CONTRIBUTION OF SCIENCE SUBJECTS TOWARDS DEVELOPMENT OF CREATIVITY AND INNOVATION AMONG THE YOUNG GENERATION IN PUBLIC SECONDARY SCHOOLS IN KWIMBA DISTRICT

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION IN CURRICULUM DEVELOPMENT AND DESIGN (MED-CDD)

OF THE OPEN UNIVERSITY OF TANZANIA

2025

CERTIFICATION

The undersigned certifies that they have read and hereby recommend for acceptance by the Open University of Tanzania a dissertation titled “The Contribution of Science Subjects towards Development of Creativity and Innovation among Young Generation in Public Secondary Schools in Kwimba District” in partial fulfilment of the requirement for the award of the Master of Education In Curriculum Design And Development (MED-CDD).

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Supervisor

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Date

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DECLARATION

I, **Boniventure Ng'andilo,** declare that the work presented in this dissertation is my own work and that it has not been presented to any other university or Institution for a similar or any other degree award. It is in this regard that I declare this work to be my original. It is hereby presented in partial fulfillment of the requirements for the Master of Education in Curriculum Design and Development (MED-APPS).

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Signature

……..……..

Date

DEDICATION

I sincerely dedicate this research work to my family members, including my lovely wife, Paulina Simba, for her support.

ACKNOWLEDGEMENT

Thanks and recognition should be extended first to my almighty God for intervention in the whole research process. Secondly, I would like to acknowledge the Open University of Tanzania for its deep commitment to teaching curriculum development and design. Furthermore, the completion of this work would not have been possible without the unfailing support provided by various individuals. I would like to extend my heartfelt thanks to all those who contributed to the success of this study.

I am incredibly grateful to all of them. I am particularly indebted to my supervisor, Dr. Christopher Charles Getera from the Open University of Tanzania, who, at times, provided me with clear directives on what to do, how to do it, and to what extent. This study benefited markedly from the modifications he recommended. Thanks to the Kwimba District Council, which kindly granted me a permit to conduct this research within their area of mandate. Moreover, I would like to extend my appreciation to my beloved wife, Paulina Simba, for her persistent and intuitive support.

ABSTRACT

This study assessed the contribution of science subjects to the development of creativity and innovation among the young generation in public secondary schools in Kwimba District. It was guided by four objectives: to determine the driving forces for students to undertake science subjects, to examine how these subjects promote creativity and innovation, to assess students' levels of creativity and innovation, and to evaluate challenges and solutions in teaching science subjects. The study was guided by the theories of creativity and diffusion of innovation and adopted a pragmatic paradigm with a mixed-methods approach using a convergent design. Data were collected from eight public secondary schools in Kwimba District, involving 380 students, 40 teachers, and 8 head teachers selected through purposive and stratified random sampling. Validity and reliability were ensured through pilot testing, and data analysis was systematically conducted with ethical considerations observed. Findings revealed that parental influence, peer relationships, and school systems significantly affected students' choices of science subjects. Science subjects enhanced creativity and innovation through practical learning, though traditional teaching methods limited this potential. Challenges included a shortage of qualified teachers, inadequate laboratory facilities, and insufficient resources. The study concluded that collaboration among parents, schools, and communities is vital for enhancing creativity in science education. It recommended that the government strengthen science education by improving laboratory facilities and teacher training to foster creativity and innovation.

Keywords: *Science Subjects, Development, Creativity And Innovation, Public Secondary Schools.*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF ABBREVIATION

BCT	Biology Creativity Test
DOI	Diffusion of Innovation
SCTB	Scientific Creativity Test in Biology

CHAPTER ONE

INTRODUCTION AND BACKGROUND INFORMATION

1.1 Introduction

This study examined the role of science subjects in fostering creativity and innovation among secondary school students. The chapter presents the background to the problem, the statement of the problem, the research objectives, the research questions, the significance of the study, the scope and delimitation of the study, as well as the definition of operational key terms.

1.2 Background to the Problem

The modern world is increasingly shaped by rapid advancements in science and technology, making scientific literacy an essential driver of national development. Sustainable progress cannot be achieved without significant investment in science and technology, which serve as the backbone of industrialization, communication, and innovation (Kihwele, 2014). Over time, science and technology have influenced virtually every aspect of human civilization, from agriculture and medicine to manufacturing and communication, highlighting their central role in societal growth and global competitiveness.

The evolution of science and technology can be divided into several key periods: the ancient era, the Middle Ages, the Scientific Revolution, the Industrial Revolution, and the modern digital age. Each period brought significant advances in human knowledge and innovation. The invention of the computer in the 20th century, for instance, transformed the way humans process information, solve problems, and create solutions. Gale eBook (2023) notes that computers have enabled scientists to

perform calculations with greater accuracy and speed, while the internet and social media in the 21st century have reshaped global communication and knowledge sharing. Such technological developments demonstrate the power of scientific education in fostering creativity and problem-solving abilities that are essential for societal transformation.

Science education, therefore, extends beyond theoretical knowledge to the development of practical and innovative abilities. Okpala (2006) argues that science teaching strengthens learners' capacity to apply scientific principles to real-life problems. This perspective highlights the role of science education in fostering creativity and innovation that can drive social and economic transformation. Accordingly, governments worldwide invest heavily in science education to cultivate a generation capable of generating technological solutions to pressing issues such as climate change, public health, and sustainable energy.

In the United States, science education is widely recognized as a major contributor to creativity, innovation, and economic competitiveness. The STEAM programs equip students with the skills necessary to solve complex real-world problems through experimentation, design, and collaboration (Stehle & Peters Burton, 2019; Khalil et al, 2023). Hands-on learning, mentorship, and technology-rich environments have been shown to increase students' interest in science careers and enhance their critical thinking abilities (Aguilar & Pifarre Turmo, 2019). Inquiry-based, project-oriented, and interdisciplinary approaches allow learners to actively construct knowledge rather than passively receive it, fostering creativity and problem-solving skills (Windschitl, Thompson, & Braaten, 2018). Additionally, initiatives such as maker

spaces, robotics programs, and innovation laboratories provide platforms for experimentation, intellectual risk-taking, and the practical application of scientific knowledge (Bevan et al. 2015).

In China, science education has been strategically employed to foster creativity, innovation, and national development. Wang, Xu, and Mao (2018) report that aligning training programs with industry needs, implementing stepwise open-source practice systems, and organizing innovation competitions significantly enhanced students' awareness of entrepreneurship and innovative thinking. At the secondary level, research on a "Workshop + Project" curriculum at Zhengzhou No. 12 Middle School revealed that integrating maker education, STEAM components, and multidimensional assessment strategies effectively promoted students' creativity and innovation skills (Zhang, 2021). These findings suggest that China is transitioning from rote learning to more practical, innovation-driven approaches that engage students in active problem-solving.

In Indonesia, science education is increasingly recognized as a key mechanism for promoting creativity and innovation among students. The government has prioritized STEM education to prepare young learners for the challenges of the 21st century and the demands of Industry 4.0 (Nugroho, Permanasari, & Firman, 2020). Curricula such as "Kurikulum 2013" and "Merdeka Belajar" emphasize inquiry-based, project-oriented, and interdisciplinary learning, creating opportunities for students to develop critical thinking, creativity, and problem-solving skills (Zulnaidi, et al. 2021; Suryadi, 2019).

In South Africa, Naidoo and Reddy (2023) demonstrate that higher-education science and mathematics instruction is evolving to respond to the Fourth Industrial Revolution (4IR), with an emphasis on technology-based teaching over traditional rote methods. Incorporating interactive digital tools and sustainable practices enhances student engagement and fosters creative thinking in STEM fields. Similarly, STEAM initiatives in secondary schools improve learners' innovation capacities when hands-on, inquiry-based activities are integrated into teaching (Sincuba, 2024). These highlight the importance of providing students with opportunities to explore, experiment, and apply their knowledge in real-world contexts, thereby nurturing creativity and innovation.

In Kenya, the integration of science-process skills into secondary school STEM curricula through hands-on experiments, open-ended questioning, and collaborative inquiry enhances students' creative and innovative capacities (Kirimi and Njagi, 2024). Such approaches promote flexible thinking, critical problem-solving, interdisciplinary connections, and teamwork skills. Embedding these skills in science and mathematics prepares learners for future scientific careers and fosters a mindset that is oriented toward experimentation and real-world applications.

The study of science subjects has become increasingly crucial for preparing the younger generation to engage effectively in the global economy. Mabula (2012) emphasizes that science education enables students to make informed career choices and participate confidently in a technologically advanced world. Science equips learners with analytical, critical thinking, and creative skills necessary for addressing complex societal challenges.

In Tanzania, policymakers recognize the importance of science education in preparing the young generation for scientific and technological advancement. Gardner, Csikszentmihalyi, and Damon (2002) emphasize that nurturing creativity through science education fosters curiosity, imagination, and innovative traits critical for national development. Effective secondary school science teaching lays the foundation for future scientists, inventors, and entrepreneurs who can make meaningful contributions to the nation's progress.

Following independence, Tanzania implemented policies and projects to strengthen science education as a driver of technological and economic growth. Initiatives such as the Unified Science Teaching Project and the East African School Science Project (1965, 1976, 1995, 1997, 2005, and 2007) aimed to enhance curricula, laboratory facilities, and teaching methods to make science more accessible and meaningful to learners (Hongoke, 1997; Mabula, 2012). These efforts were intended to prepare students to be self-reliant, innovative, and equipped for scientific careers that support national development.

Despite these initiatives, Tanzania continues to face challenges in achieving substantial progress in science education. The implementation of the Tanzania Development Vision 2025 resulted in a marginal increase in secondary school science enrollment, from 32% in 2015 to 35% in 2019 (NECTA, 2015, 2019). Mwabukojo (2020) argues that a primary limitation is the continued focus on factual content and examination performance rather than fostering creativity and innovation. Additionally, many students perceive science subjects as difficult, resulting in low enrolment and poor academic performance. NECTA 2022 results indicate that

79.92% of students failed Basic Mathematics, 32.16% failed Biology, and 31.66% failed Physics, reflecting persistent challenges in teaching and learning.

These realities underscore the need to re-examine how science subjects are taught in Tanzanian schools and whether they effectively promote creativity and innovation. Science education should extend beyond preparing students for examinations or science-related careers to foster imaginative thinking, experimentation, and problem-solving skills applicable across various life contexts. This is especially important for Tanzania's youth, who constitute the nation's most significant resource for innovation and development.

Understanding how science education fosters creative and innovative thinking in this context is crucial for enhancing teaching strategies, revising curricula, and aligning education with national development objectives. Since science education is globally acknowledged as vital for building scientific and technological literacy, this study seeks to assess the contribution of science subjects to the development of creativity and innovation among young people in public secondary schools in Kwimba District.

1.3 Statement of the Problem

Science education, particularly practical and inquiry-based learning, is widely recognized as a critical driver of scientific and technological advancement, equipping students with the knowledge and skills necessary for creativity and innovation (Eze & Akubue, 2007). Through science education, learners acquire functional competencies in scientific processes, which are essential for problem-

solving, experimentation, and technological development. In developing countries, specifically Tanzania, promoting a science culture and technological innovation among the younger generation is central to achieving the goals of Vision 2025, which emphasizes the need for a semi-industrial economy driven by knowledge and innovation (Mabula, 2012).

To achieve these goals, the Tanzanian government has implemented several strategies, including curriculum reforms, the employment of additional science teachers, and the establishment of school laboratories, all aimed at improving practical science education (Mabula, 2012). Despite these efforts, the secondary school science curriculum in Tanzania remains theoretical, mainly outdated, and often disconnected from students' daily experiences and societal needs (Archer et al., 2009). Consequently, many students opt out of science subjects when selecting optional courses at the upper secondary level. In contrast, others are discouraged from taking them altogether due to perceived difficulty or lack of relevance (Osaki, 2007).

Although previous studies have explored various aspects of science education in Tanzania, including challenges in implementation and policy perspectives (Mhaiki, 1986; Semali, 2012), there is a paucity of research specifically examining how science subjects contribute to the development of creativity and innovation among students. This gap is significant because fostering creative and innovative capacities through science education is vital for preparing the young generation to participate effectively in technological and economic development. Therefore, this study aims to investigate the contribution of science subjects to enhancing creativity and

innovation among students in public secondary schools in Kwimba District, providing insights for improving teaching strategies and aligning science education with broader national development goals.

