relationship between learning approaches and academic achievement in different disciplines of study such as mathematics, reading ability and biology. Furthermore, most of these studies have used a sample of university students whose academic structure is different from secondary school students.

Miyuki et al. (2021) conducted a meta-analysis study to investigate the association between learning strategies and academic success among nursing students in Japan. The analysis included a systematic review and a quantitative synthesis among 11 selected studies from various learning domains. The meta-analysis findings showed a strong and substantial correlation between learning strategies and students' academic success. Further, the research demonstrated a positive significant relationship between the academic progress and learning techniques applied among medical students. This study

was carried out in Japan, with a different academic set up and cultural environment from those of Kenya. Further, the study findings are important because they demonstrate the relationship between learning styles and academic success. However, learning approaches and chemistry achievement variables examined by the present research were not considered. The current study was therefore necessary to bridge the knowledge gap.

Salhoobi (2021) carried out a quasi-experimental design study to examine the influence of flipped classroom (FC) learning approach on the chemistry achievement among the secondary school students in New York State, U.S. The study had a target population of all 10^{TH} grade chemistry students in the general level classroom. Purposeful sampling was used in selecting two teachers and 90 students who participated in the study. Data were gathered using the Multiple-choice assessments .The obtained data scores of the two groups from the prior assessment and post assessment were analyzed using a series of four two-way ANCOVA tests. The outcome showed a positive correlation between the learning approach strategy and academic achievement in chemistry. The study only used conveniently a small sample size of 90 students that may have been subject to sampling error (Sovocool et al.,2018), Studies carried out employing a large sample size may be of great help in finding out the relationship between learning approaches and chemistry achievement among secondary school students.

Olic et al. (2019) examined the association between levels of learning approaches and chemistry achievement among university learners in Serbia. The study examined a sample size of 46 students from the science department. The data were obtained using questionnaires and then was analyzed using descriptive statistics. Regression analysis was also used to examine the impact of learning strategies on chemistry achievement.

The results revealed that deep approach mode of learning had a significant correlation towards chemistry achievement. The study-involved university students with relatively a small sample size of 46 students, hence were empirical studies were needed with relatively a large sample size from secondary school students to compare the findings.

A study by Samuel and Obikizie (2020) investigated how Nigerian students' achievement in Chemistry was correlated by the contextual teaching-learning approach (CTLA). The study employed Quasi-experimental design with a sample size of 129 students obtained from six different learning institutions within Anambra State in Nigeria. Data were collected using questionnaires, and analyzed quantitatively and qualitatively. The findings obtained showed a significant positive correlation between CTLA and chemistry achievement among students in Nigeria. The reviewed study examined contextual teaching-learning approach method while the current study investigated the relationship between learning approaches and chemistry achievement among the Kenyan students.

Another study carried out in India by Pradhan (2021) analyzed the impact of collaboration learning approaches and chemistry achievement of secondary school learners. The study embraced experimental inquiry design with a sample size of 30 students who were randomly selected from the secondary schools of Mayurbhanj District, Odisha. The achievement test was designed with 40 objective items that were then administered to the selected sample. The data obtained were then analyzed using different statistical techniques. The results obtained revealed that collaborative learning strategies had a positive effect on the students' chemistry achievement. In order to fill the research gap and advance chemistry knowledge towards learning chemistry, the current study focused on the relationship between learning approaches and chemistry

achievement. Furthermore, the age and academic structure of the respondents required for a related study in Kenya using a sample of secondary school students.

Leticia (2020) conducted a correlational study to examine the link between accounting students' learning styles and academic success at Cape Coast University in Ghana. During the study, 154 fourth-year students were used as the sample size. The cumulative grade point average was used to collect data on academic achievement, while the Study Skills Inventory for Students was used to gather information on students' learning styles. Descriptive analysis was done using the mean and standard deviation. Hypothesis testing was also done using Pearson's product moment correlation coefficient. The result obtained indicated that surface learning approaches had an inverse relationship with academic achievement. The reviewed study focused on academic achievement as the outcome variables among the university students unlike the current study that focused on chemistry achievement among the secondary students to bridge the knowledge gap for the study.

In Rwanda Sibomana (2021) carried out a research to examine the influence of cooperative learning on secondary school chemistry achievement. The experimental design was adopted and a sample of 257 students was used to conduct the study. The Organic Chemistry Achievement Test (OCT) was utilized to collect data, which was then analyzed using the Summary of Product Safety Standards (SPSS) and MS Excel 2016. The study's findings revealed that students who adopted a cooperative learning approach demonstrated greater achievement in chemistry. The study adopted experimental research design that used relatively small sample of 257 students, which may have affected the results of the study. The present study used correlational research design with a large sample size of 446 students in Kenya for more conclusive findings in the local context.

Majiwa et al. (2020) took a study to determine how secondary school students in Mandera Central Sub-County, Kenya performed in mathematics after being exposed to constructivism as a learning technique. The sample size of 222 students was used with a target population was 2,573 participants; the study employed an experimental research design. With the help of SPSS version 24, the quantitative data was examined using descriptive statistics. The results showed that the constructivism learning technique by students had a positive significant correlation on mathematics achievement. However, the current study was centered on chemistry achievement, unlike the reviewed study, which examined the achievement in mathematics with different content and methodology of teaching.

2.3 Relationship between Grit and Achievement in Chemistry

The relationship between grit and achievement of chemistry has been the subject of attention to many researchers. A descriptive-correlation design study was conducted by Christopher (2020) to examine how grit, self-efficacy and goal orientation is related to university students' academic achievement (Mathematical Statistics Achievement) at Nueva Ecija University in the Philippines. The study employed the Survey-questionnaires and the achievement test in statistics for data collection. The data were examined using a variety of techniques, including standard deviation, percentages, t-test, an ANOVA, stepwise multiple regression analysis, and Pearson r. The outcomes showed a substantial positive association between grit and success in mathematical statistics. The reviewed study was conducted among university students and sub-levels of grit (interest and perseverance) were not given much attention in the prediction of chemistry achievement. Informed by these studies, the present study examined the extent to which domains of grit are associated to chemistry achievement to address the existing gap.

A research project conducted by Usman et al. (2021) examined the correlation between grit and achievement among pharmacy graduates in Malaysia. The study used a sample size of 247 college students. A computerized, validated, and customized short grit scale was used to gather the data, which covered the period from 2019 December to 2020 January. The participants did a self-report on their grit towards academic achievement and their cumulative grade point average (CGPA) was established. The findings showed a strong correlation between grit ratings and academic success, as well as a consistent enthusiasm in learning. The reviewed study may not be generalized to secondary school students since the sample was drawn from university students with their own academic system. The current study focused secondary school students for geralization purpose to fill the literature gap of the study.

Mikyoung (2022) did a study to determine how much grit and socio-cognitive mindfulness affect affective achievement among nursing students enrolled in Kwangju Women's universities, Korea. The research used a cross-sectional approach. The sample size of 220 nursing students participated during the study of whom 102 were sophomores while 118 were junior students. Data were gathered using the emotional achievement exam, along with questionnaires created to gauge grit and socio-cognitive awareness. The findings obtained showed that grit was positively correlated with socio-cognitive mindfulness and achievement sentiments. In contrast to the current study, which focused on chemistry achievement as the outcome variable, the reviewed study focused on cognitive mindfulness and emotions achievement among medical students.

Edoka et al. (2020) examined the relationship between grit and parental monitoring on academic success among undergraduate students in South-Eastern Nigeria. The study employed correlational research design with a sample size of 203 students. Multiple regression was used to analyze the collected data. The findings suggested that grit and

academic success had a positive significant correlation. The analysis further showed that there was no correlation between parental supervision and achievement in school. The reviewed study focused on grit and academic success while the present study focused on achievement in chemistry to address the knowledge gap.

In China, Wang (2020) did a study to establish the effect of IQ and Grit on academic attainment among the students from rural and poor background families in China .A sample size of 2931 students who were randomly selected participated during the study. To assess the kids' cognitive abilities, the Raven's standard progressive matrices and the Wechsler intelligence scale were used. A circular-based mathematics test was used to gauge academic competence, while the grit scale was used to gauge non-cognitive abilities (or "grit"). According to the results, typical pupils' academic achievement was positively impacted by IQ and grit. The results further supported the idea that grit was negatively correlated with academic success among individuals with low IQs .However, the study did not examine the relationship between learning approaches, grit and chemistry achievement, an academic gap that the present study sought to fill.

In Kenya, there is a scarcity of research on the correlation between grit and chemistry achievement. A related study conducted by Brigid (2022) examined the relationship between grit and academic achievement among high school students in Bungoma, Kenya. A correlational research design was used with a sample size of 72 students. Data were collected using grit questionnaires and then analyzed using ordinal logistic regression. The result obtained demonstrated that achievement in chemistry was significantly predicted by the student's grit. The reviewed study used a small sample size of 72 students that was not appropriate for generalization, unlike the present study that used a relatively larger sample size of 446 participants to allow generalization from the findings.

2.4 Gender Differences in Learning Approaches and Grit

This section presents related literature on gender differences in learning approaches and grit

2.4.1 Gender Differences in Learning Approaches

Several studies have been conducted on gender differences in learning approaches and achievement in chemistry but contradictory results have noted.

Ahsanah (2020) carried out a study to establish on how gender and age differences relate with strategies used in language learning among the junior and senior high school students in Indonesia. A quantitative study design was adopted with a sample size of 118 students participating in the study. Data were gathered using the SILL (Strategy Inventory of Language Learning) and interviews. With the help of SPSS software version 20, the independent samples T-test, and the Mann Whitney U-test, the obtained data were analyzed. The results showed that there was no discernible difference between the preferences of male and female for language acquisition methodologies. The reviewed study, nevertheless, focused on languages, as opposed to the current study, which examined the achievement in chemistry among secondary school students.

Tebello and Som (2021) carried out a study to determine on how Teacher inequalities by gender, and age, influence learning practices among the undergraduate students in the university of Lesotho. A sample size of 312 students selected by quota sampling method participated in the study. Descriptive research design were adopted during the study. For data collection, a questionnaire containing 37 items was designed with four levels of learning techniques (classroom practices, studying practices, evaluation practices, and academic integrity activities). A one-way analysis of variance and the independent samples t-test were used to analyze the data using descriptive and

comparative statistics. The results showed that the only instructional strategy with a discernible gender difference in students' learning strategies was academic integrity practices. However, there was no significant gender difference in all other learning practices. Due to cross-cultural differences that exist in educational systems and policies among different countries, there is need for the present study to provide more information on gender differences in learning approaches and grit within Kenya.

Bayiga and Sarah (2021) explored the association between gender differences on vocational education in Luweero district, Uganda. During the study, a descriptive cross-sectional survey design was adopted. The sample size for study was selected using simple random sampling and selective sampling procedures. After that, data were collected by the use of questionnaires that had both closed and open-ended questions. The numeric data was analyzed using frequency tables and percentages, while the qualitative data was analyzed using content analysis and statistical software for social scientists (SPSS).The findings showed that there were no significant differences in attitudes toward vocational education between male and female learners. The findings revealed that there was no substantial gender differences in vocational education among learners. However, this was a contradictory outcome from other studies hence the need for the current study.

In Kenya, Mutua and Oyoo (2020) carried out a study on the relationship between gender differences and learning strategies among the secondary students. The study used explanatory sequential mixed methods design with 488 form three learners from Nairobi County as the sample size. Data were obtained using the designed questionnaires and interviews. The findings showed that both rehearsal and elaboration learning techniques differed significantly by gender. Further, the study established no discernible gender disparities in organizational learning practices. Given that the study

was delimited to learning strategies, a related study in both learning approaches and grit in relation to gender differences was necessary to add to the existing knowledge.

2.4.2 Gender Differences in Grit

Studies by different researchers have been carried out to examine gender differences in grit. However, remarkable inconsistencies in the findings has been obtained. In Chinese Xiayu (2020) carried out a study on the association between gender and subdomains of grit. A sample size of 1009 Chinese undergraduate students participated in completing self-assessment questionnaires that were used for data collection. The data was subsequently analyzed using a linear regression model, which revealed a correlation between grit (persistence and perseverance) and gender in relation to the support of teacher autonomy and social competency .The result further indicated that the lower levels of grit was only significant for male students but not for the female students. The reviewed study involved university students with advanced cognitive faculty, unlike the current study that used adolescents in secondary school.