Suppose the problem of neglecting creativity and innovation in science education is not urgently addressed. In that case, Tanzanian secondary school students will continue to be limited to rote learning, acquiring theoretical knowledge without the critical thinking, problem-solving, and inventive skills essential for technological progress. This will perpetuate poor performance in science subjects, low student engagement, and a scarcity of skilled innovators and scientists capable of driving national development. Consequently, the country's vision of achieving a semi-industrial economy and fostering a culture of scientific and technological innovation will be severely undermined, leaving the younger generation ill-prepared to compete in a rapidly evolving, knowledge-driven global economy. Failure to act decisively risks entrenching stagnation in scientific creativity, diminishing economic competitiveness, and constraining Tanzania's ability to transform its human capital into a catalyst for sustainable development.

1.4 Research Objective

This section covered general objectives and specific objectives as follows;

1.4.1 General Objective

To investigate the contribution of science subjects towards the development of creativity and innovation among the young generation in public secondary schools in Kwimba District.

1.4.2 Specific Objectives

The specific objectives of this research were;

i) To determine the driving forces for students to undertake science subjects in secondary school in Kwimba district

ii) To examine how science subjects promote creativity and innovation in students interacting with that curriculum.

iii) To assess the level of creativity and innovation of students taking science subjects in selected schools.

iv) To evaluate the challenges and ways to overcome them in secondary school science teaching that promotes creativity and innovation in selected schools.

1.5 Research Questions

The above objectives aimed to answer the following questions:

i) What are the science subjects learning driving forces on students' creativity and innovation from selected schools?

ii) How does a science student age in selected schools, influencing creativity and innovation?

iii) To what extent do science students from selected schools show their creativity and innovation ability?

iv) What are the challenges and ways that can be used to overcome those challenges of science teaching in promoting students' creativity and innovation?

1.6 Significance of the Study

The findings of this study offer policymakers and the Ministry of Education critical guidance on how science subjects can be leveraged to foster creativity and

innovation among students. By identifying the aspects of science education that most effectively cultivate innovative thinking, the study informs curriculum reforms, teaching standards, and education policies aimed at producing scientifically literate graduates capable of addressing technological and societal challenges. This is particularly important for achieving national development goals, including Tanzania's Vision 2025, which emphasizes the promotion of a science culture and technological innovation among the young generation.

Education stakeholders, including school administrators, teachers, and curriculum developers, can benefit from the study by gaining insights into practical instructional strategies that foster creative and innovative learning. Understanding how inquiry-based methods, practical experiments, and hands-on activities influence student engagement and critical thinking enables educators to design more meaningful lessons and optimize resources, such as laboratories and learning materials. These insights help schools in creating learning environments that encourage experimentation, collaboration, and problem-solving, ultimately strengthening students' capacity for innovation.

For learners, the study highlights the role of science subjects in developing essential skills for personal, academic, and professional growth. By participating in practical and inquiry-driven science education, students cultivate creativity, flexible thinking, and problem-solving abilities, preparing them for future STEM careers and real-world challenges. Additionally, the research contributes to the broader academic community by providing empirical evidence on how science education supports creative and innovative capacities, offering a foundation for further studies and

informing researchers, educators, and practitioners on best practices for nurturing innovation in secondary schools.

1.7 The Scope and Delimitation of the Study

This study examined the role of science subjects in fostering creativity and innovation among students in public secondary schools in Kwimba District. It explores how engagement with science education shapes students' creative thinking, problem-solving abilities, and innovative skills. By focusing on secondary-level students, the research offers valuable insights into effective teaching practices, curriculum design, and instructional strategies that foster creativity and innovation, underscoring the potential of science education to equip learners with the skills necessary for addressing real-world challenges.

The research was limited to public secondary schools in Kwimba District, specifically targeting students in Forms III and IV who have sufficient exposure to science subjects, as well as science teachers who can provide professional perspectives on curriculum delivery, teaching methods, and challenges in fostering creativity. Private schools, primary schools, and other educational levels are excluded to maintain a clear focus on the secondary education context. The study also concentrated on school-based factors, including curriculum implementation, teaching strategies, and classroom practices. In contrast, external factors such as socio-economic background and community resources were not the primary focus. This delimitation ensured that the findings directly reflect the contribution of science subjects to nurturing creativity and innovation in the school environment.

1.8 Operation Definitions of the Key Terms

1.8.1 Creativity: is the ability that human beings have to transcend traditional ways of thinking or acting and develop new and original ideas, methods, or objects. It is an act of turning a new and imaginative idea into reality.

1.8.2 Innovation: Is an idea that has been transformed into a practical reality. It is the action required to create a new idea, process, or product that, when implemented, leads to positive and effective change. Innovation involves two methods: thinking and producing.

1.8.3 Science subjects: these are subjects based on observation, experimentation, gathering of factual information, and the formulation of theories to explain the behavior of phenomena, such as palaeontology, geology, physics, chemistry, biology, virology, astronomy, and astrophysics.

1.8.4 Public secondary schools are those secondary schools owned by the Tanzanian government.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This part contained reviews of theories and a review of empirical studies. The review of the related literature was organized and presented according to the major themes derived from the research objectives. The chapter concluded with a demonstration of the knowledge gap and a conceptual framework.

2.2 Theoretical Literature Review

In research, a theory serves as a systematic framework for understanding, explaining, and predicting phenomena, guiding the entire research process from problem formulation to data interpretation. It provides a lens through which researchers can identify key variables, establish relationships, and interpret findings in a meaningful context (Creswell, 2014; Neuman, 2014). Theories serve critical functions, including explaining why events occur, predicting outcomes under specific conditions, guiding research design, and integrating results with existing knowledge to advance understanding (Sekaran & Bougie, 2016). This study was guided by two theories: the theory of creativity and the diffusion of Innovation theory. Both of which were discussed below.

2.2.1 Theory of Creativity

Creativity theory, which traces its origins to the nineteenth century, emerged from developmental process theories where creativity was understood as a transition from one level of understanding to another (Gruber, 1980). Freud's seminal essay, *"Creative Writers and Daydreaming" (1907), significantly influenced early*

conceptualizations by suggesting that the imaginative play of children gradually transforms into adult daydreams, highlighting the child's capacity to create their own worlds. Subsequent theorists, including Piaget, Vygotsky, and Gardiner, further expanded on these ideas, emphasizing the active role of the learner in inventing rather than merely discovering knowledge. Piaget, in particular, considered play a symbolic process that nurtures creative imagination and proposed that children encode environmental features in ways that facilitate problem-solving and innovation (Ayman Nolley, 1999; Piaget, 1970). Thus, creativity is understood not simply as spontaneous inspiration, but as a structured developmental process in which individuals construct new schemas, reorganize their thoughts, and generate novel ideas.

The creativity theory emphasizes the continuum of creativity from ordinary, everyday problem-solving to historically significant innovations, highlighting that all individuals possess varying degrees of creative potential (Vygotsky, 1978). It recognizes that creativity can manifest differently even within the same domain and that the level of creative output at any moment depends on the interaction of cognitive, environmental, and personal factors (Gardiner, 1983). Additionally, Piaget's notion of schema construction underscores that creativity involves the reorganization of thought rather than the mere accumulation of knowledge.

However, the theory has limitations; it does not directly address how creativity can be systematically promoted through formal subjects such as science. Amabile (2012) notes that while creativity theories provide comprehensive models of the social and psychological components of creative work, they offer limited guidance for practical

educational applications, particularly in domain-specific fields like science.

In this study, creativity theory provided a foundational lens to examine how science education can foster innovative thinking among students. By emphasizing that learners actively construct knowledge and generate new ideas, the theory supports the exploration of science subjects as platforms for developing creative capacities. The researcher applied this theory to assess how inquiry-based, problem-solving, and practical approaches in science teaching encourage students to creatively encode information, reorganize their understanding, and apply knowledge in novel ways. Furthermore, it informed the evaluation of how both domain-specific skills in science and domain-general cognitive processes contribute to students' ability to innovate, thereby guiding data collection and interpretation regarding the development of creativity and innovation among secondary school learners in Kwimba District.

2.2.2 The Theory of Diffusion of Innovation

Diffusion of Innovation (DOI) theory, developed by E.M. Rogers in 1962, is one of the foundational theories in social sciences, originating in communication studies to explain how ideas, practices, or products gain momentum and spread through a population or social system over time. The theory posits that adoption occurs when individuals perceive an idea, behavior, or product as new or innovative, leading to a change in their behavior (Rogers, 2003). Key factors influencing adoption include relative advantage, or the perceived superiority of the innovation over existing alternatives; compatibility, or the alignment with the adopter's values, experiences, and needs; complexity, which relates to how difficult the innovation is to understand

or use; trainability, the degree to which the innovation can be tested before adoption; and observability, the extent to which the results of the innovation are visible to others (Wayner & Lamorte, 2022). This theory provides a framework for understanding how new concepts, technologies, and practices diffuse across individuals and social networks.

The Diffusion of Innovation theory explains how innovations are adopted and spread within a society, identifying key factors that affect adoption, including the characteristics of the innovation, the adopters, and the communication channels used to disseminate information. It also predicts the rate of adoption and helps institutions such as schools identify early adopters to create momentum for broader acceptance. Additionally, the theory helps identify barriers to adoption and develop strategies to overcome them. However, DOI theory assumes homogeneity among individuals, neglecting differences in resources, social support, culture, and geographic context (Mohamed, 2023; Wayner & Lamorte, 2022). The theory also assumes a linear adoption process, whereas in reality, adoption can be non-linear, influenced by feedback loops and external socio-economic and political factors. These limitations highlight the need for contextual adaptation when applying DOI to real-world scenarios.

In relation to this study, the DOI theory is relevant for examining how secondary school students adopt and engage with science subjects as vehicles for creativity and innovation. By viewing science education as an “innovation” within the learning environment, the theory helped the researcher to understand how students perceive the value, relevance, and applicability of science knowledge and practical skills. It

also provided a framework to assess how teaching methods, school resources, and peer influence can affect the adoption of creative and innovative thinking among learners. Through this lens, the researcher can analyze the factors that facilitate or hinder students' engagement with science subjects, thereby providing insights into strategies for enhancing creativity and innovation in secondary schools in Kwimba District.

2.3 Empirical Literature Review

The review of empirical studies is organized into four themes, drawn from the research objectives.

2.3.1 The Driving Force that Influences the Students to Take Science Subjects

Seang et al. (2021) investigated the factors influencing upper secondary students' choice between science and social science streams in Cambodia. The study revealed that a combination of personal characteristics, such as interest and perceived ability, family influences including parental guidance and socioeconomic status, and school-related factors like teacher support and access to learning resources, shaped students' choices. Additional considerations included peer influence, anticipated university opportunities, and concerns about passing the Grade-12 national examinations, which often discouraged students from selecting the more demanding science stream.

The study highlighted a declining trend in science-track enrolment, emphasizing the challenges in promoting STEM education and building innovation capacity in Cambodia. Although Seang et al. (2021) provided valuable qualitative insights into

students' decision-making processes, it was limited by a small sample size and focused primarily on subject or track choice rather than the development of creativity or innovation, suggesting a need for further research linking science education engagement with creative and innovative outcomes.

Omondi (2013) conducted a study in Kenya to investigate the factors influencing students' choice of science subjects in secondary schools, with a focus on Lang'ata High School in Nairobi County. The study identified several determinants of subject choice, including students' personal interest, perceptions of science, availability of resources, teacher guidance, career aspirations, and gender-related differences. Students were more likely to select science subjects when they perceived them as relevant, engaging, and beneficial for future careers. At the same time, inadequate resources, poorly equipped laboratories, and limited teacher support discouraged engagement.

Teacher encouragement and quality of instruction were found to significantly shape students' subject selection, highlighting the role of educators in motivating learners toward science. While Omondi (2013) provided valuable insights into the factors affecting science subject uptake, the study was primarily focused on urban areas and employed a case-study approach. It did not directly explore the subsequent development of creativity and innovation among students. This gap highlights the importance of extending research to rural contexts, such as Kwimba District in Tanzania, where limited facilities and teaching resources may have a different impact on students' engagement with science and their creative and innovative capacities.

Huruma (2015) examined the factors influencing secondary school students' choice of science subjects in Tanzania, with a focus on schools in the Kibaha District. The study found that a combination of personal interest, perceived ability, the quality and availability of teaching and learning resources, teacher influence, and career aspirations shaped students' subject choices. In particular, the presence of adequate laboratories, textbooks, and science-trained teachers increased the likelihood that students would select science subjects; conversely, resource shortages and weak teaching discouraged students from pursuing science.

The study also highlighted gender and socioeconomic elements, noting that girls and students from less-resourced schools were less likely to opt for science subjects. While Huruma (2015) offered valuable insights into subject-choice dynamics in a Tanzanian context, it did not extend to examining how the selection of science subjects translated into outcomes such as creativity or innovation among students, indicating a gap for further research linking science engagement to creative/innovative thinking.