Oluyemo et al. (2020) investigated the relationship between gender differences and mathematics interest (grit) and achievement among the junior secondary schools (JSS) in Nigeria. The research was conducted using a correlational survey method with a target population of 5,368 learners. A sample size of 361 students were chosen to take part in the study using a multi-stage stratified random sampling process. The mathematics achievement test (MAT) and an inventory on students' interest in mathematics (ISIM) were applied to assemble data during the study. The data obtained was then analyzed using chi-squarest-test,biseria correlation and simple regression of ordinary least square (OLS). The research findings showed that male students performed better in mathematics interest and achievement as compared to the female

students. However, the reviewed study explored on mathematics interest and achievement unlike the present study that focused on chemistry achievement to bridge the knowledge gap.

2.5 Learning Approaches and Grit as Predictors of Academic Achievement in Chemistry

There are limited studies that have been carried out on how learning approaches and grit jointly predict achievement in chemistry. However, some studies have been conducted separately on how learning approaches and grit predict chemistry achievement. The current study was informed by the findings of these studies in order to investigate the prediction of chemistry achievement from learning approaches and grit to bridge the knowledge gap. Yaure et al. (2021) carried out the longitudinal study to establish how college students' grades are determined by their level of grit in USA. The quantitative research approach was utilized to assemble data from the students using grit questionnaire. The students' academic achievement was measured using GPA. Data analysis was performed using regression analysis and the findings disclosed that grit significantly envisaged academic success. The study was done among the college students in the US, and then the researcher proposed the same study to be conducted in secondary schools to find out whether the same results could be obtained to help learners improve their achievement in chemistry.

Victor et al. (2020) investigated how predict-explain-observation-explain (PEOE), Vee Heuristic (VH), discussion strategies, and other interaction effects of treatments and gender influenced organic chemistry achievement among secondary school students in Ekiti State, Nigeria. The study involved a sample size of 308 students in. The analysis

of covariance (ANCOVA) method was used for data analysis that was collected using the Organic Chemistry achievement Test (OCAT). Predict-explain-observation-explain (PEOE) and Vee Heuristic techniques were found to have a substantial impact on the students' ability to learn organic chemistry, according to the findings there was no discernible interaction between therapy and gender that would have affected the students' achievement in organic chemistry. The present study was conducted on the prediction of learning approaches towards chemistry achievement among secondary school students, whereas the reviewed study focused on the influence of learning approaches and other academic techniques on the achievement of organic chemistry.

Oduol et al. (2022) study in Kilifi County, Kenya focused on how learning approaches predicted academic success among students of form two in Kaloleni Sub-county,Kilifi county, Kenya. A correlational design was used a sample size of 320 students who were randomly selected. The GOAL-S scale and the cumulative mean grade of the academic achievement were used for data collection. The data were then analyzed using the SPSS version 21, the Pearson's coefficient and regression analysis. The result showed that academic achievement was predicted by the learning approaches used during learning process. The reviewed study focused on general academic achievement unlike the present study that focused on chemistry achievement among secondary school students in Kisii County.

2.6 Literature Reviewed Summary and Gap Identification

Many of the study literatures reviewed largely focused on learning strategies and academic achievement as the predictor and outcome variables. The reviewed literature further showed that learning strategies could have both negative and positive significance on academic achievement. However, there was little research on the relationship between learning approaches and grit in relation to chemistry achievement

among secondary school students. Additionally, the majority of the studies were conducted among university and college students where different instructional and study approaches were used which may affect learning outcome compared to secondary schools. Some of the studies reviewed reported contradictory findings of both negative and positive significant relationship hence the need for the current study.

The literature on the association between chemistry achievement and grit is scanty. Majority of related studies concentrated on the connection between IQ and academic accomplishment, self-efficacy, goal orientation, and parental supervision. The intent of the current study remained to ascertain the relationship between learning approaches, grit and chemistry achievement among secondary school students in Kenya. Majority of the studies conducted on gender differences showed that there was no substantial gender variance in learning approaches and grit. Different other studies indicated contradictory findings between the two predictor variables and chemistry achievement. For more knowledge in this are to eradicate the contradiction, there was need for the current study.

The extent to which learning approaches and grit jointly predict chemistry achievement among the secondary students has not been explored. Most related reviewed studies focused on the above constructs separately with regard to academic ability. The present research focused on how learning approaches and grit simultaneously predict chemistry achievement.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the research design, variables and the location of the study are presented. The chapter also presents the target population for the study, sample size and sampling procedures, pilot study, the research instruments used for data collection, logical and ethical considerations.

3.2 Research Design

This research adopted predictive correlational research design. Simon and Goes (2013) contend that correlational design is appropriate in a study where manipulation of the independent variables is not possible due to ethical reasons. The design also helps the researcher to examine the degree and direction of the relationship between two or more

variables (Fraenkel et al., 2015). Data were collected by the use of questionnaires and chemistry pro forma. The study's design was acceptable and helpful in gaining a general understanding of the association between chemistry achievement among secondary school students, grit, and learning approaches. The study further investigated whether gender moderated the relationship between learning approaches and grit for chemistry achievement.

3.3 Research Variables

Predictor variables were learning approaches and grit. Learning approaches were measured at two sub domains; surface approach and deep approach while grit was also measured at two sub domains; interest and perseverance. The predictor variables were evaluated at the interval level using a five point Likert scale. The outcome variable was Chemistry achievement. This variable was measured at interval level using the scores of the students in the end term chemistry examination. Students' gender was the moderator variable, which was categorized as either male or female.

3.4 Location of the Study

The study concentrated on public secondary schools located in Etago sub-county (Kisii County) which had a steady decline in chemistry achievement from 2018 to 2022. The statistics revealed that approximately 81% of the candidates score below grade D in chemistry in the national examination every year. The Sub-county has always been ranked the last among the eleven Sub-counties in Kisii County over this period as shown in Table 3.1.

Table 3.1

K.C.S.E Chemistry Results for the Period 2018 and 2022

Sub Counties	2018	2019	2020	2021	2022
Kisii Central	3.90	3.35	3.23	2.76	3.37
Masaba South	3.11	3.41	2.59	2.38	3.46
Nyamache	3.28	3.05	3.56	4.30	3.65
Kenyenya	3.14	3.62	3.11	3.23	3.34
Etago	1.82	1.94	1.92	1.91	1.80

Source. Kisii County Education Office Examination Report (2022)

Table 3.1 indicates that Etago sub-county has been registering comparatively below average achievement in chemistry from the year 2018 to the year 2022. The mean scores registered in the five consecutive years were below average and this called for the present study to investigate the factors for such achievement. There is scanty research in Kisii County that examines the below average achievement. However, a related study by Bitok (2019) recommended further studies on other factors that influence learning of chemistry and therefore the current study focused on learning approaches and grit in Etago Sub County to fill the gap.

3.5 Target Population

The study targeted 27 public secondary schools in Etago Sub County in Kisii County with 3,320 form three students. The form three students were the most appropriate for the study, this was because they have been to secondary school longer enough hence most of them have developed relatively stable learning approaches and grit for learning chemistry. They were also selected because they had taken the subjects of their choice. Form four learners would have been included in the study, but due to their busy

schedules with revision for national examinations, they would not have had adequate time to complete the questionnaires.

3.6 Sampling Techniques and Sample Size Determination

This survey adopted purposive, simple random and stratified sampling techniques. The three categories of schools and the form three classes were selected purposively due their specific characteristics that associated to the topic of study. Using stratified sampling procedures, the six public secondary schools with a sample size of 446 students were chosen. This was because of their different levels of achievement in chemistry. Participants in the study from each school were chosen using simple random sampling. This technique was suitable because each student was given an equal chance to take part in the study. The Six secondary schools in which one was an extra county school, two were county schools, and three sub county schools participated in the study.

3.6.1 Sampling Techniques

Purposive sampling was employed in selecting Etago Sub County and a group of form three students taking chemistry. The sub county was selected because it has continued performing below average in chemistry and it has always been ranked among the last three sub counties in national examinations. The researcher involved form three students because the grit and learning approaches questionnaires were recommended for adolescents aged between 16 to 18 years. Form four students fall within the age bracket but being a candidate class it might have been difficult to get sufficient time to fill the questionnaires. The students from every school were selected using simple random sampling. This technique was appropriate because it provided an equal opportunity for all students to take part in the study.

3.6.2 Sampling Size Determination

Schools were selected using Kothari (2021) recommendation of 10% and above while the students sample was obtained using Slovin's (1960) formula;

$n = \frac{N}{1+N(e)^2}$; where N is the target population and e is the margin of error (0.05).

$n = \frac{3,320}{1+3,320(0.05)^2} = 357$

The schools were selected based on the Kothari (2021) sampling methodology, which recommends taking a sample size between 10% and 20%. To offset non-response rates, Burke and Christine (2014), proposed the following sample size adjustment formula: "Number of participants to include in original sample" = "Number of people expected to respond" / "Probability of response" = Number of participants to be included in original sample. The desired sample size is "357" and the expected response rate is "80". Therefore, the corrected number of participants is "357 / 0.80 = 446.

The proportionate sampling formula was used to determine the sample size from each school group, as shown below.

$n\text{-}sc = \frac{N-sc}{N-T} \times 446$

Where n-sc represent the sample size from each school category, N-sc is the target population in the school category and N-T represent the total target population. Table 3.2 shows the distribution of the sample schools of different categories.

Table 3.2

Sampling Frame and Sample Size

	Sample

School Category	No. of schools	Student enrolment		Schools	Students	
		M	F		M	F
ECS	2	320	186	1	43	25
CS	6	447	476	2	60	64
SCS	19	849	1042	3	114	140
Total	27	1,616	1,704	6	217	229
		3320			446	

Note. ECS- Extra County Schools; CS- County Schools; SCS- Sub County Schools;

The study was conducted in six public secondary schools, with a sample size of 446, this represented 13.43% of the target population. Similarly, the six secondary schools represented 22.22% of the total number of schools within Etago sub-county.

3.7 Research Instruments

This study used learning approaches questionnaire, grit questionnaire and chemistry achievement pro forma to collect data. The questionnaire (Appendix B) contain three major sections. Section A Background information data, section B contained data obtained on learning approaches and section C contained data gathered on grit.

3.7.1 Learning Approaches Questionnaire

The study adapted the learning approaches questionnaire that was used among students of different academic standards developed by Lastusaari et al. (2016), α =.80. The researcher was given permission by the authors to use the questionnaire during the study (Appendix F).The questionnaire comprises of 17 items that were measuring learning approaches on a scale with five possible responses ranging from Strongly Disagree to Strongly Agree. The highest expected score was 85, while the lowest expected score was 17. According to the authors, scores above 60 indicated the deep leaning approaches, while scores below 35 indicated the surface approach mode of leaning.

3.7.2 Grit Questionnaire

The researcher used the grit questionnaire that measured the domains of grit among learners developed by Angela Duckworth (2007) with 12 items, α =.72. The questionnaire adapted had two levels of grit namely: Interest and Perseverance. The first six items in part (i) of the questionnaire were measuring interest while the other six in the part (ii) of the questionnaire were measuring perseverance. The variables were assessed on a scale with five possible responses ranging from (Strongly Disagree to Strongly Agree). According to the author, the questionnaire was scored through taking the total of each item's marks. The highest score was 60, and the lowest score was 12.A score between 48 and 60 indicated high level of grit while the score below 30 signified low level of grit. The score that ranged between 35 and 45 indicated moderate level of grit.

3.7.3 Chemistry achievement Pro Forma

To measure the student's chemistry achievement, the researcher examined the achievement records of the form three students. The total chemistry marks for the form three term one both midterm and end term examinations in 2023 were collected. The average score for every form three student in the two chemistry examinations was then tabulated and used to make comparisons.

3.8 Pilot Study

The preliminary research investigation took place in one of the schools in the Sub County, which was not incorporated into the main study. Content and face validity was determined by university supervisors. The study instruments were pre-tested by the researcher for clarity particularly in item questions. Modifications required were identified. For instance, part of the language used was above the level of participants and needed modifications. The questionnaires were found to be valid and reliable, with

the reliability coefficients statistically determined as presented in Table 3. 3. The-learning approaches questionnaire reliability was .79 while the grit scale reliability was found to be .81. According to Roopa and Rani (2012), a reliability coefficient of .70 and above is considered appropriate for the questionnaire to be used in a survey study. Based on this statistical recommendation both learning approaches and grit questionnaires used during the study were reliable.