Komba and Ndalichako (2014) investigated the driving forces influencing secondary school students' choice of science subjects in Tanzania, focusing on 18 schools across different regions. The study found that students' choices were shaped by a combination of personal interest, perceived ability, teacher influence, parental guidance, and the availability of school resources. However, external circumstances often played a decisive role; inadequate laboratories, lack of qualified science teachers, limited teaching materials, and the challenges of learning science in English frequently discouraged students from selecting science subjects. The study

also revealed that students were influenced by the perceived relevance of science to their daily lives and future career opportunities; however, many opted for arts subjects due to difficulties in coping with science content. While Komba and Ndalichako (2014) provided valuable insights into the factors driving subject choice in Tanzania, they did not examine how engagement in science subjects translates into creativity or innovation among students. This gap underscores the need for further research to investigate the relationship between science education participation and the development of creative and innovative capacities in Tanzanian secondary schools.

2.3.2 Science Subjects Promote Creativity and Innovation in Students

Ramma et al. (2015) conducted a study on creativity and innovation in Science and Technology education, focusing on bridging the gap between secondary and tertiary levels of education. The study aimed to investigate how science and technology learning environments impact students' creativity and innovative capacity as they transition from secondary to university education. Using a mixed-methods approach, the researchers collected data through questionnaires administered to trained secondary school teachers and university students, complemented by interviews for triangulation.

The findings indicated that both teachers and students recognized the essential role of science and technology education in nurturing creativity and innovation. However, the study revealed a significant disconnect between the educational goals outlined in curricula and the actual classroom practices implemented. The limited use of practical experiments, lack of creativity-oriented activities, and inadequate

instructional support were found to hinder students' ability to think critically and innovatively.

Despite providing valuable insights into how science education can foster innovation, the study had several methodological limitations. The study involved a relatively small sample size drawn from only three institutions, which limited the generalizability of the results. Additionally, gender and contextual factors were not adequately considered, potentially overlooking variations in how creativity develops among different student groups. The study, therefore, emphasized the need for further empirical research involving diverse stakeholders, such as students, teachers, school administrators, and quality assurance personnel, to better understand how science subjects can effectively promote creativity and innovation across educational levels. These findings highlight that for science education to enhance creativity and innovation, instructional approaches must be more practical, inclusive, and aligned with real-world problem-solving.

Susan (2019) conducted a study in Kwara State, Nigeria, to examine the influence of senior secondary school physics education on students' creativity and innovation, with particular attention to its implications for entrepreneurial capacities. The study aimed to investigate the impact of learning physics on the development of students' creative and innovative thinking skills. A total of 250 senior secondary school physics students were selected from twenty schools using a quantitative research design. Data were collected through a 12-item questionnaire designed to measure the extent to which physics education fosters creativity and innovation. The instrument underwent face and content validation, and its reliability coefficient was established

at 0.79, indicating a high degree of internal consistency. The collected data were analyzed using frequency counts, percentages, and mean ratings to identify patterns and trends related to students' perceptions of creativity and innovation in physics learning. The findings revealed that physics education has a positive influence on students' creative and innovative abilities by enhancing their problem-solving skills, logical reasoning, and capacity to apply scientific concepts in real-life situations.

While the study provided valuable evidence linking science education, specifically physics, to creativity and innovation, it was limited by its exclusive use of questionnaires as the sole data collection instrument. The lack of qualitative methods, such as interviews or classroom observations, restricted the depth of insight into how instructional practices shape students' creative experiences. Additionally, the study focused only on students' perspectives, neglecting the views of teachers and administrators who play a crucial role in facilitating creativity in science education. Nevertheless, the research highlights the importance of science subjects in fostering creative and innovative thinking, suggesting that integrating hands-on experiments, collaborative projects, and entrepreneurial applications into physics education could further enhance students' creativity and innovation skills.

In Tanzania, Komba and Shukia (2023) conducted a study titled *"An Analysis of the Basic Education Curriculum in Tanzania: The Integration, Scope, and Sequence of 21st Century Skills."* The purpose of this study was to investigate the extent to which the Tanzanian basic education curriculum promotes essential 21st-century skills, including creativity, critical thinking, collaboration, and problem-solving, among graduates. The researchers employed a mixed-methods approach, involving the

collection of data through interviews and a documentary review. Their analysis focused on determining whether the curriculum content, structure, and implementation strategies effectively promote the skills outlined in national educational policies. The study revealed that while Tanzanian educational policy documents, such as the Education for Self-Reliance philosophy, the 2014 Education and Training Policy, and the National Curriculum Framework, emphasize the integration of 21st-century competencies, a disconnect remains between these policy intentions and their actual realization in classroom practice.

Although the study successfully linked curriculum design to skill development, its scope of data collection methods was limited, as it primarily relied on interviews and document reviews, while neglecting the use of questionnaires and classroom observations. These limitations reduced the depth of insight into how 21st-century skills are practically implemented in schools. The current research, therefore, expands on this by employing a broader range of tools, including questionnaires, interviews, document reviews, and observations, to obtain richer and more comprehensive data.

Komba and Shukia (2023) concluded that, although the curriculum theoretically supports the development of 21st-century skills, challenges such as inadequate funding, a shortage of qualified teachers, and a lack of continuous professional development programs hinder its effective implementation. Their findings highlight the persistent gap between curriculum policy and classroom reality, emphasizing the need for systemic reforms to ensure that Tanzanian students not only learn about creativity and critical thinking but also acquire these skills through active,

experiential learning practices.

2.3.3 The Level of Creativity and Innovation of Students Taking the Science Subject

Redo et al. (2021) investigated the Dimensions of Creativity in High-Ability Secondary School Students. The objective of the study was to analyze the dimensions of creativity in high-ability teenage students. The study was conducted in Spain, where a sample of 315 students was taken. The study employed a quantitative approach, where the Torrance Test of Creative Thinking assessed the fluency, flexibility, and originality dimensions using the Scientific-Creative Thinking Test. The study was exploratory by nature.

The study employed a single approach to reach its conclusion. By relying on a single approach in the previous study, the researcher of the current study believes that some vital information concerning the level of creativity and innovation among students may not have been well triangulated. The current research employs a mixed approach to capture both qualitative and quantitative information. The study used questionnaires, document searches, interviews, and observations to collect data, rather than relying solely on a test. The results of Redo et al. (2021) provide evidence that high-ability students achieve higher scores in both the figurative creativity and scientific creativity dimensions. A significant relationship between creativity and high ability was therefore established. Students with high skills and qualities require the educational support necessary to develop their talent.

In Kenya, Chumo (2014) conducted research on the Effects of practical investigation on scientific creativity among secondary school biology students in Kericho District,

Kenya. The aim was to examine the effect of the Practical Investigation laboratory approach on scientific creativity among Form Three biology students in Kericho District. The study utilized a population of all Form Three students in Kenya, from which a sample of 180 students was selected from four schools. These 180 students were randomly chosen purposefully. The researcher used the Biology Creativity Test (BCT) and the Scientific Creativity Test in Biology (SCTB) to triangulate the needed information.

Through the decision of Chumo (2014) to use only form three students as a sample of the research and the decision to study only biology subjects and using Biology Creativity Test (BCT) and Scientific Creativity Test in Biology (SCTB), the researcher of the current study is in thought that the researcher may have failed to obtain results from other groups like teachers, head of schools and school quality assurers. Additionally, the researcher from the previous study could have employed questionnaires, interviews, observation, and document searches to gather more helpful information. The current study will use Forms 3 and 4 as the sample size, and questionnaires, interviews, observation, and document search as the instruments for data collection. By doing so, the researcher of the current study believes that some useful information was obtained.

Matiku (2019) conducted a study in Tanzania to examine the relationship between creative thinking, metacognitive thinking, and academic performance among secondary school students. The study aimed to determine how these two cognitive abilities contribute to students' overall academic achievement. A quantitative research design was employed, involving a sample of 444 students, 217 males and

227 females from different secondary schools. Data were collected using standardized tests that measured creative and metacognitive thinking, as well as students' academic records. The results indicated a strong positive correlation between creative thinking, metacognitive ability, and academic performance, suggesting that students who exhibit higher levels of creativity and self-regulated learning tend to achieve better academically. These findings underscore the crucial role of creative and reflective thinking in enhancing problem-solving skills and overall learning outcomes among secondary school students in Tanzania.

Although the study provided valuable insights into the relationship between thinking skills and academic success, it was limited to quantitative methods. It did not include qualitative approaches such as interviews or classroom observations. This narrowed the understanding of how teaching practices and school environments contribute to the development of creative and metacognitive skills. The current research addresses these limitations by employing a mixed-methods approach, incorporating questionnaires, interviews, observations, and document reviews to gain a more comprehensive understanding of how science subjects foster creativity and innovation. Matiku's (2019) findings emphasize the importance of integrating instructional strategies that nurture creativity and metacognition as a means to improve both innovation and academic performance among students.

2.3.4 Challenges and Ways to Overcome Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation

Sarsani (2019) conducted a study in India to explore the promotion of creative thinking among secondary school students. The study involved a sample of 373

students and 88 teachers from nine government schools, using multiple data collection instruments, including questionnaires for both students and teachers, scales measuring teachers' encouragement of creativity in the classroom, interviews with teachers, and checklists completed by head teachers regarding out-of-school activities. The findings indicated that students' creative thinking was strongly influenced by teacher support, classroom practices, and the availability of extracurricular opportunities that encouraged problem-solving and innovation.

Teachers who actively fostered creativity in lesson planning and encouraged experimentation and idea generation contributed significantly to higher levels of creative thinking among students. The study also highlighted the importance of school policies and leadership in providing an environment conducive to creativity, demonstrating that both in-class and out-of-class activities play a crucial role in nurturing innovation. While Sarsani's (2019) research provides valuable empirical evidence on promoting creativity in secondary schools, it primarily focuses on classroom and school-level interventions without directly linking engagement in specific science subjects to creativity and innovation, indicating a potential area for further investigation in contexts such as science education.

Dorsah et al. (2024) conducted a study in the Kassena-Nankana Municipality of Ghana to examine the challenges in teaching integrated science in junior high schools. Using a positivist paradigm and a survey design, the study purposefully sampled eleven integrated science teachers to gather their perspectives on the difficulties encountered in delivering science instruction. The findings revealed several key challenges, including inadequate teaching and learning resources, large

class sizes, insufficient teacher training, and limited practical laboratory opportunities. These constraints negatively affected the effectiveness of science instruction and limited students' engagement in hands-on learning activities, which are essential for fostering creativity and problem-solving skills.

The study emphasizes the crucial role of teacher preparedness, resource availability, and supportive learning environments in promoting effective science education. However, while Dorsah et al. (2024) focused on the challenges in teaching science, the study did not directly assess how these challenges impact students' creativity and innovation, suggesting a need for further research linking instructional quality and resource adequacy to the development of creative and innovative capacities among learners.

Kawonga (2017) conducted a study in Morogoro Municipality, Tanzania, to examine the challenges faced by science teachers in nurturing young scientists in secondary schools. The study employed a cross-sectional research design and collected data through questionnaires, focus group discussions, and structured interviews with science teachers. The analysis, conducted using frequencies and percentages, revealed several significant challenges hindering the development of future scientists, including limited laboratory facilities, a shortage of teaching and learning materials, large class sizes, insufficient teacher training, and low student motivation.

These constraints were found to negatively affect the quality of science instruction and restrict opportunities for students to engage in practical experiments, problem-solving, and innovative activities. While the study provided valuable insights into the

barriers faced by science educators, it did not directly investigate how these challenges influence students' creativity and innovation, highlighting a gap for further research on the link between science teaching practices and the development of creative and innovative capacities among secondary school students in Tanzania.

Kibona, Ndabi, and Kibona (2020) conducted a study in Mbeya to investigate the professional development needs of secondary school science teachers and their implications for effective science teaching. The study used a quantitative, cross-sectional survey design and involved 256 science teachers selected through stratified sampling. Data were collected using structured questionnaires that assessed teachers' pedagogical knowledge, content mastery, and use of modern teaching technologies. The findings revealed several challenges affecting the quality of science teaching, including inadequate mastery of complex science content, limited pedagogical skills, and insufficient familiarity with contemporary teaching tools and methods. These deficiencies were identified as key barriers to fostering higher-order learning outcomes, including creativity and innovation among students.

The study emphasized the importance of targeted professional development programs in strengthening teachers' instructional competence, enhancing practical teaching skills, and integrating modern pedagogical approaches into science lessons. While the research primarily focused on teacher preparation and instructional challenges, it offers valuable insights into potential strategies for overcoming barriers that hinder the promotion of creativity and innovation in secondary school science education in Tanzania.