3.8.1 Validity of the Instruments

The questionnaire was adapted and used from the already developed one; the validity of the instrument was therefore evidenced from the previous users of the questionnaire by other researchers Knekta et al. (2019).The university supervisors and peer review also discussed the results obtained from the pilot study to ascertain the content validity of the questionnaire. The content validity of the tools was further improved by reviewing literature on learning approaches and grit. During the process, some words were simplified to the standards of the respondents.

3.8.2 Reliability of the Instruments

Cronbach Alpha strategy was employed to assess the reliability of the research instruments. A sample size of 30 students was used in the pilot study, which was done in one of the schools. To determine the instrument reliability, data were gathered, coded in SPSS, and examined. The results obtained using the data from Table 3.3 shows the results of the pilot study.

Table 3.3

Reliability of the Questionnaires

Scale	No. Items	(Author)	(Pilot)

Learning Approaches Questionnaire	17	.80	.79
Grit Questionnaire	12	.72	.81

3.9 Data Collection Techniques

Data were obtained from the students who participated in the study through administering of questionnaires and chemistry achievement pro forma. The respondents were guided on how to fill the questionnaire by the researcher in about 15 minutes. The researcher gave the respondents about 5 minutes to ask some questions for any clarifications that they required after which the respondents were allowed to complete the questionnaires given. When the students completed filling the questionnaires, the researcher collected them from the students and took them for further processing and analysis. This was an appropriate method for the study since it helped the researcher to collect more data within the shortest time possible (Roopa & Rani, 2012).

3.10 Data Analysis

The questionnaire forms were given codes and then data from each of them was coded into the computer, which was installed with SPSS. The outliers and the missing data were checked from the coded data in the computer. The evidence was analyzed using inferential as well as descriptive statistics. Inferential statistics was used to examine the following statistical hypotheses;

$H_0$1: There is no significant relationship between learning approaches and chemistry achievement among the form three students in Etago sub-county. Statistical test; Pearson product moment correlation.

$H_0$2: There is no significant relationship between grit and chemistry achievement among the form three students in Etago sub-county. Statistical test; Pearson product moment correlation.

$H_0$3: There are no significant gender differences in both learning approaches and grit in chemistry achievement among the form three students in Etago sub-county. Statistical test; Independent samples t-test.

$H_0$4**:** The learning approaches and grit do not significantly predict chemistry achievement among form three students in Etago sub-county. Statistical test; multiple regression analysis.

3.11 Logistical and Ethical Considerations

3.11.1 Logistical Considerations

Kenyatta University's graduate school sent the researcher an initial letter of introduction that was used to apply for a study's permission at Kenya's National Commission for Science, Technology and Innovation (NACOSTI). Subsequently, the researcher visited the County Commissioner and the Director of Education of Kisii County to secure a letter of approval for the study. After obtaining all necessary authorization documents, the researcher scheduled meetings with the principals of the schools studied to determine the most suitable time to collect data.

3.11.2 Ethical Considerations

The researcher adapted both grit and learning approach questionnaires, which were used to collect data. In line with ethical principles for research, the researcher requested for written consent from the developers utilize the research tools. Participation of the learners in the study was voluntary. The purpose of the study was clarified to the

participants after which a consent form was given to each of them to read. After understanding what the study was all about, they made a decision of participation and signed a consent form with all the details concerning the study.

CHAPTER FOUR

PRESENTATION OF RESULTS, INTERPRETATION AND DISCUSSION

4.1 Introduction

The chapter presents the findings of the study, as well as their interpretation and discussion. Information is presented using descriptive statistics. The findings are reported in accordance with the study goals. It covers general and demographic statistics such as the return rate of the study equipment, gender, age, and school type. This starts by providing descriptive statistics of each of the study variables' ratings, followed by hypothesis testing and discussion of the findings.

4.2 General and Demographic Information

This section discusses the return rate of the research instruments, gender and age of the students and school types.

4.2.1 Return Rate

The study involved a sample of six secondary schools. These comprised of one extra county school, two county schools and three sub-county schools. Sixty-eight questionnaires were administered in the extra-county school; 124 in the county schools and another 254 distributed in the sub-sub-county schools; resulting in an aggregate of 446 questionnaires .During data coding and entry, two questionnaires were not returned. Six had more than seven items that were not filled while three questionnaires had more than one response hence did not meet the criteria to be included in the data analysis. The return rate of the research instruments is presented in Table 4.1.

Table 4.1

Return Rate of the Research Instruments

		QA		QR		RR
		Male	Female	Male	Female	
Type of school	ECS	43	25	41	25	97.10%
	CS	60	64	58	63	97.60%
	SCS	114	140	110	138	97.60%
Sub Total		217	229	209	226	97.50%
Total		446		435		

Note. ECS = Extra County Schools; CS = County Schools; SCS = Sub County Schools; QA = Questionnaires Administered; QR = Questionnaires Returned; RR = Return Rate

Table 4.1 shows that 446 questionnaires were administered to the learners across three distinct types of schools. Calculation of the return rate was done based on the adjusted sample size of 446 obtained using Burke and Christine's (2014) formula discussed in section 3.6.2. Out of the 446 questionnaires, 217 were administered to male students and 229 to female students.

During data entry, 209 questionnaires among male respondents were returned for analysis. This translated to 96% return rate. For female respondents, 226 out of the 229 administered questionnaires were returned which was a return rate of 99%. Based on the initial sample of 446 students, the questionnaire return rate was therefore, 93%. According to Fincham (2008), a questionnaire return rate of 65% and above is appropriate for the survey research.

4.2.2 Gender and Age of Respondents

The gender and the age of the students across the different school categories are presented in Table 4.2.

Table 4.2

Age by Gender Cross Tabulation

		Gender		Total
		Male	Female	
Age	16 and below	17(37.80%)	28(62.20%)	45(10.30%)
	17-21	192(49.20%)	198(50.80%)	390(89.70%)
	22 and above	0 (0.00%)	0 (0.00%)	0 (0.00%)
Total		209 (48.00%)	226(52.00%)	435(100.00%)

Table 4.2 indicates that in the three categories of schools in which the study was conducted, there was a sample of 209(48%) male respondents and 226 (52%) female respondents.45(10.30%) respondents were below 16 years of age out of which 17(37.80%) were male and 28(62.20%) were female. On the other hand, 390(89.70%) respondents were aged between 17 and 21 where 192(49.20%) were male and 198(50.80%) were female. This shows that majority of the students in the study were between the ages of 17 and 21.

4.3 Relationship between Learning Approaches and Chemistry Achievement

The study's primary goal was to determine the relationship between learning approaches and chemistry achievement. Sections 4.3.1 and 4.3.2 presents descriptive statistics on learning approaches and chemistry achievement while sections 4.3.3 and 4.3.4 deals with hypothesis testing and discussion of the findings.

4.3.1 Descriptive Statistics of Learning Approaches Scores

The learning approaches scores were analyzed using descriptive statistics and the outcomes are presented in Table 4.3.

Table 4.3

Descriptive Statistics of Learning Approaches Scores

	Min	Max	*M*	*SD*	*Sk*	*Kur*
LA	29.00	78.00	53.93	8.92	-.02	-.06
Surface LA	13.00	44.00	28.74	5.62	-.09	.19
Deep LA	12.00	37.00	25.02	4.74	-.15	-.27

Note. *N*= 435. Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* = Skewness; *Kur* =Kurtosis; LA = Learning Approaches

The outcomes show that the average score for learning approaches was 53.93, (*SD* = 8.92). The minimum and maximum scores were 29.00 and 78.00, respectively, with a range of 49.00. The minimum score was 17, and the maximum was 85. The skewness and kurtosis scores were -02 and -06, respectively. The scores for skewness and kurtosis were less than three. This indicated that the data for learning approaches were normally distributed across the three categories of schools, Orcan (2020).

The descriptive statistics of learning approaches by gender were also analyzed to determine whether there were gender differences in learning approaches. Table 4.4 shows descriptive statistics of learning approaches by gender.

Table 4.4

Descriptive Statistics of Learning Approaches by Gender

Gender	N	Min	Max	Range	*M*	*SD*	*Sk*	*Kur*
Male	209	29.00	78.00	49.00	54.47	8.26	-.04	.99
Female	226	33.00	73.00	40.00	53.43	9.48	.03	-.67
Total	435	29.00	78.00	49.00	53.93	8.93	-.02	-.06

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis

Table 4.4 shows that, while the mean value for female students was 53.43 (*SD* = 9.48), it was 54.47 (*SD* = 8.26) for male students. Male students obtained a maximum score of 78.00 and a minimum score of 29.00, with a range of 49.00. For female students, the scores ranged from 33.00 to 73.00, with a score range value of 40.00. The skewness coefficient for male students was -.04, and for female students it was .03 whereas male and female students' kurtosis values were 0.99 and -0.67, respectively. The skewness and kurtosis coefficients indicate that the data was normally distributed. The results further confirmed that male students scored better in learning approaches as compared to the female students. Table 4.5 shows descriptive statistics of learning approaches by age.

Table 4.5

Descriptive Statistics of Learning Approaches by Age

Age	*N*	Min	Max	Range	*M*	*SD*	*Sk*	*Kur*
16 and below	45	29.00	72.00	43.00	53.24	9.15	-.26	.39
17-21	390	30.00	78.00	48.00	54.01	8.90	.01	-.10
Total	435	29.00	78.00	49.00	53.93	8.92	-.02	-.06

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis

Table 4.5 reveals that students under the age of 16 had an average score of 53.24 points (*SD* = 9.15). The maximum score was 72.00, the minimum score was 29.00, and the

range was 43.00. The skewness and kurtosis coefficients were -.26 and 0.39 in that order. The students aged 17-21 had a mean score of 54.01 points (*SD* = 8.90), with the maximum score being 78.00 and the minimum score 30.00. The range was 48.00, and the kurtosis and skewness coefficient were -0.01 and 0.10, respectively. The findings revealed that the students in the age bracket of between 17 and 21 had better learning approaches compared to those who were less than 16 years of age. The skewness and kurtosis coefficients revealed that the scores were normally distributed.

Descriptive Statistics of learning approaches in relation to school category was equally examined. Table 4.6 presents the findings obtained.

Table 4.6

Descriptive Statistics of Learning Approaches by Type of School

Type of school	*N*	Min	Max	Range	*M*	*SD*	*Sk*	*Kur*
ECS	66	29.00	72.00	43.00	60.17	8.99	-1.82	.71
CS	121	32.00	77.00	45.00	53.82	8.39	-.31	.62
SCS	248	30.00	78.00	48.00	52.33	8.45	.49	.40
Total	435	29.00	78.00	49.00	53.93	8.92	-.02	-.05

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis; ECS = Extra County Schools; CS = County Schools; SCS = Sub County Schools

The results show that learning approaches mean score of the students from extra county schools was 60.17 (*SD* = 8.99). The mean score for county and sub county schools were 53.82(*SD* = 8.39) and 52.33(*SD* = 8.45), respectively. The minimum and maximum

scores of students from extra county schools were 29.00 and 72.00, respectively with a range of 43.00. The minimum and maximum scores for the students in county schools were 32.00 and 77.00, respectively with a range of 45.00. For the students in sub county schools, the minimum score was 30.00 and the maximum was 78.00.The range between the lowest and highest score was 48.00. The results showed that students from extra county schools had the highest mean score while students from sub county schools had the lowest mean score. The skewness and kurtosis coefficients from the three categories of schools indicated a normal data distributed. The descriptive statistics of learning approaches subdomains is shown in Table 4.7

Table 4.7

Descriptive Statistics of Learning Approaches Sub Scales

	N	Min	Max	*M*	*SD*	*Sk*	*Kur*
Surface LA	435	13.00	44.00	28.74	5.62	-.09	.19
Deep LA	435 ,	12.00	37.00	25.02	4.74	-.15	-.27

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis

Learning approaches were measured at two domains, namely; surface learning approach and deep learning approach. The Surface learning approaches had an average score of 28.74 points (*SD* = 5.62), with a maximum score of 44.00, a minimum score of 13.00 points and a range of 31.00 points. Deep learning approaches had an average score of 25.02 points , with the highest score of 37.00 points, the lowest score of 12.00 points, and a score range of 25.00 points (*SD* = 4.74). The skewness coefficient and kurtosis coefficient of the surface learning approaches was -.09 points and.19 points

respectively. The skewness coefficient for deep learning approaches was -0.15 while the Kurtosis coefficient was -0.27. The result revealed that the surface learning approaches had the highest mean score of 28.74 compared to deep learning approaches, which had a mean score of 25.02. The skewness and kurtosis for both the surface and deep learning approaches showed that there was a normal distribution of the result scores.

4.3.2 Descriptive Statistics of Chemistry Achievement Scores

This section presents descriptive statistics of chemistry achievement scores. Table 4.8 gives a summary of the descriptive statistics of chemistry achievement standardized scores.

Table 4.8

Descriptive Statistics of Chemistry achievement Standardized Scores

	N	Range	Min	Max	*M*	*SD*	*Sk*	*Kur*
Chemistry T score	435	46.85	34.23	81.08	49.14	9.80	.75	.03

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis

The table indicates that the minimum score for chemistry achievement was 34.23, the highest score was 81.08, the standard deviation was 9.80, and the mean score was 49.14. The skewness coefficient was 0.75 and the kurtosis coefficient stood at 0.03 showing that the scores were normally distributed. Table 4.10 gives descriptive statistics of chemistry achievement by gender.

Table 4.9

Descriptive Statistics of Chemistry achievement by Gender

Gender	*N*	Min	Max	Range	*M*	*SD*	*Sk*	*Kur*
Male	209	34.23	81.08	46.85	50.15	8.22	.54	.37
Female	226	34.23	77.24	43.01	48.05	10.99	.70	-.50
Total	435	34.23	81.08	46.85	49.14	9.79	.75	.03

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis

Table 4.9 establishes that the average mark for male respondents was 50.15 (*SD* = 8.22) while that of female students was 48.05 (*SD* = 10.99).The maximum score for the male students was 81.08 while the minimum score was 34.23. Female students had a minimum and maximum score of 34.23 and 77.24, respectively. This implies that male students had higher scores in chemistry compared to female students. Similarly, the skewness and kurtosis coefficients showed that data were normally distributed. To ascertain the differences in chemistry achievement by age, the researcher carried out a descriptive statistics analysis and obtained the result in Table 4.10

Table 4.10

Descriptive Statistics of Chemistry Achievement by Age

Age	*N*	Min	Max	Range	*M*	*SD*	*Sk*	*Kur*
16 and below	45	34.23	72.63	38.40	49.10	9.96	.84	.14
17-21	390	34.23	81.08	46.85	49.40	9.79	.74	.03
Total	435	34.23	81.08	46.85	49.14	9.80	.75	.03

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis

The outcome of Table 4.10 shows that the minimum and maximum scores for the students under the age of 16 was 34.23 percent and 72.63 percent, respectively, with the range being 38.40 percent. The mean score was 49.10 (*SD*=9.96). The skewness coefficient was 0.84 while the kurtosis was 0.14. The minimum and maximum scores for the students aged between 17 to 21 years was 34.23 and 81.08 respectively with the mean score of 49.40 (*SD*=9.79) .The skewness and kurtosis coefficients were 0.74 and 0.03, respectively. The results implies that the students in the age category of 17 to 21 had a better achievement in chemistry compared to those less than 16 years. The skewness and kurtosis coefficients revealed that there was normal distribution.

The Table 4.11 shows the descriptive statistics of chemistry achievement by school categories.

Table 4.11

Descriptive Statistics of Chemistry Achievement by School Type

Type of school	*N*	Min	Max	Range	*M*	*SD*	*Sk*	*Kur*
ECS	66	34.23	77.24	43.01	59.79	8.66	-.06	.16
CS	121	34.23	74.17	39.94	48.79	8.45	.41	.20
SCS	248	34.23	81.08	46.85	46.47	8.76	1.25	1.44
Total	435	34.23	81.08	46.85	49.14	9.80	.75	.03

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur*= Kurtosis; ECS = Extra County Schools; CS = County Schools; SCS = Sub County Schools

Table 4.11 demonstrates that the extra county schools' lowest and highest scores were 34.23 and 77.24, respectively with a range of 43.01. The average score was 59.79 (*SD* = 8.66). The coefficients for skewness and kurtosis were -0.16 and 0.06 respectively. The county schools had a minimum and maximum score of 34.23 and 74.17, respectively. The county schools' average score was 48.79 (*SD* = 8.45). The skewness and kurtosis coefficients were, respectively, 0.41 and 0.20. The sub county schools' lowest and highest test scores were 34.23 and 81.08, respectively. With a *SD* of 8.76, the mean score was 46.47. Kurtosis and skewness coefficients were 1.25 and 1.44, respectively. The average score for sub county schools was lower than the average score for extra county schools. The kurtosis and skewness indicates a well-distributed sample of data. The results showed that the extra county schools had better achievement in chemistry than the county schools.

4.3.3 *Hypothesis Testing on the Learning Approaches and Chemistry Achievement*

The primary objective of the study was to determine the correlation between the learning strategies employed by the chemistry students and the chemistry proficiency of the form three learners in Etago Sub-County, Kisii County. To achieve this, the following hypothesis was statistically tested using the Pearson product moment correlation coefficient test.

$H0_1$ There is no significant relationship between learning approaches and chemistry achievement among the form three students in Etago Sub-county.

Table 4.12

Correlation between Learning Approaches and Chemistry Achievement

	Chemistry Score
LA	.58**
Surface LA	.36**
Deep LA	.76**

Note. LA = Learning Approaches; *N* = 435

Table 4.12 reveals that there was a positive significant correlation between learning approaches and chemistry achievement, r (433) = .58, p<.05. Similarly, the results showed a positive significant correlation between the domains of learning approaches and chemistry achievement. In the Surface learning approach and chemistry achievement, r (433) =.36, p<.05, and in the deep learning approach and chemistry achievement r (433) =.76, p<.05. The findings imply that achievement in chemistry is significantly correlated to both domains of learning approaches.

Table 4.13

Regression model summary for Learning Approaches sub domains

Model	R	R^2	Adjusted R^2	*SEE*
1	.71[a]	.49	.49	7.17
2	.72[b]	.52	.51	7.06

Note. *R* = Multiple correlation co efficient;R^2 = Proportion of the Variance; *SEE* = Standard error of the estimate

a. Predictors: (Constant), Deep Learning Approach; Surface Learning Approach

b. Predictors: (Constant), Deep Learning Approach; Surface Learning Approach; Deep Learning Approach Gender; Surface Learning Approach Gender

The results in Table 4.13 indicate that the surface and deep learning approaches were the predictor variables in model 1.The multiple regression coefficient of the two predictor variables was 0.71 which shows that surface and deep learning approaches strongly predicted achievement in chemistry. *R* square was .49 suggesting that 49% variance in chemistry achievement can be explained by both surface and deep learning approaches. When the gender of the students as a moderator variable was included in model 2, the regression coefficient increased by 0.1 and the *R* square also increased by 0.03. To establish if the two sub domains of learning approaches significantly predicted chemistry achievement, ANOVA was conducted and the results are presented Table 4.14.

Table 4.14

Model		*SS*	*Df*	*MS*	*F*	Sig.
	Regression	15749.76	2	7874.88	153.19	.00[b]
1	Residual	15935.92	433	51.41		
	Total	31685.68	435			
	Regression	16341.87	4	4085.47	82.01	.00[c]
2	Residual	15343.81	431	49.82		
	Total	31685.68	435			

Note. *SS* = Sum of Squares; *Df* = Degree of Freedom; *MS* = Mean Squares
a. Dependent Variable: Chemistry T score
b. Predictors: (Constant), Deep Learning Approach; Surface Learning Approach
c. Predictors: (Constant), Deep Learning Approach; Surface Learning Approach; Surface Learning Approach Gender; Deep Learning Approach Gender

The findings obtained in model 1 in Table 4.14 shows that surface and deep learning approaches significantly predicted chemistry achievement among the students, $F(2,433) = 153.19$, $p < .05$. When gender as a moderator variable was introduced in model 2, the model still significantly predicted chemistry achievement F (4,431) = 82.01, $p < .05$. The regression coefficients of the predictor variables are shown in Table 4.15 given below.

Table 4.15

Regression Coefficients for Learning Approaches Sub Levels

Model					*T*	*P*
		B	*SE*	*B*		
	(Constant)	15.80	2.38		6.63	.00
1	X_1	.22	.09	.12	2.44	.01
	X_2	1.60	.10	.77	15.42	.00
	(Constant)	15.87	2.36		6.73	.00
	X_1	.08	.25	.04	.31	.00
2	X_2	1.11	.28	.54	3.96	.00
	X_3	.18	.16	.31	1.13	.26
	X_4	.31	.19	.47	1.66	.10

a. Outcome Variable: Chemistry T score

Note. X_1 = Surface Learning Approaches; X_2 = Deep Learning Approaches; X_3 = Moderation term between Surface Learning Approaches and Gender; X_4 = Moderation term between Deep Learning Approaches and Gender; B = Unstandardized Coefficients; SE = Standard Error; β = Standardized Coefficients

Model, 1 Table 4.15 shows that the multiple regression coefficient of the surface learning approaches was 0.22 and that of deep learning approaches was 1.60. The results reveal that both domains of learning approaches significantly influence the achievement of chemistry among students in secondary schools. Surface learning

approach had a positive significant regression coefficient of β = 0.22, p<.05.This suggest that a unit change in surface learning approach results to 0.22 change in the chemistry achievement. Deep learning approach had a regression coefficient of β =1.60, p< .05.This similarly implies that a unit change in deep learning approach leads to 1.60 change in chemistry achievement.

The prediction equation for the Model 1 was as given below.

$\hat{Y} = 15.80 + 0.22\ X_1 + 1.60\ X_2 + ε$----------1

Where $\hat{Y}$ = Predicted chemistry achievement; X_1= surface learning approaches, X_2 = deep learning approaches, and ε = standard error.

In model 2, gender was introduced as the moderator variable. This changed predictive value of surface learning approaches from .22 to .08 and that of deep learning approaches from 1.60 to 1.11. The changes of the predictive values on both surface and deep learning approaches were not statistically significant on the achievement of chemistry (β =0.18, p = .26 and β = 0.31, p = .10 respectively). The prediction equation developed from the regression coefficients in model 2, was as follows:

$\hat{Y} = 15.87 + 0.08\ X_1 + 1.11\ X_2 + ε$----------2

Where $\hat{Y}$ = Predicted chemistry achievement; X1= Surface Learning approaches, X_2 = Deep learning approaches and ε = standard error.

Using the regression equation from model 2, it was found that a change of one unit in the surface learning approaches was associated with a change of 0.08 in chemistry achievement; similarly, the unit change in deep learning approaches resulted to a change in the achievement of chemistry by 1.11.

Based on the findings obtained, the null hypothesis was rejected since both domains of learning approaches significantly predict achievement in chemistry.

4.3.4 Discussion of the Results

This study sought to explore the relationship between the learning approaches and achievement in chemistry. The results indicated that the learning approaches were positively significant towards the achievement chemistry among students. Furthermore, the researcher found learning strategies that involves kinesthetic styles; visual and auditory develop the interest of students in understanding abstract concepts in science subjects. The results of Ibitham's (2020) study are corroborated by the findings of this study. The results indicate that learning approaches play a key role in learning and learning outcomes. Effective learning strategies enhance retention of learnt content, which is key to better achievement in academics. Thus, to enhance achievement in chemistry in secondary schools it is necessary to guide students to adopt appropriate learning strategies.

The results of the research also were in support of the theoretical point of view on learning approach Marton and Saljo (1976),that classifies learning approaches into two; deep learning approach and surface learning approach. According to the model, deep learning approach is an effective approach that influences students in understanding most abstract scientific concepts. The model further argues that the learning environment, learning outcome and the behavior of the student are the most important aspects that directs learners towards learning strategies.

Olic et al. (2019) did a study whose findings supported by the current study. The study sought to find the relationship between learning approaches and chemistry achievement among students. The results revealed that deep learning approach significantly correlates with students' achievement in chemistry. The researcher further suggested that the sufficient support given to students by both teachers and parents, helps them to

adopt the right learning approaches required to improve their academic achievement more particular in chemistry.