2.4 The Research Gap

Existing empirical studies in Kenya, Cambodia, and Tanzania (Seang et al., 2021; Omondi, 2013; Huruma, 2015; Komba & Ndalichako, 2014) have investigated the factors driving students' choice of science subjects. These studies highlight that factors such as personal interest, teacher guidance, parental influence, career aspirations, and availability of school resources significantly shape students' engagement in science. However, most of these studies focused on subject choice rather than examining how participation in science subjects translates into the development of creativity and innovation. Additionally, many studies were limited to urban or specific school contexts, neglecting rural areas where resource constraints may differently affect students' learning experiences and creative potential.

Research investigating the role of science subjects in promoting creativity and innovation (Ramma et al., 2015; Susan, 2019; Komba & Shukia, 2023) highlights the positive impact of science education on students' creative thinking and problem-solving skills. Nevertheless, these studies often employed small sample sizes, limited data collection methods, or focused on either secondary or tertiary education without integrating perspectives from teachers, students, and school administrators. Studies measuring the level of creativity and innovation among students (Redo et al., 2021; Chumo, 2014; Matiku, 2019) concentrated mainly on high-ability students or single subjects, with minimal triangulation of data sources. Consequently, there remains insufficient empirical evidence on how engagement in science subjects, supported by effective teaching practices, fosters creativity and innovation across a broader student population.

Studies on challenges in secondary school science teaching in Tanzania and other contexts (Sarsani, 2019; Dorsah et al., 2024; Kawonga, 2017; Kibona, Ndabi & Kibona, 2020) reveal recurring obstacles, including inadequate laboratories, insufficient teaching resources, lack of professional development, large class sizes, and low student motivation. While these studies provide valuable insights into teaching constraints, they rarely explore the direct link between these challenges and students' creative and innovative outcomes. This indicates a clear research gap: there was a need for comprehensive studies that integrate multiple stakeholders and data collection methods to examine how science teaching practices, school resources, and curriculum implementation collectively influence the development of creativity and innovation among secondary school students, particularly in rural Tanzanian districts like Kwimba.

2.5 Conceptual Framework

The conceptual framework highlights key factors, including professional development, infrastructure, motivation, funding, and policy, that critically influence the effectiveness of science subjects in fostering creativity and innovation among students. Professional development equips teachers with the necessary skills, pedagogical knowledge, and innovative strategies to deliver science lessons that stimulate critical thinking and problem-solving. Adequate infrastructure, including well-equipped laboratories and accessible learning facilities, provides a supportive environment for practical experimentation and hands-on learning, which are essential for nurturing innovation. Motivation, both intrinsic and extrinsic, encourages students to actively engage with science content, explore ideas, and apply knowledge creatively. Sufficient funding ensures the availability of learning materials, modern teaching technologies, and continuous teacher training, all of

which enhance the quality of science education. Policy frameworks guide curriculum design, teaching practices, and assessment standards, ensuring that creativity and innovation are integral to science education. Together, these guiding factors establish the conditions necessary for science subjects to effectively develop students' creative and innovative capacities, linking institutional support, resources, and motivation to meaningful educational outcomes.

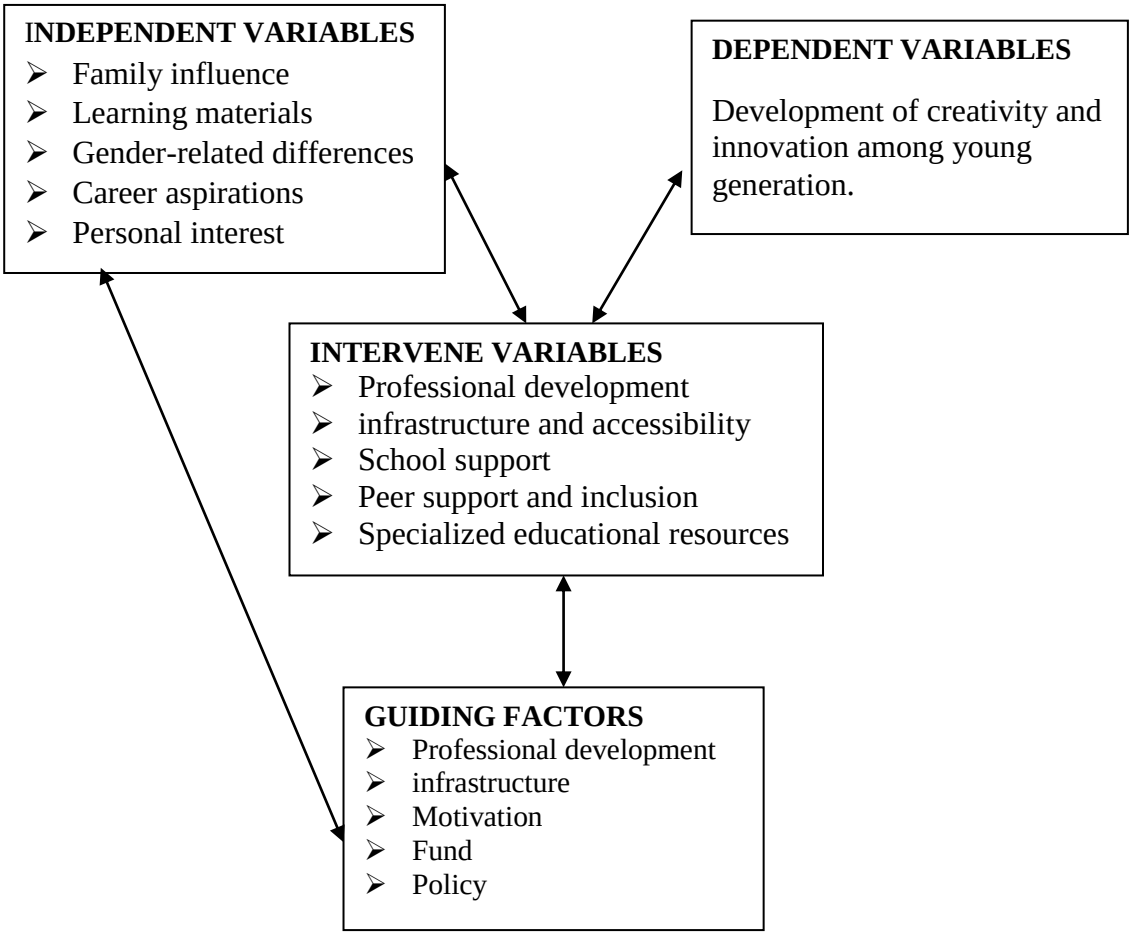

Figure 2.1: Conceptual Framework

Figure 2.1: The Relationship between Variables in the contribution of science subjects towards the development of creativity and innovation among the young generation in public secondary schools.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines how data were collected and analysed. It encompasses the research philosophy, research approach, research design, study area, targeted population, sample, and sampling techniques. Additionally, this chapter introduces the data collection methods, data analysis procedures, validity and reliability, as well as ethical considerations.

3.2 Research Paradigm

Creswell (2014) suggests that pragmatism is ideal for research that seeks to address practical issues by drawing from multiple methods, ensuring that the findings are grounded in real-world experiences and outcomes. The study adopted pragmatism, a philosophical paradigm developed by scholars such as Charles Sanders Peirce, William James, and John Dewey, which emphasizes the practical application of knowledge and acknowledges that truth is not absolute but emerges from lived experiences and practical consequences (Besta, 2010). The reasons for opting for this approach are that, in educational research, pragmatism enables the blending of both objective and subjective perspectives to fully capture the complexities of academic practices, particularly in inclusive settings.

Objective knowledge is the facts and data that can be measured and observed. For example, in this study, objective data may include the number of students taking science subjects, their academic performance records, and responses from structured questionnaires that assess their levels of creativity and innovation. Subjective

knowledge, on the other hand, focuses on personal experiences, attitudes, and perceptions that cannot be directly measured but provide deeper insight into participants' motivations and interpretations of their learning environment. This study, therefore, integrated both forms of knowledge by combining quantitative data on students' engagement and performance in science subjects with qualitative insights from interviews and observations.

3.2.1 Research Approach

This study employed a mixed-methods research approach, combining both quantitative and qualitative methods to provide a comprehensive understanding of the contribution of science subjects to the development of creativity and innovation among students in public secondary schools in Kwimba District. The mixed approach was guided by the pragmatic research paradigm, which emphasizes the use of multiple methods to effectively address research questions and capture both measurable trends and in-depth perspectives (Creswell, 2014). The quantitative component of the study involved the use of questionnaires to collect numerical data on students' engagement in science subjects, their perceived creativity levels, and the factors influencing their participation. This approach helped in identifying patterns and relationships between science learning and creativity development.

On the other hand, the qualitative component involved interviews and observations aimed at exploring teachers' and students' experiences, perceptions, and attitudes towards science subjects and their role in fostering creativity and innovation. This allowed the researcher to gain richer insights into how teaching methods, curriculum content, and learning environments influence students' creative and innovative

thinking. The integration of both approaches enabled triangulation, thereby increasing the validity and reliability of the findings. Overall, the mixed research approach provided a balanced and holistic understanding of the research problem, aligning with the study's goal of generating both statistical evidence and contextual interpretation relevant to improving science education practices in Tanzania.

3.2.2 Research Design

A convergent research design was employed in this study to effectively integrate both quantitative and qualitative data in addressing the research objectives. According to Creswell and Plano Clark (2018), this design allows the researcher to collect both types of data concurrently, analyze them separately, and then merge the results to draw comprehensive and corroborated conclusions. The primary purpose of using the convergent design is to gain a deeper and more holistic understanding of the contribution of science subjects to creativity and innovation among students by combining the strengths of both numerical and descriptive data.

In this design, quantitative data were gathered through questionnaires administered to students and teachers to identify measurable trends such as the extent of students' engagement with science subjects, their perceived creativity levels, and factors influencing their motivation. At the same time, qualitative data were collected through interviews and classroom observations to explore teachers' and students' experiences, teaching practices, and perceptions regarding the role of science education in fostering creativity and innovation. The two sets of data were then compared and interpreted together to identify areas of convergence or divergence, ensuring a comprehensive understanding of the phenomenon under study.

The strength of the convergent research design lies in its ability to provide both breadth and depth of analysis. Quantitative findings provided generalizable patterns, while qualitative insights revealed the contextual and experiential aspects underlying those patterns. This combination enhanced the validity and reliability of the study's findings, ensuring that the results are grounded in both empirical evidence and lived experiences. Therefore, the convergent design was particularly suitable for this research, as it aligns with the pragmatic paradigm guiding the study, which focuses on practical solutions through the integration of objective data and subjective insights.

3.3 Study Area

Kwimba District, situated in the Mwanza Region, is predominantly rural, with an estimated population of 480,025, of whom 92% reside in rural areas (National Bureau of Statistics, 2024). The local economy relies heavily on small-scale agriculture and livestock farming, with limited exposure to technological and industrial development. Educational indicators highlight significant challenges: only 36% of individuals aged five years and above have completed formal education, and literacy among household heads stands at 61.3%, which is below the regional average of 64.7% (National Bureau of Statistics, 2024). These factors indicated systemic constraints that likely affect students' engagement with science subjects and their potential for creativity and innovation.

Despite government initiatives to improve science education, schools in Kwimba continued to face numerous obstacles. Of the 39 public secondary schools in the district (Kwimba District Council, 2024), many lack adequately equipped

laboratories, limiting students' opportunities for hands-on learning and experimentation. Additional challenges included a shortage of qualified science teachers, insufficient teaching resources, and an overly theoretical curriculum, which reduced student interest and the practical relevance of science education (Mabula, 2012; Osaki, 2007).

Understanding science education in Kwimba District is therefore essential for assessing its role in fostering students' creativity and innovation. Effective science teaching should connect classroom learning to real-life contexts, promoting curiosity, experimentation, and problem-solving skills (Semali, 2012). However, persistent deficiencies in facilities, instructional materials, and teacher training continue to limit these outcomes. Investigating the educational environment in Kwimba provides valuable insights into strategies for enhancing science education, strengthening creative and innovative capacities among rural learners, and supporting Tanzania's broader goal of transitioning toward a knowledge-based and semi-industrialized economy.

3.4 Targeted Population

The entire group of individuals that a researcher intends to study or draw conclusions about is referred to as the targeted population. It includes all members who meet the specified criteria for a particular research question or objective, from which a sample may be drawn (Creswell, 2014). In this study, the researcher identified the targeted population by reviewing official records and organizational structures within the public secondary school education system of the study area.

The study involved 2,288 science students, 200 science teachers, 41 head teachers, and 8 school quality assurance officers to capture a comprehensive view of the factors influencing creativity and innovation in science education. Students were included to assess engagement and learning outcomes, teachers to provide insights on instructional practices and challenges, head teachers to highlight school management and support, and quality assurers to offer a systemic perspective on curriculum implementation. This selection ensured that the study gathered holistic data from all key stakeholders involved in science education.