Siddiqui et al. (2020) did a study whose findings were in agreement with the current study. The researcher examined the contributions of blended learning styles among students towards the achievement of chemistry. The focus of the study was to satisfy the learners' psychological needs through motivation, completion of the task and self-efficacy .The result obtained showed that blended learning styles among learners of different academic abilities had a positive significant impact on chemistry achievement among the students. The finding of the study-demonstrated students' academic achievement is highly guided by a combination of different approaches to learning that addresses all forms of domains. Teachers were therefore advised to apply a variety teaching approaches to boost the achievement in chemistry among students.

This study confirms the correlation between student academic achievement and the learning approaches employed by students. The results demonstrate that learning approaches have a significant influence on student academic success. Specifically, students who employed deep learning approaches were more successful than those who employed surface learning approaches in the study of chemistry.

The study results were consistent with the findings of Samuel and Obikizie (2020) who explored the effect of contextual teaching and learning approach (CTLA) on Chemistry achievement in Nigeria. The findings obtained showed a significant effect between CTLA and chemistry achievement among students in learning institutions. The reviewed study examined a variety of learning techniques while the current study investigated the relationship between specific learning approaches (Deep and Surface) and achievement of chemistry. The results suggest contextual approach mode of

learning among students is important in monitoring their learning approaches and enabling them to become self-regulated and motivated learners in school.

The research findings support the results that was obtained by another study explored by Oduol et al. (2022) found out that there was a positive statistical significance link between metacognition planning and academic achievement among students. The researcher argued that the abstract and mathematical nature of most chemistry concepts required metacognition skills and proper planning towards learning. The findings of the study revealed that adoption of metacognitive planning skills in learning approaches improves the achievement in chemistry.

4.4 Relationship between Grit and Chemistry Achievement

The section presents, descriptive statistics for the analysis of participants' grit scores and hypothesis testing is illustrated. The discussions on the findings are also given.

4.4.1 Descriptive Statistics of Grit Score

Table 4.16 shows the descriptive statistics of scores on grit.

Table 4.16

Descriptive Statistics of Grit

	Min	Max	*M*	*SD*	*Sk*	*Kur*
Grit	25.00	52.00	37.11	4.32	.40	.35
Grit Interest	10.00	28.00	19.33	2.95	.06	.05
Grit Perseverance	9.00	27.00	17.54	2.93	.03	.34

Note. Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis

The Table 4.16 shows that the average score for grit on interest was 19.33(standard deviation =2.95). Scores ranged from 10 to 28, with the highest score being 28. The sub-scale of interest had skewness and kurtosis coefficients of 0.06 and 0.05, respectively. The average score for grit and persistence was 17.54, with a standard deviation of 2.93.The range of the scores was 18 with a maximum of 27 and a minimum of 9.The kurtosis and skewness coefficients were 0.34 and 0.03 respectively. In comparison to perseverance sub-scale, which had a mean score of 17.54 the results showed that grit interest, had the highest mean score of 19.33.

Table 4.17

Descriptive of Grit by Gender

Gender	*N*	Min	Max	*M*	*SD*	*Sk*	*Kur*
Male	209	25.00	52.00	37.19	3.98	.27	1.28
Female	226	28.00	51.00	37.02	4.61	.45	-.23
Total	435	25.00	52.00	37.11	4.32	.40	.35

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* =Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis

The findings presented in Table 4.17, outlines the descriptive statistics for grit by gender. The mean score for male students was 37.19 (*SD* = 3.98), slightly higher than the mean score for female students 37.02 (*SD* = 4.61)). The maximum score for male students was 52, with a minimum score of 25. The maximum and minimum scores for the female students were 51 and 28 respectively.

Table 4.18

Descriptive of Grit by Age

Age	*N*	Min	Max	*M*	*SD*	*Sk*	*Kur*
16 and below	45	25.00	45.00	36.91	4.26	-.06	.31
17-21	390	26.00	52.00	37.13	4.33	.44	.36
Total	435	25.00	52.00	37.11	4.32	.40	.35

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* = Skewness; *Kur* = Kurtosis

The present results confirm the data presented in Table 4.18, which demonstrates the average score for students who were less than 16 years was 36.91 (*SD* =4.26).They had a maximum score of 45 and a minimum score of 25 with a range of 20. The skewness and Kurtosis coefficients were -.06 and .31 respectively. The students between the age of 17 to 21 years had a mean of 37.13 (*SD* =4.33). Their minimum and maximum score were 26 and 52 respectively with the range of 26. They had skewness coefficient of .44 and kurtosis coefficients of .36. The results indicated that the students between the ages of 17 to 21 had a higher grit as compared those who were less than 16 years. The data used showed normal distribution.

Table 4.19

Descriptive of Grit by School Type

Type of school	*N*	Min	Max	*M*	*SD*	*Sk*	*Kur*
ECS	66	25.00	45.00	39.95	4.29	-1.78	2.44
CS	121	27.00	48.00	37.04	3.92	-.03	.26
SCS	248	26.00	52.00	36.38	4.21	1.15	1.77
Total	435	25.00	52.00	37.11	4.32	.40	.35

Note. *N* = Sample size; Min = Minimum; Max= Maximum; *M* = Mean; *SD* = Standard deviation; *Sk* =Skewness; *Kur* = Kurtosis; ECS = Extra County Schools; CS = County Schools; SCS = Sub County Schools

The mean score for the schools in extra county was 39.95 (*SD* = 4.29), as shown in Table 4.19. The range was 20 while minimum and maximum scores were 25 and 45 respectively. The extra county schools' skewness coefficient was -1.78 while the kurtosis coefficient was 2.44. The mean for the county schools was 37.04 (*SD* = 3.92). The range of the scores was 21 with 27 as the minimum and 48 as the maximum. The skewness and kurtosis coefficients were -0.03 and 0.26 respectively. The Sub-county schools' mean score was 36.38 (*SD* = 4.21). The minimum score was 26 and the maximum score was 52, with a range of 26. The coefficient for skewness was 1.15, and the coefficient for kurtosis was 1.77. The highest average score was achieved by the extra county schools, with a mean score of 39.95, and the lowest average score was 36.38 for the sub-regional schools.

The levels of grit were further grouped in three main classifications; low, moderate and high and their chemistry mean scores were determined. The Table 4.20 shows the results obtained.

Table 4.20

Level of Grit and Chemistry Mean Score

Grit Levels	*N*	*M*	*SD*
Low	125	32.31	1.88
Moderate	302	38.76	2.98
High	8	49.63	1.78
Total	435	37.11	4.32

Note. *N*=Sample size; *M*= Mean score; *SD*= Standard deviation

Table 4.20 shows that the students with high grit level obtained the highest mean score of 49.63 with a standard deviation of 1.78 on chemistry achievement. Those with moderate grit had a mean of 38.76 with a standard deviation of 2.98, while the students who had low level of grit scored a mean of 32.31 with also a standard deviation of 1.88 in the achievement of chemistry.

4.4.2 Hypothesis Testing

To find out the relationship between grit and chemistry achievement among the students, the following hypothesis was tested.

H02: There is no significant relationship between grit and chemistry achievement among secondary students. The hypothesis was tested using Pearson correlation analysis and the results are presented in Table 4.21.

Table 4.21

Correlation between Grit and Chemistry Achievement

	Chemistry score
Grit	.65**
Grit Interest	.82**
Grit Perseverance	.52**

Note. *N* =435

Table 4.21 demonstrates that there was strong positive significant correlation between grit and chemical achievement r (433) = .65, $p < .05$. Additionally, the findings revealed that there was positive significant correlation between the domains of grit and chemical achievement. For interest; r (433) = .82, $p < .05$ and for perseverance domain; r (433) = .52, $p < .05$.The alternative hypothesis was adopted and the null hypothesis rejected. The findings show that grit plays a crucial role in the achievement of chemistry.

The grit scale contained two sub scales that included; Interest and perseverance. The prediction of each of the sub scale in the achievement of chemistry was examined using multiple regression analysis and the results are given in the Table 4.22

Table 4.22

Regression model summary for grit Sub Levels

Model	*R*	R^2	Adjusted R^2	*SEE*
1	.82[a]	.68	.67	5.59
2	.83[b]	.68	.68	5.53

a. Predictors: (Constant), Grit-Perseverance, Grit-Interest

b. Predictors: (Constant), Grit-Perseverance, Grit-Interest, Gender

The findings in the Table 4.22 show that perseverance and interest were the predictor variables in model 1.The multiple regression co efficient of interest and perseverance as the predictor variables was 0.82 indicating a strong positive correlation towards chemistry achievement. *R* square was .68 implying that 68% variance in chemistry achievement can determined by both sub levels of grit as a predictor variable on learning chemistry. In model 2, the gender of the learners as a moderator variable was included in the model, the regression co efficient was .83 and the *R* square remained .68. To examine if the two levels of grit significantly predicted chemistry achievement, ANOVA was conducted and the results are shown in Table 4.23.

Table 4.23

ANOVA for Grit Sub Domains

Model		*SS*	*Df*	*MS*	*F*	Sig.
1	Regression	28160.15	2	14080.08	450.66	.00[b]
	Residual	13497.04	433	31.24		
	Total	41657.19	435			
2	Regression	28460.11	3	9486.70	309.82	.00[c]
	Residual	13197.09	432	30.62		
	Total	41657.19	435			

Note. *SS* = Sum of Squares; *Df* = Degree of Freedom; *MS* = Mean Squares
a. Dependent Variable: Chemistry T score

b. Predictors: (Constant), Grit Perseverance, Grit Interest

c. Predictors: (Constant), Grit Perseverance, Grit Interest, Gender

Table 4.23 shows that in model 1, both perseverance and interest as the subscales of grit significantly predict the chemistry achievement, F (2, 433) = 450.66, p<.05. In model 2, the researcher investigated the influence of gender as a moderator variable. The results further indicated a significant prediction of chemistry achievement F (3,432) = 309.82, p< .05, from interest and perseverance even in the inclusion of gender

as a moderator variable. The regression analysis and the results of the regression coefficients are shown in Table 4.24.

Table 4.24

Regression Coefficients for Grit Sub Domains

Model					*T*	*P*
		B	*SE*	B		
1	(Constant)	.68	2.49		.27	.00
	X_1	2.52	.16	1.79	15.12	.00
	X_2	.08	.17	.05	.48	.02
2	(Constant)	.12	2.42		.05	.00
	X_1	.79	.53	.24	1.49	.00
	X_2	1.73	.58	1.20	2.98	.00
	X_3	.99	.30	1.12	3.28	.17
	X_4	.94	.33	.96	2.86	.32

Note. Outcome Variable: Chemistry T score ; X_1= Interest; X_2 = Perseverance; ; X_3 = Moderation term between Interest and Gender; X_4 = Moderation term between Perseverance and Gender; B = Unstandardized Coefficients; SE = Standard Error; β = Standardized Coefficients

The model, 1 in the Table 4.24 shows that the regression coefficient of interest was 2.52 while that of perseverance was determined as 0.08. The findings indicated that both domains of grit significantly predicts the achievement of chemistry among secondary students. The subscale of interest had a positive significant regression coefficient of β = 2.52, p<.05.This implies that a unit change in the interest of the learners towards chemistry results to 2.52 change in the chemistry achievement. Perseverance had a regression coefficient of β =0.08, p< .05.This similarly shows that a unit change in the perseverance leads to 0.08 change in chemistry achievement.

The prediction equation for the Model 1 was as given below.

$\hat{Y} = 0.68 + 2.52\ X_1 + 0.08\ X_2 + \acute{\varepsilon}$----------1

Where $\hat{Y}$ = Predicted chemistry achievement; X_1= Interest, X_2 = Perseverance, and $\acute{\varepsilon}$ = standard error.

In Model 2, gender was included as the moderator variable. This decreased the predictive value of interest to .79 and increased the predictive value of perseverance to 1.73. The predictive values of the moderator terms were not statistically significant in predicting achievement in chemistry β =0.99, p = .17 and β = 0.94, p = .32 in that order. The regression coefficient prediction equation in model 2, was given as:

$\hat{Y} = 0.12 + 0.79\ X_1 + 1.73\ X_2 + \acute{\varepsilon}$----------2

Where $\hat{Y}$ = Predicted chemistry achievement; X1= Interest, X_2 = Perseverance and $\acute{\varepsilon}$ = standard error. Based on the findings obtained, the null hypothesis was rejected since

interest and perseverance as the domains of grit significantly predicted achievement in chemistry.

4.4.4 Discussion of the Results

The second goal of the study was to look at the correlation between grit and chemistry achievement among the students. Descriptive analyses were first carried out. The descriptive results showed that majority of the students had moderate levels of grit for the chemistry achievement. Those who had the low levels of grit were similarly more as compared to those with high levels of grit. For better understanding of the students' scores in order to facilitate comparison of scores in the present study, the scores were classified into low, moderate and high grit levels.

The findings showed that there was a significant positive correlation between grit and chemistry achievement, r (433) = .65, $p < .05$. Similarly, the study showed that there was a correlation between the subscales of grit and achievement in chemistry. Students with high level of grit in learning chemistry are persistence, determined and resilient in handling most of the abstract concepts in chemistry. This kind of characteristics give the students' academic autonomy resulting to better achievement in chemistry. The results of the study are in agreement with those of Christopher (2020) about the impact of grit on students' academic success. The researcher established a causal relationship between student grit, self-efficacy, and goal orientation and academic accomplishment (Statistics in Mathematics). The findings demonstrate that tenacity is essential to academic success across all subject areas.

The results of the present investigation supported a study conducted in China by Wang (2020). The study looked into how kids' IQ and grit affected their academic

achievement as secondary school students. The findings showed that typical pupils' academic success is positively influenced by IQ and grit. The researcher argued that individual differences in chemistry achievement among students was explained by the variations in IQ and grit. Students with low achievement in IQ and grit level were found achieving lowly in chemistry. The results show that grit is an important predictor of chemistry achievement. Grit traits help students to remain focused on chemistry learning tasks until they achieve success.

The findings of this study concur with those of Edoka et al. (2020), whose study examined the influence of grit on academic success among students .The outcome showed a strong, positive correlation between tenacity and academic success. The study also revealed that there was no correlation between parental supervision and other academic variables such academic background, institutional dedication, academic experience, and academic success expectations. The researcher concluded that grit is key to academic achievement especially science subjects. The study indicated that grit as a predictor influence the academic achievement and learning process in general. Even if the study focused on academic success, this point to the crucial role that grit plays in learning achievement in chemistry.

This study confirms the findings of the widely cited Mingming (2019). This metaanalysis involved grade 12 learners and compared grit levels to academic achievement. The study found that grit levels had a positive correlation with academic achievement, which was attributed to the use of different modalities of self-empathy and achievement goal orientation as mediators. As a result, secondary school students who achieved high levels of grit were more successful in chemistry compared to those who achieved low levels.

The results of the study demonstrate that grit and academic achievement are inextricably linked. The interest and passion of the students, which are components of grit, positively contribute to a academic achievement. Consequently, teachers must motivate and support students to increase their grit in order to improve their achievement in chemistry. This is further supported by the findings of the study by Usman et al. conducted in 2021. A related study, conducted in 2019, examined the relationship between adaptability and achievement in chemistry among secondary students in the sub-county of Rachuonyo. The result showed that adaptability significantly correlated to achievement in chemistry, further demonstrating the significance of grit in chemistry success.

4.5 Gender Differences in Learning Approaches and Grit in Chemistry Achievement

This section presents descriptive statistics of learning approaches and grit scores based on gender of the students, hypothesis testing and discussion of the results.

4.5.1 Descriptive Statistics of Learning Approaches and Grit by Gender

Table 4.25 reveals the mean for male and female students in learning approaches and grit.

Table 4.25

Descriptive of Learning Approaches and Grit Scores based on Gender

Gender		LA	Grit
	N	209	209
Male	Mean	54.47	37.19
	Std. Deviation	8.26	3.98
	N	226	226
Female	Mean	53.43	37.02
	Std. Deviation	9.48	4.61

Table 4.25 shows that the mean scores for the male students in both learning approaches and grit were 54.47 (*SD* = 8.26) and 37.19 (*SD* = 3.98) respectively while the mean for the female students in learning approaches and grit were obtained to be 53.43(*SD* = 9.48) and 37.02 (*SD* =4.61) in the same order. The study reveals that the male students performed slightly higher in both learning approaches and grit as compared to the female students.

4.5.2 Hypothesis Testing

To examine the existence of gender differences in both learning approaches and grit in chemistry achievement, the following hypothesis was tested.

H03 There is no significant gender differences in both learning approaches and grit in chemistry achievement.

Table 4.26

Independent Samples T Test for Gender Differences in Learning Approaches and Grit

		t	*Df*	Sig. (2-tailed)
LA	Equal variances assumed	1.22	433	.23
	Equal variances not assumed	1.22	431.45	.22
Grit	Equal variances assumed	-.39	433	.70
	Equal variances not assumed	-.39	431.09	.70

The findings revealed that there were no statistically significant gender differences in learning approaches, t (433) = 1.22, p = .23. Therefore, the null hypothesis was retained suggesting that male and female students do not differ substantially in the learning approaches they used in studying chemistry. Similarly the result revealed that there were no statistically significant gender differences in grit, t (433) = -.39, p = .70.The null hypothesis was also retained implying that the student grit do not differ substantially on basis of gender towards the study of chemistry.

4.5.3 Discussions of the Results

The third objective of the study was to determine whether gender differences in learner's learning approaches and grit had an impact on learning chemistry. The results of the study indicated that there were no major differences in learning approaches or grit between male and female students. This conclusion is in line with the findings of the study conducted by Ahsanah in 2020, which examined the relationship between gender and age differences and learning strategies. The results of this study confirmed that

there were no notable gender differences in language learning strategies used in secondary school students. This confirms that in some learning areas and domains, there are no significant gender differences.

Tebello and Som (2021) findings were contrary to those of the current study. The study's primary goal was to ascertain how faculty, gender, and age variables affect students' learning behaviors. According to the study's conclusions, the only instructional strategies that significantly influenced students' perceptions of gender were those that promoted academic integrity. In contrast, there was no discernible gender difference in any other aspects of learning. The findings imply that students of both sexes may adopt different learning strategies and orientations depending on their level of education. This may be the reason for the contradictory findings because the two studies involved students from different levels of learning; university and secondary schools.

Xiayu (2020) conducted a similar study whose findings contradicted the previous studies. The purpose of this study was to determine the relationship between grit (persistence and consistency) and gender in support of teacher autonomy and social competency among students. The results showed that the higher level of consistency was positively significant for both male and female students towards academic achievement. The results further indicated that the lower level of consistency was only significant for male learners but not for female.

Oluyemo et al. (2020) investigated gender differences in mathematics interest (grit) and achievement among the junior secondary schools. The research findings showed that male students performed better in mathematics interest and achievement as compared to the female students. This was contrary to the results of the present study. The

differences was attributed to the learning domains that the two studies focused on. In another study, Mutua and Oyoo (2020) investigated gender as a moderating factor on learning strategies among secondary school students. The result obtained revealed that there was a significant gender difference in both rehearsal and elaboration learning strategies. The study further established that there was no significant gender difference in organizational learning strategies. The findings suggest that boys and girls may or may not differ in their learning constructs because the current study reported contradictory results.

Marcellinus and Chibuogwu (2020) looked at the relationship between gender variations in learning approaches of high and low performers in Biology. The study's findings demonstrated that independent and collaborative learning approaches were more predisposed to high accomplishment in biology than dependent and avoidant learning approaches, which were associated with low achievement. The outcome further demonstrated that female students out performed male students, who out performed themselves utilizing autonomous learning techniques. Bayiga and Sarah (2021) studied the association between gender differences on attitudes and perseverance towards vocational education among students. The result obtained revealed that there was no significant differences in attitudes and perseverance between male and female students towards vocational education. This further confirms that in some learning domains, male and female students do not differ significantly.

4.6 Prediction of Achievement in Chemistry from Learning Approaches and Grit

The forth objective of the study was to determine the predictive weights of both learning approaches and grit in chemistry achievement among the students. To test the objective, the following hypothesis was formulated;

$H_0$4**:** The learning approaches and grit do not significantly predict chemistry achievement among students.

The hypothesis was tested through multiple regression of the analysis. Table 4.27 shows the assumption test by regression analysis.

4.6.1 Test for Assumptions of Regression Analysis

The study examined the following assumptions of regression; normal distribution, Heteroscedasticity and Homoscedasticity and Multicollinearity and Singularity**.** Table 4.27 shows normality test results.

Table 4.27

Normality Test Results

	N	Skewness	Kurtosis
Surface LA	435	-.09	.19
Deep LA	435	-.16	-.27
Grit	435	.40	.35

Table 4.27 shows the distribution of the data for the learning approaches domains. The surface learning approach had a skewness coefficient of -0.09 and kurtosis coefficient of .19. The results show that the surface learning approaches was approaching normal distribution. The deep learning approach had skewness of -0.16 and kurtosis of -0.27. For grit, the skewness coefficient was 0.40 and the kurtosis coefficient was 0.35. According to Orcan (2020), scores are considered to be normally distributed when the coefficient values fall within the range of one for skewness and kurtosis. Since all the skewness and kurtosis values were within the range recommended by Orcan (2020),

the scores were normally distributed. The assumption of normality was also tested using a histogram and the results indicated that the scores of the criterion variable were normally distributed.

The assumption of heteroscedasticity and homoscedasticity was tested using normal p-p plot (Appendix D). The results obtained showed that the assumption of constant variance was met.

To assess the multicollinearity and singularity in the predictor variables, the researcher adopted VIF (Variance Inflation Factor) and Tolerance. The results were presented in Table 4.28.

Table 4.28

Tolerance and VIF

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Grit	.37	2.67
	Surface LA	.53	1.91
	Deep LA	.49	2.01

Note. LA = Learning Approaches; VIF = Variance Inflation Factor

Model 1 in Table 4.28 shows that grit had a tolerance of 0.37 and VIF of 2.67 while surface learning approaches had a tolerance of 0.53 and VIF of 1.91. The tolerance and VIF of deep learning approach was 0.49 and 2.01 respectively. The results implied that there was no multicollinearity in the grit, surface learning approaches and deep learning approaches. This was in line with the recommendation made by Oke et al. (2019) who

revealed that VIF less than 10 indicates that the variables are not highly correlated. Therefore, the data met the multicollinearity and singularity assumption. Having met all the assumptions, the data was subjected to hypothesis testing.

4.6.2 Hypothesis Testing

To determine the predictive weights of both learning approaches and grit in chemistry achievement, the following hypothesis was tested.

H04: The learning approaches and grit significantly do not predict chemistry achievement. The result for the analysis is given in Table 4.29

Table 4.29

Regression Model Summary for the Prediction of Chemistry achievement from Learning Approaches and Grit

Model	R	R^2	Adjusted R^2	*SEE*	ΔR^2	*F*	Sig.
1	.68[a]	.46	.46	7.40	.46	133.96	.00
2	.72[b]	.52	.51	7.03	.05	18.15	.00

a. Predictors: (Constant), Grit, Learning Approaches
b. Predictors: (Constant), Grit, Learning Approaches, Grit Gender, Learning Approaches Gender

The results in Table 4.29 show that in model 1, 46% variance in the prediction of achievement of chemistry can be explained by learning approaches and grit among the students. The findings further shows that learning approaches and grit had a positive strong correlation with the achievement in chemistry, $R = 0.68$. Model 2 shows the prediction of achievement in chemistry from the moderator terms between grit and gender and learning approaches and gender. The results indicate that $\Delta R^2 = 0.05$, showing that the moderation between the predictor variables and gender accounts for 5% variance in chemistry achievement. Change in R square was statistically significant,

ΔR^2= 0.05, $p < .05$.To establish whether learning approaches and grit predict chemistry achievement, ANOVA analysis of variance was conducted and the result is shown in the Table 4.30.

Table 4.30

ANOVA for the Prediction of Chemistry achievement from Learning Approaches and Grit

Model		*SS*	*Df*	*MS*	*F*	Sig.
	Regression	14689.15	2	7344.58	133.96	.00[b]
1	Residual	16996.53	433	54.83		
	Total	31685.68	435			
	Regression	16480.99	4	4120.25	83.46	.00[c]
2	Residual	15204.69	431	49.37		
	Total	31685.68	435			

Note. *SS* = Sum of Squares; *Df* = Degree of Freedom; *MS* = Mean Squares

a. Dependent Variable: Chemistry T score

b. Predictors: (Constant), Grit, LA

c. Predictors: (Constant), Grit, LA, Grit Gender, LA Gender

Table 4.30 shows the results of the ANOVA for the prediction of chemistry achievement from learning approaches and grit. In model 1 the result revealed that learning approaches and grit significantly predict chemistry achievement, F (2,433) =133.96, $p < .05$. Therefore, the null hypothesis was rejected.