3.5 Sample Size and Sampling Techniques

3.5.1 Sample Size

The sample size in this study consisted of 440 respondents from the Kwimba district. This number was chosen to collect enough information while keeping the study manageable. It included 8 secondary schools, 380 students, 40 secondary science teachers, 8 heads of schools, and 4 school quality assurers. The sample size of 440 respondents was considered sufficient because it provides a large enough group to yield reliable and meaningful results while remaining manageable for data collection and analysis. It ensures adequate representation of all key stakeholder groups, including students, science teachers, head teachers, and school quality assurers, allowing the study to capture diverse perspectives on science education and its influence on creativity and innovation.

Additionally, this size supports statistical analysis and comparisons across subgroups, such as gender or school type, enhancing the accuracy and generalizability of the findings within the study area (Creswell & Creswell, 2018).

The sample composition is indicated in Table 3.1.

Table 3.1: Sample Composition by Sampling Technique, Data Collection Method, and Respondent Category (n = 440)

Sampling Technique	Data Collection Method	Category of Study Respondents	Sample Size
Purposive	Interview	Heads of school	08
Purposive	Interviews	School Quality Assurance Officers	04
Stratified	Questionnaires	Science Teachers	40
Stratified	Questionnaires	Students	380
		Total number of respondents: 440	

Source: Researcher, 2025.

3.5.2 Sampling Techniques

The study employed both probability and non-probability sampling techniques to ensure the collection of reliable and in-depth information. Specifically, stratified sampling, a type of probability sampling, was used to identify and include participants with experience in teaching and learning science education in public secondary schools. In addition, purposive sampling, a non-probability technique, was applied to select individuals in leadership and managerial roles who met the study's inclusion criteria due to their direct involvement in decision-making processes (Creswell & Creswell, 2018).

3.5.2.1 Purposive Sampling

Purposive sampling was used to select 8 head teachers and 4 school quality assurers based on their specific positions and roles within the selected secondary schools. This technique was applied because these individuals hold key responsibilities in school management, curriculum implementation, and quality assurance, making their insights crucial for the study. The selection process involved identifying all head

teachers of the 8 chosen schools and including them in the sample, ensuring that each school's administrative perspective was represented. Similarly, school quality assurers who were directly responsible for monitoring and evaluating these schools were identified through the district education office and included in the study. By deliberately choosing participants with relevant knowledge and authority, the researcher ensured that the data collected were rich, focused, and directly aligned with the objectives of examining factors influencing science education, creativity, and innovation.

3.5.2.2 Simple Stratified Random Sampling

Simple stratified random sampling was employed to select 380 science students and 40 science teachers, ensuring the sample was representative and captured the diversity within the schools. The population was first divided into strata based on gender, with male and female students and teachers grouped separately. A proportional number of participants were then randomly selected from each stratum**,** ensuring that every individual had an equal chance of inclusion and providing balanced representation. This approach minimized selection bias, enabling the study to gather comprehensive perspectives from both students and teachers and provide reliable insights into science education practices and their impact on creativity and innovation in the selected secondary schools.

3.6 Data Collection Methods

Data collection is the process of systematically gathering and measuring information on variables of interest, enabling researchers to answer stated research questions, test hypotheses, and evaluate outcomes (Creswell & Creswell, 2018). Questionnaires and

interviews were used to collect data, ensuring the collection of accurate and relevant information from respondents.

3.6.1 Questionnaire Method

The questionnaire method was used to collect data from science teachers and science students in public secondary schools. The researcher employed an open-ended questionnaire guide to facilitate the collection of both qualitative and quantitative data, following a mixed-methods approach (Creswell & Creswell, 2023). Although open-ended questionnaires are often associated with a higher likelihood of non-response errors, this challenge was addressed by personally informing participants about the importance of their input. Respondents were assured of confidentiality and given adequate time, at least one hour, to complete the questionnaires, thereby reducing the risk of incomplete or inaccurate responses.

The questionnaire included both open and closed-ended questions. The closed-ended items were measured using a five-point Likert scale: (1) Agree, (2) Strongly Agree, (3) Undecided, (4) Disagree, and (5) Strongly Disagree. This structure enabled respondents to express their views clearly and consistently, allowing for practical analysis of the quantitative data. The combination of question types provided both broad statistical insights and rich qualitative feedback, enhancing the depth and credibility of the findings.

3.6.2 Interview Method

The study employed semi-structured interviews to collect qualitative data related to the research objectives from school heads and school quality assurance officers. The

semi-structured format allowed for a combination of open-ended, closed-ended, and follow-up questions based on the respondents' answers (Creswell, 2022). During the interviews, participants shared their experiences, perceptions, and opinions.

The interviews lasted between 20 and 30 minutes and were conducted one-on-one. This format provided in-depth data as participants were able to freely express their knowledge, thoughts, beliefs, and concerns about the topic (Creswell, 2022). The one-on-one setting enabled the researcher to thoroughly explore participants' experiences through the use of probing questions (Kumar, 2020). Probing helped guide the discussion and collect accurate information without interrupting or leading the respondents' answers.

The researcher utilized interpersonal skills and experience to establish rapport with participants during the interviews. This rapport encouraged participants to share more detailed and honest information.

3.6.3 Observation Method

The observation method was used to assess the laboratory arrangements in the selected secondary schools. Using a structured observation guide, the researcher systematically recorded the availability, organization, and functionality of laboratory equipment and facilities. Attention was given to whether the laboratories were equipped correctly, safe, and adequately organized to support practical science activities. The arrangement of workstations, accessibility of materials, and overall readiness of the laboratory for experiments were carefully noted. This approach provided direct, first-hand evidence on the adequacy of laboratory settings, which is

crucial for understanding how well schools support hands-on science learning and the development of practical skills among students.

3.7 Data Analysis Procedures

Data collected in this study were analyzed using both quantitative and qualitative techniques to ensure a comprehensive understanding of the factors influencing science education, creativity, and innovation in Kwimba District. Quantitative data from questionnaires were first checked for completeness, coded, and entered into SPSS software for statistical analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize responses and identify trends among students and teachers. In addition, inferential statistics were applied where necessary to examine relationships between variables and assess the significance of observed patterns, providing a solid basis for drawing conclusions and making comparisons across groups.

Qualitative data obtained from interviews and observation notes were analyzed through thematic analysis. The researcher transcribed responses, organized the data into meaningful categories, and identified recurring themes related to laboratory arrangements, teaching practices, and students' engagement in science activities. Triangulation was employed by comparing information from multiple sources to validate findings and enhance the reliability of interpretations. By combining quantitative and qualitative analyses, the study generated rich, credible, and well-supported insights into how science education is delivered and its impact on fostering creativity and innovation among secondary school students.

3.8 Validity and Reliability of the Study

3.8.1 Validity of the Study

The validity of this study was ensured through careful planning and the use of multiple strategies to enhance the accuracy and credibility of the findings. Data were collected using questionnaires, interviews, and observations, allowing for triangulation to cross-check information and minimize bias. Purposive and stratified random sampling techniques were applied to select participants, ensuring that all key stakeholders, including students, science teachers, head teachers, and school quality assurers, were adequately represented. Stratifying students and teachers by gender and class level further improved the representativeness of the sample. Additionally, all data collection instruments were carefully designed and pre-tested to ensure clarity, relevance, and consistency. Together, these measures strengthened the generalizability of the study, ensuring that the results accurately reflected the factors influencing science education and its role in fostering creativity and innovation in Kwimba District.

3.8.2 Reliability of the Study

Reliability in research refers to the consistency and stability of a measurement or assessment tool. A study is considered reliable if it consistently produces similar results under the same conditions over time. In the context of research, reliability ensures that the data collection methods yield dependable and repeatable results, which is crucial for the credibility and validity of the findings (Karnia, 2024). To ensure reliability, triangulation was employed in the study by consulting multiple data sources through semi-structured questionnaires, semi-structured interviews, and

structured observations, which were later compared for congruency.

3.9 Ethical Consideration

Ethical considerations in research are critical to ensure the rights, dignity, and welfare of research participants are protected. They guide researchers in conducting studies in a responsible and ethical manner (Resnik, 2020). In this study, the researcher requested permission from OUT to send an introductory letter to the administrators of the selected area. Anonymity and confidentiality would be protected, and every participant would have the option to participate voluntarily in the study; all these measures were taken to strengthen respondents' confidence. The researcher adhered to research conduct and ensured that there was no adverse effect on the respondent by obtaining informed consent.

CHAPTER FOUR

DATA PRESENTATION AND DISCUSSION OF THE FINDINGS

4.1 Introduction

This chapter presents, analyzes, interprets, and discusses the data related to investigating the contribution of science subjects to the development of creativity and innovation among the young generation in public secondary schools in Kwimba District. The study was guide by four research objectives which include to determine the driving forces for students to undertake science subjects in secondary school at Kwimba districts, to examine how science subjects promotes creativity and innovation to students interacting with that curriculum, to assess the level of creativity and innovation to students taking science subjects in selected schools and to evaluate the challenges and ways to overcome challenges of secondary schools science teaching in promoting creativity and innovation in selected schools.

Data collection for the study involved the use of an interview guide, observation checklist, and a questionnaire. Furthermore, qualitative data were analyzed and interpreted thematically, whilst quantitative data were analyzed and interpreted using descriptive analysis. The chapter was structured according to the study's objectives, including the response rate, demographic data, and the presentation and discussion of the findings.

4.2 Demographic Information

This section presented the participants' demographic information, specifically that of the teachers, which included their gender, age, education level, and teaching experience, as well as the students' information, including class level and age. This

data helps identify patterns and trends, enabling researchers to interpret results more accurately and assess how different demographic factors may influence the study's outcomes.

4.3.1 Demographic Characteristics of Teachers

The demographic description of teachers included their gender, educational qualifications, and teaching experience. The researcher was interested in using demographic information to understand the appropriateness of their responses to the study-related questions. The demographic information of the teachers helped the researcher understand the specific background characteristics of the respondents who participated in the study (Connelly, 2013). The results are presented in Table 4.1.

Table 4.1: Teachers' Demographic Information (n=40)

Category	Frequency	Percentage (%)
Gender		
Male	**23**	**57.5**
Female	**17**	**42.5**
Age		
Below 29 years	7	17.5
30-40 years	27	67.5
41-50 years	7	12.5
Above 51 years	1	2.5
Education Qualification		
Diploma	10	25
Degree	30	75
Master	0	0
Others	0	0
Teaching Experience		
Below 5 years	16	40
6-10 years	13	32.5
11-15 years	11	27.5
16-20 years	0	0
Above 21 years	0	0
Total	40	100

Source: Field Data (2025).

Table 4.1 presents demographic information of teachers categorized by gender, age, educational qualification, and teaching experience. In terms of gender distribution, the majority of participants are male, accounting for 57.5%, while females represent 42.5%. Looking at the age composition, the dominant age group is those between 30 and 40 years, making up 67.5 percent of the total. Followed by individuals below 29 years and those aged 41-50 years, which comprise 17.5 percent and 12.5 percent, respectively. Only a small fraction, 2.5 percent, of the participants fall into the age category of 51 years or older.

Regarding educational qualification, a significant portion of the group holds a degree, representing 75 percent, while a smaller proportion, 25 percent, possesses a diploma. Notably, there are no participants with master's degrees or other qualifications. In terms of teaching experience, 40 percent have less than 5 years, while 32.5 percent possess 6 to 10 years of experience, and 27.5 percent have 11 to 15 years of teaching experience. There are no participants with 16 to 20 years or more than 21 years of teaching experience. Overall, the table illustrates a predominantly young, male demographic with a strong educational background and varying levels of teaching experience.

4.4 The Driving Forces for Students to Undertake Science Subjects

In this objective, both a questionnaire and an interview guide were employed to collect data from teachers, students, school heads, and school assessors. Responses were categorized and analyzed using a six-point scale as proposed by Taherdoost (2019): where 0–29 represented (extreme minority), 30–49 (minority), 50–59

(slightly majority), 60–70 (majority), and 71–89 (great majority), and 90–100 (extreme majority). Their responses are presented in Table 4.2.

Table 1.4: Teachers' Response to the Driving Forces for Students to Undertake Science Subjects

Statements	**SA**		**A**		**U**		**D**		**SD**	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
The parents are the ones who influence students to decide to take science subjects at their school	23	57.5	17	42.5	0	0	0	0	0	0
Students themselves are the ones who decide to take science subjects at your school.	10	25	30	75	0	0	0	0	0	0
The friends are the ones who influence students to take science subjects.	16	40	13	32.5	11	27.5	0	0	0	0
The class teachers are the ones who influence students to take science subjects.	29	72.5	8	20	1	2.5	1	2.5	1	2.5
The school where you're teaching has set a system for students to take science subjects.	19	47.5	18	45	2	5	1	2.5	0	0
The students choose to take science subjects because these subjects have a wide range of applications in the job market.	17	42.5	19	47.5	0	0	2	5	2	5

Source: Field Data (2025)
Key: *SD=Strongly Disagree, D=Disagree, U=Undecided, A=Agree and SA=Strongly Agree*

Table 4.2 shows that the extreme majority (100%) of teachers agreed and strongly agreed that parents influence students' decisions to take science subjects. This data suggests that parents play a crucial role in guiding students toward science,

underscoring the importance of parental support and encouragement in educational decisions. These findings align with those of Seang et al. (2021), who identified the family factor as one of the factors influencing students' decisions to take science subjects.