Model 2, Shows gender as a moderator variable in the prediction of chemistry achievement from learning approaches and grit. The results indicated that gender did not significantly moderate the prediction of chemistry achievement from learning approaches and grit F (4,431) =83.46, $p < .05$.The regression coefficient of the prediction model is shown in Table 4.31

Table 4.31

Regression Coefficients for Prediction of Chemistry Achievement from learning approaches and grit

Model		*B*	*SE*	*β*	*T*	Sig.
	(Constant)	6.02	3.62		-1.66	.00
1	X_1	.29	.07	.27	4.46	.00
	X_2	1.08	.134	.47	7.81	.00
	(Constant)	7.88	3.53		-2.23	.03
	X_1	1.15	.19	1.04	6.03	.00
2	X_2	.24	.28	.10	-.85	.00
	X_3	.62	.13	1.94	-4.70	.09
	X_4	.98	.19	2.00	5.09	.11

a. Outcome Variable: Chemistry T score X_1= Learning Approaches; X_2 = Grit X_3 = Moderation term between Learning Approaches and Gender ; X_4 = Moderation term between Gender and Grit; ; B = Unstandardized Coefficients; SE = Standard Error; β = Standardized Coefficients

As shown Table 4.31, in model 1, Learning approaches and grit significantly predict the achievement in chemistry. The regression co efficient of learning approaches in model 1 was 0.29, $p < 0.05$. Grit had the predictive regression coefficient of 1.08, $p<0.05$.The findings shows that both predictor variables were statistically significant in predicting chemistry achievement. The prediction equation for model 1 was as follows;

$$\hat{Y} = 6.02+0.29X_1+ 1.08X_2 + \acute{\varepsilon} \text{ ----------1}$$

Where;

$\hat{Y}$ = Predicted Chemistry achievement.

X_1 = Learning Approaches

X_2 = Grit

The regression equation above indicates that a unit change in learning approaches led to 0.29 change in chemistry achievement. Similarly, a unit change in grit was associated with 1.08 change in chemistry achievement.

In Model 2, gender was tested as a moderator variable in the prediction of chemistry achievement from learning approaches and grit. The predictive value of learning approaches increased from 0.29 to 1.15 and that of grit decreased from 1.08 to 0.24.Gender does not significantly moderate the prediction of chemistry achievement from learning approaches and grit. The predictive equation was as shown below;

$$\hat{Y}= 7.88+1.15X_1+0.24X_2 + \acute{\varepsilon} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where;

$\hat{Y}$ = Predicted chemistry achievement

X_1= Learning Approaches

X_2 = Grit

X_3 = Moderation term between Learning Approaches and Gender

X_4 = Moderation term between Grit and Gender

Using the regression equation in model 2, a unit change in learning approaches results to 1.15 change in the chemistry achievement. Similarly, a unit change in grit contributes to 0.24 change in the achievement of chemistry. The findings further indicated that gender does not significantly moderate the prediction in chemistry achievement from learning approaches and grit.

4.6.3 Discussion of the Results

In the fourth objective, the researcher sought to determine the predictive weight for chemistry achievement from learning approaches and grit. The regression coefficients

obtained from the regression models show that both learning approaches and grit significantly predict the achievement in chemistry. It was also found that gender does not significantly moderate the prediction in chemistry achievement from both learning approaches and grit. The research findings were in line with the findings of Yaure et al. (2021).The study investigate how grit predicted academic achievement among the students. The results established that grit (interest, passion and perseverance) significantly predict academic achievement of students in different areas of study. The researcher further argued that perseverance and resilience increases learning tasks and efforts to improve retention of concepts among students. The results suggest that the level of grit is important in regulating the learning process and academic achievement among learners in school.

These study findings also support the results of Oduol et al. (2022). The study investigated how learning approaches predicted academic achievement among the secondary school students. The results of the study demonstrated that metacognitive planning had a positive significant relationship with academic achievement. Similarly, the study indicated that academic achievement was predicted by the learning approaches used during learning. As demonstrated by the current study, the metacognitive skills that are explored by the study help the learners to be aware of their thinking process and guide their learning approaches, thus achieving more regardless of the learning context.

The research's findings concur with those of Anthony et al. (2020). The goal of the study was to determine whether student grit was a predictor of academic success. Age, gender, drive, and grit were found to be significant determinants of students' academic success. Additionally, the findings showed that grit was the best predictor of academic accomplishment among the children. Despite the fact that the study employed academic

achievement as the outcome variable, the findings show that grit is essential in predicting success in chemistry because it has a strong correlation with academic achievement. Additionally, the students with high grit level are motivated to achieve more in chemistry regardless of the gender.

The findings of this study support those of Victor et al. (2020). In this study, achievement in organic chemistry among secondary school students was examined in relation to predict-explain-observation-explain (PEOE), Vee Heuristic (VH), discussion techniques, and other interaction effects of treatments and gender. According to the study's findings, the learning techniques predict-explain-observation-explain (PEOE) and Vee Heuristic had a substantial impact on how well the students performed in organic chemistry. Similarly, the findings confirmed that there was no significant effect of the student gender on the organic chemistry achievement among the learners. The findings of the research suggested that the discussions and other forms of interactions students engage in their studies; significantly improve their achievement in different areas of study particularly in chemistry.

The study findings of the current study are consistent with those of Duckworth et al. (2007), which established that the achievement of difficult goals entails sustained and focused perseverance and interest. The researcher shows that the abstract and complex nature of science subjects require an increased and sustained interest and perseverance among students. Silvervarg et al. (2018), carried out a study that was anchored on grit theory and established that the students with higher persevering ability scored better in academic achievement compared to those with lower perseverance ability. The Result suggested that science teachers should expose learners to different models, diagrams

and chats during learning to increase their interest and perseverance levels while learning new ideas.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary, conclusions and recommendations. It begins with the summary of the results based on the objectives of the study, conclusion and then the recommendations. The recommendations are further classified into further research recommendations and then practice and policy recommendations.

5.2 Summary

The main goal of this study was to investigate the relationship between learning approaches and grit as predictors of chemistry achievement. Particularly, the study aimed at establishing the relationship between learning approaches and chemistry achievement, investigating the relationship between grit and chemistry achievement, examining gender differences in learning approaches and grit and finally developing a predictive equation of chemistry achievement from learning approaches and grit.

The first objective of the study was to establish the relationship between learning approaches and chemistry achievement. A positive significant correlation was established between learning approaches and chemistry achievement. The study findings further revealed both domains of learning approaches had a positive significant relationship with chemistry achievement.

In line with the second objective, the study investigated the relationship between grit and chemistry achievement. The result showed that there was a positive and statistically

significant correlation between grit and chemistry achievement. Similarly, the domains of grit (Interest and perseverance) had positive correlation coefficients with chemistry achievement.

The third objective of the study sought to examine gender differences in both learning approaches and grit and chemistry achievement. The outcomes demonstrated that there were no significant gender differences in learning approaches and grit.

The fourth objective aimed at finding out the predictive weight of chemistry achievement from both learning approaches and grit. The findings indicated that learning approaches and grit predict achievement in chemistry. It was found that 46% variance in achievement in chemistry was explained by leaning approaches grit.

5.3 Conclusion

The study found out that there was a significant relationship between learning approaches and grit in chemistry achievement. The domains of learning approaches namely; deep learning approach and surface learning approaches were found to play a crucial role in the achievement in chemistry. The results suggest that students with well skills of learning approaches achieve more in chemistry. It is therefore important that students be trained to apply both learning approaches in their studies in order to enhance the highest level of achievement during learning chemistry.

In the second objective study found that there was a positive significant correlation between chemistry achievement and grit. The results suggest that grit is a significant construct that influences the achievement in chemistry. The findings imply that in order for teachers to promote grit then they should carefully plan lessons and use teaching aids, which constitute the interest of students during learning process.

In the third objective, the study established that gender of the student had no moderator effect on the relationship between learning approaches and grit towards the achievement in chemistry. The study similarly established that learning approaches and grit significantly predicted achievement in chemistry. Therefore, regardless of the gender of the student, learning approaches and grit are important predictors that influence the achievement in chemistry among secondary school students.

5.4 Recommendations

Based on the findings, the study makes the following policy and further research recommendations

5.4.1 Practice and Theory Recommendations

i. The study established that there was a positive and significant relationship between learning approaches and grit in the achievement of chemistry. Therefore, school counsellors and chemistry teachers should sensitize and support chemistry students to enhance their learning approach skills. This will go a long way in improving the student's achievement in chemistry for better learning results. Curriculum developers should also integrate learning content with different learning activities that stimulates the interest of student during learning for better learning outcomes in chemistry.

ii. According to the study's findings, there was a positive and significant correlation between grit and chemistry achievement. Based on the findings, the study recommended that chemistry teachers should always attempt to implement efficient teaching techniques to boost students' interest and perseverance in learning chemistry.

iii. Teachers and parents should be sensitized that gender of the student has insignificant influence on learning approaches and grit in the chemistry achievement among students. This will help to eradicate the narrative that boys have better learning approaches and grit for learning chemistry compared to girls.

iv. The study established learning approaches and grit when combined together they significantly predicted achievement in chemistry. Based on the results, chemistry teachers should ensure that they adequately support the students in learning chemistry by training them to enhance both learning approaches and grit at the same time. This will go a long way in improving achievement in chemistry. The parents should also encourage and support their children in learning chemistry in order to enhance their learning approaches and grit for better achievement in chemistry

5.4.2 Recommendations for Further Research

i. The study only focused on learning approaches and grit. There is need for further research on other factors that influence achievement in chemistry, which may extend the knowledge on the research variables studied by the current study .

ii. Achievement in chemistry is also an issue of concern among college and university students. Since the current study involved a sample of secondary school students, it may be necessary to replicate this study among college and university students for more conclusive results.

iii. The researcher employed correlational research design. Further studies should be conducted using other research designs to establish if similar findings would be obtained.

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APPENDICES

Appendix A: Consent Form

Dear respondent,

I am a postgraduate student at Kenyatta University pursuing a master of education degree in educational psychology. I am conducting a research on grit and approach to learning as predictors of academic achievement in chemistry of form three students in Etago Sub County. Participation in this study is voluntary and if you wish to withdraw, you can do so any time. The information that was obtained was handled with confidential and professional manner. When responses and data was released, they were reported in summary form only and no identifying information was included in any discussion of the results.

I agree to participate in the study.

Signature……

Thank you.

Yours sincerely,

Ezra Nyasimi

E55/CE/26182/2018

Appendix B: Students Questionnaire

Instructions:

Please answer all the questions as honestly as possible. Information collected was treated with utmost confidentiality and only used for the purposes of this study. Kindly participate by ticking as appropriate. Do not write your name or name of your school on this questionnaire. Do not share your answer with anyone.

SECTION A: BACKGROUND INFORMATION

a) Indicate your gender

Male ☐

Female ☐

b) What is your age? [ ] 16 and below [ ] 17-21 [ ] 22 and above

c) What is the category of your school ?

[ ]Extra-County

[ ]County

[ ]Sub-County

[ ]National School

Section B: Learning Approaches Questionnaire

Use the following scale and tick for each statement to indicate how much you disagree or agree with each of the statements. Strongly Disagree = 1, Disagree =2, Neutral=3, Agree=4 and strongly Agree= 5

	Strongly Disagree	Disagree	Neutral	Agree	strongly Agree
PART I a.I usually do not relate what I					
b.I often do not understand how various topics in chemistry inter-					
c. I memorize chemistry concepts rather than					
d. I underline the key concepts while reading for chemistry					
e. I break topics into parts when					
f. I summarize various chemistry topics with my own words when					
g. I make my own notes when reading for examinations					
h. I make things (such as memorable phrases, acronyms					
i. During chemistry lesson, I often do not understand how new					
PART II a. After a chemistry lesson, I					
b. I usually look for additional					
c.I relate the chemistry topics covered in class with other					
d. I look for more information on chemistry topics after which I					

e. I like doing practical work					
f. I often understand chemistry concepts only after doing					
g. When doing a practical,I usually try to understand the					
h.I understand chemical topics					

SECTION C: Grit Questionnaire

Using a scale of: 1=Not like me at all, 2=Not much like me, 3=Somewhat like me, 4=Mostly like me, 5=Very much like me.