In the same vein, the extreme majority (100%) of teachers agreed and strongly agreed that students decide to take science subjects themselves. This data implies that while students have some autonomy in their choices, their decisions are often heavily influenced by external factors, such as guidance from parents and teachers.

Moreover, when one of the heads of schools was interviewed about the driving forces for students to take science subjects, he said that:

> *Parental influence on students' decisions to study science cannot be overstated; I've observed firsthand how supportive parents can inspire their children to pursue these subjects. While it's encouraging to see that many students express autonomy in their choices, the reality is that their decisions are often shaped by the guidance and expectations set by adults in their lives. Therefore, as educators, we must engage with parents to reinforce the importance of science education and encourage students to explore their interests (Interview with Head of School A, 2024).*

The quotation suggests that fostering strong relationships between schools and parents is crucial for promoting student interest in science subjects. Additionally, schools should provide resources and workshops for parents to understand better how they can support their children's educational choices. Overall, a collaborative approach that combines parental support with student autonomy is essential for fostering a passion for science among students. The finding is disputed by Kikoti (2018), who reported minimal parental involvement.

Furthermore, the influence of friends on students' decisions about science subjects also received attention. A great majority (72.5%) of teachers agreed and strongly agreed that friends played a significant role in influencing students' choices of studying science subjects. This data suggests that friendships can have a varying impact, indicating that peer influence is substantial but not universal across all students. This finding aligns with the findings obtained by Seang et al. (2021), who highlighted the impact of family, social, and peer influences on students' choices to take science subjects.

Moreover, the researcher interviewed the head teachers about the influence of friends on students' decisions to take science subjects. One of the head teachers responded as follows;

> *Peer influence is significant in shaping students' decisions to pursue science subjects, with a substantial portion of teachers acknowledging the role of friends in this process. However, the variability in responses also highlights that not all students are equally swayed by their peers, suggesting that individual motivations and interests play a critical role. As teachers, we must consider how to leverage positive peer influences while also supporting students who may be less affected by their social circles, ensuring that every student has the opportunity to explore their interest in science (Interview, Head of School C, 2024).*

The above voices suggest that recognizing peer influence as a factor in students' science subject choices implies that schools should implement strategies to foster a positive and supportive peer environment, such as group projects and collaborative learning activities. Furthermore, understanding the diversity in how peer influence affects different students can help educators tailor their approaches to meet the needs of individual learners better. By addressing both the collective and particular aspects of student decision-making, schools can create a more inclusive and effective

science education program that encourages participation and engagement from all students. Additionally, Shao et al. (2024) found a significant and positive relationship between peer relationships and the academic achievement of junior high school students, with learning motivation and learning engagement serving as mediating factors in this relationship.

Finally, regarding the school's system for taking science subjects, the overwhelming majority (92.5%) of teachers agreed and strongly agreed with the statement that the school has created an environment conducive to students taking science subjects. These responses suggest that both institutional support and awareness of career opportunities are crucial factors in encouraging students to pursue science, underscoring the importance of schools in creating a conducive environment for science learning while also highlighting the relevance of these subjects in the job market. The results are supported by Huruma (2015), who stated that the availability of a laboratory, library, Science textbooks, and the teaching style affect the performance of Science subjects.

Students' Response to the Driving Forces for Students to Undertake Science Subjects

Students were asked to identify the driving forces that motivated them to undertake science subjects in public secondary schools in Kwimba district. Their responses were presented in Table 4.3.

Table 4.2: Students' Responses on the Driving Forces for Students to Undertake Science Subjects

Statements	SA		A		U		D		SD	
	F	%	F	%	F	%	F	%	F	%
The parents are the ones who influenced you to decide to take science subjects at your schooling level	95	31.7	117	39	59	19.7	16	5.3	13	4.3
You decided to take science subjects to pursue a career in science.	122	40.7	104	34.7	17	5.7	25	8.3	32	10.7
Your friend is the one who influenced you to take the science subject.	1	0.3	2	0.7	80	25.7	192	64	25	8.3
Your class teacher is the one who influenced you to take science subjects.	70	23.3	3	1	0	0	206	68.7	21	7
The school that you're studying at has set a system for you to take science subjects.	0	0	5	1.7	194	64.7	78	26	23	7.7
You decided to take science subjects because they have a wide range of applications in the job market.	174	58	50	16.7	47	15.7	24	8	5	1.7

Source: Field Data (2025).

Table 4.3 summarizes the students' responses regarding the various factors that influence their decision to pursue science subjects. A significant number of students reported that their parents play a crucial role in their decision-making. The majority of students (70.7%) agreed and strongly agreed that their parents influenced their choice to study science. This data indicates that parental support and encouragement are key drivers for many students. Additionally, a strong personal motivation is evident, as the majority of students (75.4%) agreed or strongly agreed that they chose to pursue science subjects to become scientists. This finding highlights that many students are driven by their aspirations and goals, reinforcing the idea that individual ambition is also a vital factor in their educational choices.

Considering the influence of friends and teachers, it appears that their impact is relatively minimal. A negligible number of students (minority, accounting for 1%) felt that friends influenced their decision, while the great majority of students (72.3%) disagreed and strongly disagreed with the statement. In terms of teachers'

influence, a great majority of students (75.7%) did not feel that teachers played a significant role in their subject selection. This data indicated that students may rely less on teachers compared to parents or personal ambition. Regarding the school's support system, the majority of students (64.7 percent) felt undecided about its influence, suggesting that the institutional framework may not be as impactful as expected.

Finally, when considering job market opportunities, a slight majority (58 percent) of students agreed that this was a reason for their choice to study science, indicating that the potential for future employment is an essential consideration for them. Overall, the data reveal that while parental influence and personal ambition are strong motivators for students, the roles of peers, teachers, and institutional support seem to play a less critical role in their decisions. Likewise, Konstantinidis (2021) reveals that teachers and student-teachers practiced their inquiry skills to varying extents, with three distinct inquiry identity profiles identified. Factors such as sense-making, ownership, agency, and emotions significantly influenced the development of the teacher-inquirer identity. The implication is that while students are primarily motivated by future job opportunities, and teachers' inquiry skills and identities are influenced by various personal and emotional factors, both teachers and institutions should consider these influences when shaping educational policies and practices better to support students' career aspirations and professional growth.

The interview with the school quality assurer showed that:

> *From this perspective, we must acknowledge the multifaceted nature of the factors that drive student interest in science subjects. The evidence suggests that both internal motivators (such as student*

> *autonomy) and external influences (from parents, friends, and teachers) play a significant role, and schools must strike a balance between nurturing individual interests and promoting supportive learning environments. By understanding the driving forces behind student choice, we can develop more targeted quality assurance strategies that prioritize student engagement and academic excellence in science education (Interview, Quality Assurer, 2024).*

The above voice underscores the importance of considering the interplay between internal and external factors in student decision-making, suggesting that quality assurance frameworks should be adopted to account for the diverse motivations and influences that shape individual student choices. Furthermore, the findings underscore the importance of school leaders adopting a data-driven approach to quality assurance, utilizing evidence-based insights to inform strategic planning and resource allocation. Thus, prioritizing student engagement and autonomy, quality assurance can help drive improvements in science education and support the academic and personal growth of students (Oktarina et al., 2023).

4.5 How Science Subjects Promote Creativity and Innovation in Students Interacting with that Curriculum

The second objective of the study aimed to examine how science subjects promote creativity and innovation in students interacting with that curriculum in public secondary schools. In this objective, both a questionnaire and an interview guide were employed to collect data from teachers, students, school heads, and school assessors.

Teachers' Response on How Science Subjects Promote Creativity and Innovation to Students Interacting with that Curriculum

Teachers were asked to demonstrate how science subjects foster creativity and

innovation in students through their interaction with the curriculum. Their responses are presented in Table 4.4.

Table 4.4: Teachers Response on How Science Subjects Promote Creativity and Innovation in Students Interacting with that Curriculum

Statements	SA		A		U		D		SD	
	F	%	F	%	F	%	F	%	F	%
Science subjects have helped students to increase their level of creativity and innovation.	14	35	23	57.5	2	5	1	2.5	0	0
Through science subjects, students have developed new objects and tools.	15	37.5	22	55	2	5	1	2.5	0	0
Science subjects have made no effort to increase students' level of creativity and innovation.	7	17.5	27	67.5	5	12.5	1	2.5	0	0
Through science subjects, students have successfully addressed some problems they have encountered recently.	12	30	21	52.5	0	0	5	12.5	2	5

Source: Field Data (2025).

Table 4.4 summarizes the teachers' responses to objective 2 of the research. In the table, SA stands for Strong Agree, A for Agree, U for Undecided, D for Disagree, and SD for Strong Disagree. According to Table 4.6, the extreme majority of teachers (92%) agreed and strongly agreed that science subjects increased students' level of creativity and innovation. This data shows that an extreme majority of teachers believe that science subjects have a positive impact on students' creative and innovative skills.

When asked if science subjects have helped students create new inventions or tools, the majority of teachers (92.5%) agreed and strongly agreed with the statement. This

data indicated that many students have indeed applied their science knowledge to create something new. On the other hand, a great majority of teachers (85%) disagreed strongly with the statement. This finding suggests that some teachers do not perceive a significant connection between science education and creative thinking. Furthermore, one of the heads of schools asserted that:

> *It is encouraging to see that a majority of our students believe that science subjects help them invent and create new things. However, the fact that some students feel that science isn't linked to creativity is of concern. We need to work on improving how we teach science to ensure that all students recognize its connection to innovative thinking (Interview with Head of School E, 2024).*

The above voice highlights a need for schools to better connect science education with creativity and innovation in their curriculum. Teachers might need to incorporate more hands-on projects and real-world applications of science to make lessons more engaging and relevant. By doing this, schools can help all students see the value of science in boosting their creative abilities.

Regarding problem-solving, the great majority of teachers (82.5%) agreed and strongly agreed that science subjects helped students solve problems they had recently encountered. This finding suggests that many students are using their science knowledge to tackle real-world challenges. Interestingly, no teacher strongly disagreed that science subjects helped them solve problems.

Likewise, head of school B said that:

> *It is reassuring to see that a significant majority of our students feel that their science education is beneficial for problem-solving in real-life situations. The absence of strong disagreement indicates that, overall, students recognize the value of science in addressing challenges they encounter. We should continue to emphasize the*

> *practical applications of science in our curriculum to strengthen further this connection (Interview, Head of School B, 2024).*

The above voice suggests that science subjects are effectively equipping students with problem-solving skills, which are essential for their personal and academic growth. However, schools should continue to enhance teaching methods by integrating more real-world scenarios and hands-on activities into science lessons. This approach could further empower students to apply their scientific knowledge to a broader range of challenges they face in everyday life.

This finding relates to Susan's (2019) study, which reported that studying physics in senior secondary school contributed positively to their ability to think creatively and innovate. Likewise, Komba & Shukia (2023) depicted that skills are explicitly incorporated into every curriculum and syllabus document at the basic and advanced secondary levels. Also, they found that, despite the clear intention and inclusion in curriculum documents, graduates are reported to lack these critical skills. In general, the results indicated that science subjects are seen as an effective way to develop students' creativity, innovation, and problem-solving skills, with most students reporting a positive impact. These findings have implications for education policymakers and educators, suggesting that science education should be prioritized for its potential to nurture these valuable skills.

Students' Response on How Science Subjects Promote Creativity and Innovation in Students Interacting with that Curriculum

Students were asked to demonstrate how science subjects fostered creativity and innovation for them when interacting with that curriculum. Their responses were

presented in Table 4.5.

Table 4.5: How Science Subjects Promote Creativity and Innovation in Students Interacting With That Curriculum. SA In the Table Represents Strongly Agree, A –Agree, U –Undecided, D- Disagree, and SD For Strongly Disagree

Statements	SA		A		U		D		SD	
	F	%	F	%	F	%	F	%	F	%
Science subjects have helped you to increase your level of creativity.	158	52.7	26	8.7	26	8.7	74	24.7	16	5.2
Through science subjects, you have developed new objects or tools.	139	46.3	30	10	22	7.3	93	31	16	5.4
Science subjects have not contributed to increasing your level of creativity.	18	6	32	10.7	154	51.3	81	27	15	5
Through science subjects, you have successfully addressed some problems that you have encountered recently.	29	9.7	188	62.7	21	7	43	14.3	19	6.3

Source: Field Data (2025).

The results from Table 4.5 revealed a significant belief among students that science subjects enhance their level of creativity. Specifically, the majority of students (61%) agreed and strongly agreed that studying science has boosted their creative skills. This data suggests that while a majority sees a connection between science education and creativity, a notable number still feel otherwise.

In terms of innovation and problem-solving, a slight majority (56.3%) of students felt that science subjects allowed them to create new inventions. Conversely, a notable number of students (31%) disagreed and strongly disagreed with this idea, reflecting some uncertainty about the inventive aspects of their learning. Notably, when asked whether science subjects contributed nothing to their creativity, a substantial majority of students (51.3 percent) disagreed, affirming the value they see

in their science education. Furthermore, the majority of students (62.7%) reported that science helped them solve recent problems, with only a minority expressing disagreement.

Overall, these results suggest that many students recognize the positive impact of science education on their creativity and problem-solving skills. At the same time, some skepticism persists among a smaller segment of the student population. Similarly, Patel et al. (2024) suggest that reducing anxiety and boosting confidence through such programs can improve students' engagement with STEM subjects and foster a positive mindset toward innovation and future careers. This finding demonstrates that while most students recognize the positive influence of science education on creativity and problem-solving, addressing the skepticism of a minority may be crucial for fully harnessing the potential of science subjects to foster innovation and confidence in STEM fields.

Generally, the school quality assurer provided that:

> *Science subjects inherently encourage students to think critically and explore new ideas, which are essential components of creativity and innovation. By engaging in hands-on experiments and collaborative projects, students learn to approach problems from multiple angles and develop innovative solutions. We must continue to support this aspect of the curriculum, ensuring that students feel inspired and empowered to innovate (Interview, School Quality Assurer, 2024).*

Thus, the emphasis on creativity within science education can significantly enhance students' ability to think critically and generate new ideas. Schools should focus on creating an interactive curriculum that encourages experimentation and collaboration, thereby fostering an environment where students feel safe to explore and innovate. This approach can lead to a more dynamic learning experience and

better prepare students for future challenges, as supported by Khalil et al. (2023), who stated that integrating STEM-based curriculum can significantly impact the development of students' creative thinking compared to students who studied under a traditional curriculum regarding the metrics of fluency, flexibility, and originality.

4.6 The Level of Creativity and Innovation of Students Taking Science Subjects in Selected Schools

This is the third objective of the study, where the respondents were assessed using the Torrance test to measure their level of creativity and innovation in the science subject. Students were provided with a set of drawings and asked to create new ones based on the existing ones. They were provided with a rectangle, a triangle, and a circle, where each student was supposed to create a new shape from those three elements. The primary objective was to assess the level of creativity and innovation in each student. The researcher observed the following;

The researcher found that a great majority of students (73%) were unable to develop a new drawing from the original provided drawing. Some of them collected the paper without doing anything, while others traced the drawing without adding new shapes. An extreme minority (27%) of students managed to develop new shapes of drawing from the provided original shapes (drawings) through a creative and innovative perspective.

That finding gave researchers insight into the issue of students standing alone and mastering their environment, revealing that students taking science subjects still exhibited minimal creative and innovative abilities. This was observed differently by local artisans whom the researcher studied. A researcher visited several carpentry

and tailoring workshops. In these groups, a researcher observed at least an effort to develop creativity and innovation. A researcher observed the new inventions of materials and objects created by these local artisans. This effort of creativity and innovation from local artisans was an issue the researcher expected to see among students taking science subjects.

From this point forward, researchers recognize the importance of a dynamic curriculum that prioritizes creative problem-solving skills. Schools should continue to invest in resources and training that support innovative teaching methods, ensuring students can express their creativity within the scientific framework. The cultivation of both knowledge and creativity better prepares students for the complexities of modern careers in science and technology. As stated by Anaktototy (2023), creating an environment that enables the school to promote creativity and innovation would bring advantages for students, preparing them for future challenges and societal demands, thereby enhancing their problem-solving skills and unlocking their potential to benefit their future careers.

Therefore, regular assessments of the science curriculum can help identify areas for improvement that will enhance student creativity and innovation. By embracing feedback and making necessary adjustments, schools can ensure that the educational environment remains conducive to creative exploration. This commitment will not only enrich students' learning experiences but also drive advancements in scientific understanding and application. Likewise, Udu (2023) added that when teachers adopt innovative practices in science education, the students’ academic achievement

is greatly enhanced.

4.7 The Challenges and Ways to Overcome Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

This is the fourth objective, where respondents were expected to identify the challenges of Secondary School Science Teaching in Promoting Creativity and Innovation in Selected Schools and propose ways to overcome these challenges.

4.7.1 The Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

This study examines the challenges faced by secondary schools in promoting creativity and innovation, with a focus on the barriers that hinder the effective implementation of innovative teaching practices in selected schools. Teachers and students provided their responses concerning the objective.

4.7.1.1 Teachers' Response to the Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

Teachers were asked to identify the challenges of secondary schools' science teaching in promoting creativity and innovation in selected Schools. Their responses were presented in Table 4.6.

Table 4.6: Teachers' Response to Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

Statements	SA		A		U		D		SD	
	F	%	F	%	F	%	F	%	F	%
A lack of science teachers at your school is the primary problem that students face in learning science subjects.	17	42.5	14	35	2	5	2	5	5	12.5
The lack of science laboratories at the school is an obstacle that hinders students from participating in	19	47.5	15	37.5	0	0	4	10	2	5
Among the challenges that students face when studying science subjects is the scarcity of science textbooks.	16	40	18	45	3	7.5	2	5	1	2.5
Science subjects' topics do not contribute to students' creativity and innovation.	15	37.5	18	45	2	5	3	7.5	2	5
Many science topics are complex for students to understand.	14	35	21	52.5	1	2.5	3	7.5	1	2.5

Source: Field Data (2025).

The data from Table 4.6 presents teachers' responses regarding the challenges of teaching science in secondary schools and how these challenges affect students' creativity and innovation. The first statement addresses the lack of science teachers, which a significant number of teachers see as a major issue. A great majority of teachers (77.5%) agreed and strongly agreed that the shortage of science teachers is a problem. Only a small number of teachers, approximately 5%, remain undecided, while an extreme minority (17.5%) strongly disagreed with the statement. This data suggests that many teachers believe having sufficient qualified science teachers is crucial for promoting effective science education.

The second statement focused on the absence of science laboratories as a barrier to practical learning. Also, a great majority of teachers (85%) agreed and strongly agreed that the lack of laboratory facilities hinders students from conducting hands-on experiments. The overwhelming sentiment suggests that having proper laboratory

resources is crucial for facilitating practical experience in science, which is key to fostering creativity and innovation. Another challenge mentioned is the scarcity of science textbooks. According to the data, the great majority of teachers (85) agreed and strongly agreed that having insufficient textbooks affects students' learning. This finding suggests that a substantial number of teachers recognize the importance of having sufficient textbooks to support students' science education.

Similarly, Ndihokubwayo (2017) reveals that science teachers face significant barriers, including time constraints, material shortages, and a lack of improvisation skills in conducting laboratory activities. Despite these challenges, teachers in schools with laboratories showed higher awareness of science laboratory activities, while students across all schools agreed on the importance of laboratory experiments and improvisation approaches. This finding suggests that improving access to science laboratories and textbooks, along with providing resources for developing improvisation skills, is crucial for enhancing practical learning and fostering creativity and innovation in science education.

The fourth statement reflects the belief that science topics do not contribute to students' creativity and innovation. Here, the great majority (83.5%) of teachers agree and strongly agree with this view. This data suggests a notable divide in perspectives, with many teachers believing that the content of science subjects may not effectively enhance students' creative thinking and innovative capabilities.

Finally, the table addressed the complexity of science topics, with the great majority of teachers (87.5%) agreeing and strongly agreeing that many issues are complex for

students to understand. Only 2.5% remained undecided, while an extreme minority of teachers (10%) disagreed and strongly disagreed with the statement. This data further emphasizes the idea that teachers are concerned about how challenging content can adversely impact students' ability to engage creatively with science subjects. Overall, the data illustrate various obstacles that teachers believe hinder the effective teaching of science, subsequently limiting students' creativity and innovation.

4.7.1.2 Students' Response to the Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

Students were asked to identify the challenges of secondary schools' science teaching in promoting creativity and innovation in selected Schools. Their responses are presented in Table 4.7.

Table 4.7: Students' Responses on the Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

Statements	SA		A		U		D		SD	
	F	%	F	%	F	%	F	%	F	%
Lack of science teachers at your school is the main problem that you're facing in learning science subjects.	14	4.7	164	54.7	26	8.7	76	25.3	20	6.7
A lack of science laboratories at your school is an obstacle that hinders students from doing science practical work.	140	46.7	17	5.7	21	7	94	31.3	28	9.3
Among the challenges you face in studying science subjects is the scarcity of science textbooks.	127	42.3	28	6	25	8.3	105	35	25	8.3
Science subjects add nothing to your creativity and innovation.	22	7.3	26	8.7	137	45.7	92	30.7	23	7.7
Many science topics are challenging to understand	83	27.7	8	2.7	182	60.7	27	9	0	0

Source: Filed Data (2025).

The data presented in Table 4.7 highlight students' responses regarding the challenges of science teaching in secondary schools and how these challenges affect their learning experience. The first statement addressed the issue of a lack of science teachers. In this case, the majority (59.4%) of students. At the same time, 8.7) remained undecided, suggesting they either don't recognize a lack of teachers as an issue or feel indifferent. Additionally, an extreme minority of students (32%) disagree, and a significant number strongly disagree. This data indicates that while some students acknowledge the challenge, there is another part that either doesn't feel it is a significant problem or believes it does not affect their education in science subjects.

The second statement concerns the lack of science laboratories, which students believe hampers their hands-on learning experience. Here, the majority of students (52.4%) agreed and strongly agreed that the absence of laboratory facilities is a barrier to practical work. Conversely, only 7% stayed undecided on this issue. A considerable minority of students (40.3%) disagreed and strongly disagreed. These responses suggested a mixed perception among students regarding the impact of laboratories on their science education, with a notable portion affirming that the lack of labs is indeed a significant challenge.

The third statement focuses on the scarcity of science textbooks. A substantial majority (48.3%) of students agreed and strongly agreed that this is an issue they face. Only 8.3% of students remained undecided, while another slight majority (43.3%) of students disagreed and strongly disagreed with that statement. This data suggests that while most students acknowledge the scarcity of textbooks, a portion

feels that it does not significantly impede their ability to learn or engage effectively with science subjects.

In the fourth statement, students were asked if they believed science topics contributed to their creativity and innovation. Here, an extreme minority of students (16%) agreed and strongly agreed with the notion that these topics do not add value to their creativity. The slight majority (45.7%) remain neutral, suggesting uncertainty about whether science subjects promote creativity. Meanwhile, a minority (38.4%) of students disagreed and strongly disagreed, indicating a division of opinion on the relevance of science topics to fostering innovative thinking.

Lastly, the table examined students' views on the difficulty of science topics. Remarkably, the great majority (60.7%) of students remained undecided regarding whether the issues are complex, implying that many may not perceive them as particularly challenging. A minority of students (27.7%) agreed, suggesting they do find the topics hard to grasp, while an extreme minority (9%) disagreed. Notably, no students strongly agreed that the issues are complex, which might indicate that perceptions of difficulty vary widely. Overall, the table reveals diverse challenges faced by students in their academic journey in science, highlighting areas that could be improved to enhance their learning and creativity.

Besides, an interview response from one of the heads of school revealed that:

> *One of the primary challenges we face in promoting creativity and innovation in science education is the rigid curriculum structure that often prioritizes rote memorization over critical thinking and reasoning. Additionally, limited resources and laboratory facilities can hinder hands-on experiments that spark students' curiosity. To*

> *foster a more innovative environment, we need to advocate for curriculum reforms and seek partnerships that provide additional resources for our science programs (Interview, Head of School H, 2024).*

Thus, schools must advocate for and implement teaching practices that emphasize inquiry-based learning and real-world applications in science. Investing in resources and facilities, along with reforming assessment methods, can significantly enhance students' ability to engage creatively with scientific concepts. As supported by Wani and Hussian (2024), educational institutions should incorporate practical, real-world learning experiences into their curriculum by transforming internal assignments into field studies. Also, another head of school shows that:

> *Teachers often feel pressured to meet standardized testing requirements, which can limit their ability to explore creative approaches in science teaching. There is also a varying level of teacher training in innovative pedagogical methods, leading to inconsistent delivery of the curriculum. To overcome these obstacles, ongoing professional development is crucial, as it equips teachers with the tools to inspire creativity and innovation in their classrooms (interview with head of school G, 2024).*

This voice implies that schools must prioritize ongoing professional development for teachers to enhance their capabilities in delivering innovative science education, thereby overcoming the constraints imposed by standardized testing. By equipping teachers with the necessary tools and training, schools can foster a more creative and engaging learning environment that inspires students to think innovatively and critically in their science studies. Similarly, Ventista and Brown (2023) suggest that training, ongoing coaching, and collaborative Continuous Professional Development (CPD) have a positive impact on student skills and learning, with long-duration CPD proving to be the most beneficial. However, the effect of learning communities on

student outcomes remains unexamined.