Use tick [√] as appropriat**e**

PART I	**1**	**2**	**3**	**4**	**5**
a.My interest in chemistry changes from time to time					
b.New content in chemistry sometimes make me forget the previous ones.					
c.I understand some chemistry concepts for a short time but later lose interest					
d. I have difficulty in following ideas in chemistry topics that are too long					
e.I become interested in discovering new ideas when learning chemistry					

f. I often set a goal when learning chemistry but later forget about it.

PART II

a.I usually complete learning a chemistry topic once have begun

b.I have been able to achieve my chemistry target in the course of learning

c.I have overcome many challenges during chemistry learning

d.Obstacles do not discourage me from excelling in chemistry

e. I am diligent enough to understand chemistry topics

f.I work harder to pursue chemistry related courses in college

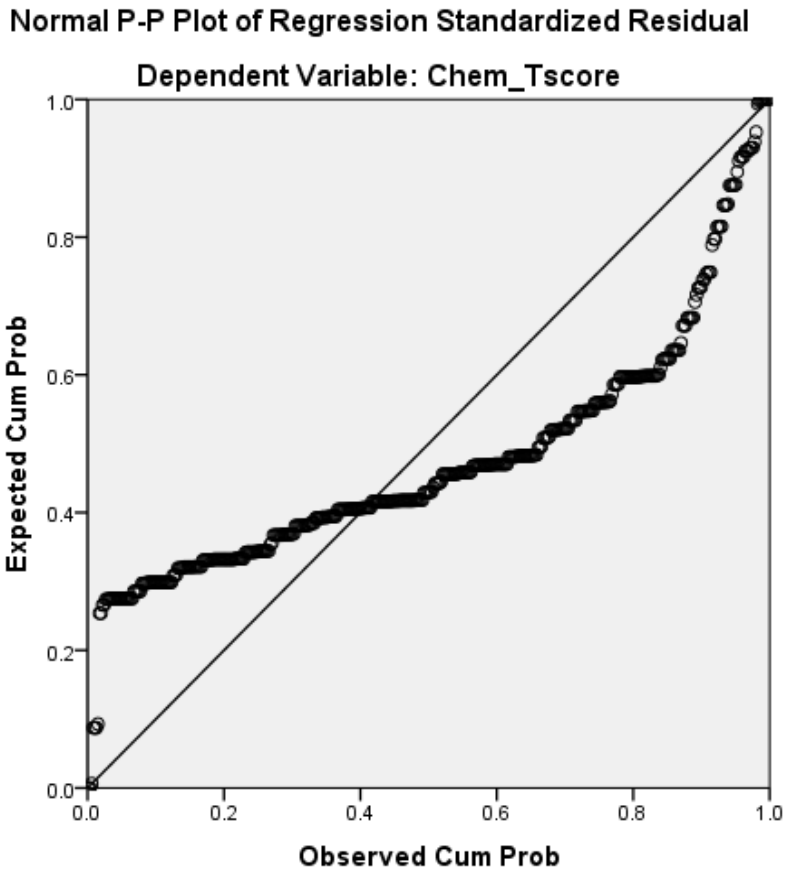
Appendix C: Pro Forma of Student's Chemistry Scores

Student's Code number----------

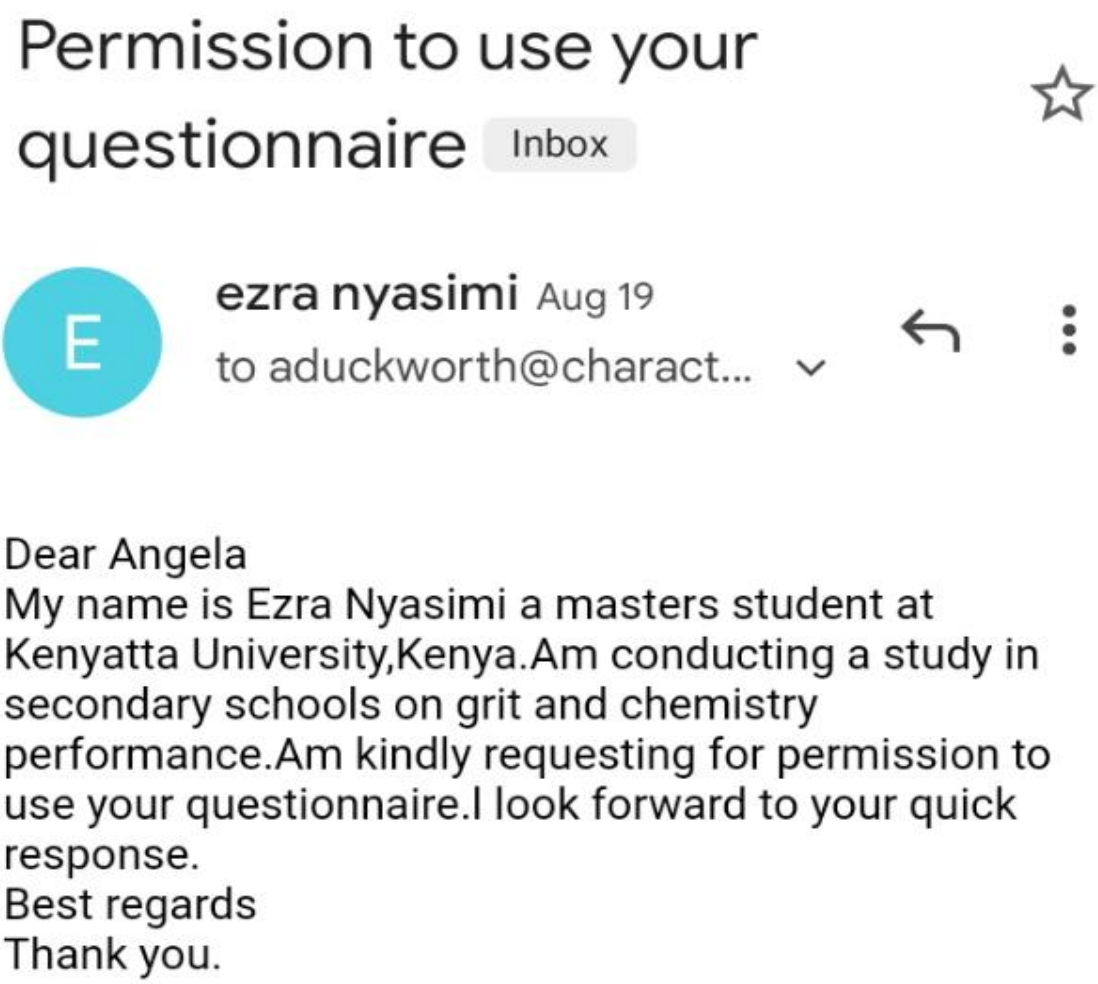
Student's chemistry achievement

Examination	**Total marks**
Mid Term One 2023	
End of Term One 2023	

Appendix D: Work Plan



Appendix E: Permission to Use Research Instruments



Permission to use your questionnaire Inbox

E

ezra nyasimi Aug 19

to aduckworth@charact...

Dear Angela
My name is Ezra Nyasimi a masters student at Kenyatta University,Kenya.Am conducting a study in secondary schools on grit and chemistry performance.Am kindly requesting for permission to use your questionnaire.I look forward to your quick response.
Best regards
Thank you.

How do I get permission to use the Grit Scale?
There are no restrictions for non-commercial uses for research, translation, or education. However, copyright protections prohibit reproduction in books, magazines, or other outlets, and/or commercial use.

For research, please note that the only validated English-language versions that we endorse have either 12 items (Duckworth et al., 2007) or 8 items (Duckworth & Quinn, 2009). The 10 item-version was what I published in the book Grit for the convenience of readers who wanted to calculate their scores by summing and dividing by 10. These scales are all extremely highly correlated (and are just subsets of the original 12-item scale), so if you've already collected data using the 10-item scale, you might point out this fact and cite this paper (click here): Duckworth, A. L., Quinn, P. D., & Tsukayama. E. (2021). Revisiting the factor structure of grit: A commentary on Duckworth and Quinn (2009). Journal of Personality Assessment. 103(5), 573-575. https://doi.org/10.1080/00223891.2021.1942022.

For most research purposes, because it more fully represents the construct of grit, I recommend the 12-item version. Note, too, that I do not keep track of translations of the Grit Scale into other languages than English but are aware, and encouraged, that other researchers have done so.

For more information on measurement, please click here.

Mika Lastusaari Aug 17

to me

Hello,

Thank you for your interest.

Yes, you can use the ChemApproach questionnaire provided that you cite to it (Lastusaari, M., Laakkonen, E., and Murtonen, M., ChemApproach: validation of a questionnaire to assess the learning approaches of chemistry students, Chemistry Education Research and Practice 17 (2016) 723–730.) whenever presenting or publishing data obtained with it.

Also, please inform me whenever you publish any data obtained with the questionnaire.

Best regards,

Mika Lastusaari.

Appendix F: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **922087**

Date of Issue: **30/June/2023**

RESEARCH LICENSE

This is to Certify that Mr.. Ezra - Nyasimi of Kenyatta University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kisii on the topic: LEARNING APPROACHES AND GRIT AS PREDICTORS OF CHEMISTRY ACHIEVEMENT AMONG FORM THREE STUDENTS IN KISII COUNTY, KENYA for the period ending : 30/June/2024.

License No: **NACOSTI/P/23/27046**

922087

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

Appendix G: Authorization Letters

OFFICE OF THE PRESIDENT

MINISTRY OF INTERIOR AND NATIONAL ADMINISTRATION, STATE DEPARTMENT FOR INTERNAL SECURITY AND NATIONAL ADMINISTRATION

Telegrams: "SUB-COUNTY", Etago.
Telephone: .....
E-mail:etagodcc@gmail.com
When replying please quote:
Ref. No.ETG/ED.12/9/VOL.1(11)

DEPUTY COUNTY COMMISSIONER
ETAGO SUB-COUNTY,
P.O. Box 10-40206
NYAMARAMBE

30TH JUNE 2023

TO ALL
ASSISTANT COUNTY COMMISSIONERS
ETAGO SUB-COUNTY

RE: RESEARCH AUTHORIZATION
MR. EZRA NYASIMI- REF. NO. 922087

The above named is a student at Kenyatta University undertaking **LEARNING APPROACHES AND GRIT AS PREDICTORS OF CHEMISTRY ACHIEVEMENT**

This is to inform you that he will be carrying out an academic research and the university has approved the research **Ref. no. NACOSTI/P/23/27046** dated **30th June 2023.** This is therefore to ask you to accord him the necessary assistance he may require.

DEPUTY COUNTY COMMISSIONER
ETAGO SUB - COUNTY
P. O. Box 10 - 40206, NYAMARAMBE
Date:.....Sign:.....

ANDREW MOTONGWA
FOR: DEPUTY COUNTY COMMISSIONER
ETAGO SUB-COUNTY

Copy to;

All Chiefs -Etago Sub-County
All Assistant Chiefs- Etago Sub-County

MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

State DEPARTMENT OF EARLY LEARNING AND BASIC EDUCATION

TELEGRAM: "EDUCATION"

TEL:058-30695

EMAIL ADDRESS: scdeetago@gmail.com

When replying please quote

SUB-COUNTY DIRECTOR OF EDUCATION

ETAGO SUB-COUNTY

P.O BOX 1155-40200

KISII.

30th JUNE , 2023

TO PRINCIPAL

I. MONIANKU SEC SCHOOL
II. NDONYO SEC SCHOOL
III. NYANGWETA SDA
IV. NYANGWETA DOK

RE: RESERCH AUTHORIZATION; EZRA NYASIMI REF.NO. 922087

The above referenced is a student at Kenyatta University and has been authorized to carry out research in our subcounty for his thesis **LEARNING APPROACHES AND GRIT AS PREDICTORS OF CHEMISTRY ACHIEVEMENT**. Your school is one of the schools earmarked for his study.

Kindly accord him the necessary assistance.

SUB COUNTY DIRECTOR OF EDUCATION
ETAGO SUB COUNTY
30 JUN 2023
Sign:.....
P.O. Box 1155-40200,KISII

Saka W.M

SCDE ETAGO

cc: CDE Kisii

cc: RDE Nyanza

Appendix H: Map of Kisii County showing Etago Sub County