Furthermore, the School Quality Assurer provided that:

> *A challenge lies in the assessment frameworks that often focus on memorization rather than the application of knowledge, which stifles creativity and innovation. Furthermore, a lack of collaboration among educators across different disciplines can limit interdisciplinary approaches that foster innovation. We must advocate for assessments that reward creativity and encourage schools to adopt multidisciplinary projects that bring science to life in creative ways (Interview, School Quality Assurer, 2024).*

Thus, revisiting assessment frameworks is crucial for promoting creativity in the science curriculum. Schools should collaborate across subject areas to implement interdisciplinary projects that encourage innovative thinking, allowing students to make connections between different fields. This change can lead to a more engaging and enriching educational experience, fostering a culture of creativity and innovation in science education.

4.7.2 Ways to Overcome Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

Additionally, under the fourth objective, teachers were expected to provide strategies for overcoming the challenges of Secondary School Science Teaching in Promoting Creativity and Innovation in Selected Schools. The responses are shown below. Improving Teacher Training: Invest in professional development programs for science teachers. Workshops can focus on innovative teaching methods, hands-on learning, and how to inspire students to think creatively. Continuous learning opportunities enable teachers to stay current with the latest techniques and scientific knowledge.

Enhancing Laboratory Facilities: Schools should prioritize the development of well-equipped science laboratories. Providing students with access to modern lab equipment enables them to conduct experiments and practical work, which is crucial for understanding scientific concepts and fostering creativity.

Nonetheless, head of school E said that:

> *We recognize the importance of investing in professional development programs for our science teachers, as they help them stay current with innovative teaching methods and foster creativity in the classroom. Additionally, we are working to enhance our laboratory facilities, ensuring that students have access to modern equipment for hands-on experiments, which is crucial for their understanding of scientific concepts. By prioritizing these areas, we believe we can create a more engaging and effective learning environment for our students (Interview with Head of School G, 2024).*

This voice suggests that investing in both teacher professional development and modernizing laboratory facilities is crucial for enhancing science education, as these initiatives will improve teachers' skills and equip students with the tools necessary for engaging in practical learning and innovative thinking.

Introducing Inquiry-Based Learning: Shift from traditional teaching to inquiry-based learning, where students ask questions, conduct investigations, and explore topics on their own. This approach encourages critical thinking and problem-solving, as students learn to formulate hypotheses and test them through experiments. Incorporating technology in teaching: Utilize technology, such as virtual labs and simulations, to supplement traditional teaching methods. Tools like educational software, interactive videos, and online resources can make science more engaging and accessible, allowing students to experiment and learn in a digital environment.

Furthermore, head of school A added that:

> *We are transitioning to an inquiry-based learning approach, encouraging students to ask questions and engage in hands-on investigations, which enhance their critical thinking and problem-solving abilities. Incorporating technology into our teaching, such as virtual labs and interactive resources, helps to make science more engaging and accessible, allowing students to experiment in a digital environment. This shift ensures that our students develop a deeper understanding of scientific concepts while staying connected to modern learning tools (interview with the head of school, 2024).*

This voice shows that adopting inquiry-based learning and integrating technology into science education will foster independent thinking, increase engagement, and provide students with diverse tools to experiment and solve problems in both traditional and digital environments.

Promoting Collaborative Learning: Encourage group projects and teamwork in science classes to foster a culture of collaboration. Working in groups enables students to share ideas, learn from one another, and develop their communication skills. Collaboration can lead to more creative solutions to problems as students build on each other's strengths. Providing access to resources: Ensure that students have the necessary textbooks, online materials, and other science resources. Libraries and digital platforms should be well-stocked with current information. Availability of resources supports independent learning and helps students expand their knowledge base.

Engaging with the Community: Connect students with local scientists, universities, and research organizations to foster meaningful connections and collaborations. Guest lectures, field trips, and mentorship programs can offer students valuable real-

world experiences that inspire them. Seeing practical applications of science in the community makes learning more relevant and engaging. Encouraging Student-Led Projects: Allow students to choose their projects or research topics related to their interests. This autonomy fosters creativity, as students explore what excites them in the field of science. Projects can culminate in presentations, where students showcase their findings and innovations.

To foster a supportive classroom environment: Create a classroom atmosphere that encourages experimentation and values mistakes as part of the learning process. When students feel safe expressing their ideas and taking risks, they are more likely to innovate. Positive reinforcement and open discussions about ideas help build confidence. Therefore, by implementing these strategies, schools can effectively address the challenges of science teaching and promote an environment that nurtures creativity and innovation in students. In addition, the quality assurer provided that:

> *To foster creativity and innovation in science education, we emphasize promoting collaborative learning where students work in groups, share ideas, and develop essential communication skills. We also ensure that students have access to a wide range of resources, from textbooks to digital platforms, enabling them to engage in independent learning and expand their knowledge. Moreover, engaging with the community through partnerships with local scientists and universities enriches students' learning experiences, making science more relevant and inspiring them to explore real-world applications (Interview, Quality Assurer, 2024).*

This voice suggests that a combination of collaborative learning, accessible resources, community engagement, student-led projects, and a supportive classroom environment can significantly enhance students' creativity, critical thinking, and innovation, enabling them to apply science concepts in meaningful ways.

In the same vein, Mpuangnan (2024) revealed that factors such as age, gender, qualifications, and professional experience influenced the integration of technology in teacher preparation programs. However, infrastructural challenges and resistance to change hindered effective technology use, necessitating increased resources and ongoing in-service training for educators. Additionally, Ammar et al. (2024) found that innovative pedagogical practices significantly enhance student engagement and competency in STEM fields; improvements in teacher training and infrastructure are crucial for their effective implementation.

The findings emphasize that enhancing teacher training and modernizing laboratory facilities are vital for fostering creativity and innovation in secondary school science education. By incorporating inquiry-based learning, technology, and collaborative strategies, educators can create engaging learning environments that promote critical thinking and problem-solving. Furthermore, addressing the infrastructural challenges and ensuring access to resources will empower both teachers and students, ultimately preparing them to thrive in a technology-driven society.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary, conclusion, and recommendations of the findings concerning the contribution of science subjects to the development of creativity and innovation among the young generation in public secondary schools in Kwimba District. The study was guide by four research objectives which include to determine the driving forces for students to undertake science subjects in secondary school at Kwimba districts, to examine how science subjects promotes creativity and innovation to students interacting with that curriculum, to assess the level of creativity and innovation to students taking science subjects in selected schools and to evaluate the challenges and ways to overcome challenges of secondary schools science teaching in promoting creativity and innovation in selected schools.

5.2 Summary of the Findings

5.2.1 The Driving Forces for Students to Undertake Science Subjects

The findings reveal that both teachers and students recognize various factors that influence students' decisions to undertake science subjects in secondary schools. Teachers highlighted the significant impact of parental influence, indicating that parents often guide students towards science. While many students assert their autonomy in choosing these subjects, they acknowledge that parental guidance plays a critical role. Peer influence, particularly from friends, also emerged as a factor, though its impact varies among students. Teachers emphasized the importance of school systems and career prospects in motivating students to select science subjects.

Overall, a collaborative relationship between parents and schools is essential in fostering student interest and commitment to science education.

5.2.2 How Science Subjects Promote Creativity and Innovation in Students Interacting with that Curriculum

The study indicates that science subjects are perceived to play a crucial role in enhancing students' creativity and innovation. Both teachers and students acknowledge that engaging with scientific concepts fosters creative thinking and problem-solving skills. Many students believe that hands-on activities and projects encourage them to think creatively and innovate. However, some students express concerns about traditional teaching methods that may limit creativity. Interviews with school leaders further highlighted the necessity of connecting science education to creative practices, suggesting that an interactive curriculum emphasizing real-world applications could significantly improve students' creative engagement with the subject.

5.2.3 The Level of Creativity and Innovation of Students Taking Science Subjects in Selected Schools

Findings suggest that students involved in science education generally experience an increase in their creative thinking and innovation abilities. While the majority recognized the value of studying science for fostering creativity, some expressed uncertainty about its direct benefits. Many students report that practical problem-solving skills gained from science directly apply to real-life situations, enhancing their understanding and appreciation of the subject. Collaborative projects within the

science curriculum are noted to stimulate creativity further, as teamwork fosters the sharing of diverse ideas and perspectives. The study highlights the need for curricula that encourage exploration and innovation, as traditional methods may hinder student engagement in science.

5.2.4 The Challenges and Ways to Overcome Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

The study identified several challenges faced in teaching science that hinder the promotion of creativity and innovation. Teachers highlighted the shortage of qualified science teachers and inadequate laboratory facilities as significant obstacles to experiential learning and creativity. Moreover, the scarcity of textbooks and the perceived complexity of science topics contribute to the difficulties students face in fully engaging with the subject. While students primarily see value in science education, they exhibit mixed feelings regarding the impact of specific topics on their creativity. Overall, both teachers and students emphasize the need for improved resources and teaching methods to foster creativity in science education.

To address the identified challenges in promoting creativity and innovation in science education, several strategies were suggested. Key recommendations include investing in teacher training to enhance innovative pedagogical approaches, developing well-equipped laboratories for hands-on learning, and integrating inquiry-based learning to encourage critical thinking. Incorporating technology and promoting collaborative learning among students were also highlighted as effective methods for enhancing student learning. Moreover, engaging with the community and allowing student-led projects can foster a more meaningful connection to

science, while creating a supportive classroom environment that encourages creative risk-taking and promotes a deeper understanding of the subject. These strategies aim to create an educational environment that encourages creativity and innovation in science subjects.

5.3 Conclusion

The findings concluded that both teachers and students agree that several factors influence students' choices to study science. Parents are seen as the most prominent supporters, guiding students towards these subjects. While many students also feel they make their own choices, they recognize that advice from parents and teachers significantly shaped their decisions. Friends can also have some influence, but not every student was affected in the same way. Schools need to work closely with parents to keep students interested in science.

Moreover, science subjects are believed to encourage creativity and innovation among students. Most students and teachers feel that working with scientific ideas helps students think creatively and solve problems. Hands-on activities and projects are constructive. However, some students feel that traditional teaching methods can limit their creativity. Schools should focus on making science teaching more interactive and relevant to real-world situations to support creative learning better.

Likewise, many students who study science believe it helps them become more creative and innovative. They often feel that learning science helps them solve everyday problems and inspires them to come up with new ideas. Working with classmates on science projects also boosts their creativity. However, some students

believe that traditional teaching methods hinder their ability to think creatively. Schools should adopt teaching methods that foster exploration and innovation in science.

Additionally, several challenges in teaching science made it difficult to promote creativity and innovation. Both teachers and students agree that a lack of qualified teachers and proper laboratory facilities makes hands-on learning difficult. Not having enough textbooks and finding some topics complicated also make it harder for students to engage fully with science. To support creativity in science education, schools need to improve resources and teaching methods. Also, there are clear strategies to overcome the challenges faced in teaching science. Investing in teacher training and enhancing laboratory facilities is a crucial step. Using inquiry-based learning encourages students to think critically, while incorporating technology and promoting teamwork makes learning more enjoyable. Engaging with the community and allowing student-led projects can enhance the relevance of science education. These strategies will help create a more supportive environment for creativity and innovation in science classes.

5.4 Recommendations

5.4.1 Recommendation for Action

Based on the summary of the findings and conclusions, the following recommendations were made.

To the Government

The government should invest more in science education by funding schools to

improve laboratory facilities and provide necessary learning materials. This funding can help ensure that all schools have the tools needed for hands-on science learning, which is crucial for fostering creativity. Additionally, the government should offer training programs for science teachers to enhance their teaching methods and keep them informed about new scientific developments.

To Policy Makers

Policy makers should develop educational policies that emphasize the importance of creativity and innovation in science education. They can create guidelines that encourage schools to adopt inquiry-based learning and student-led projects, thereby helping students engage actively in their own learning. Furthermore, policymakers should promote collaboration between schools and local scientists or universities to provide students with real-world experiences in science.

To School Administrators

School administrators should prioritize creating a supportive learning environment by fostering strong relationships with parents and the community. They can organize workshops and events to engage parents in their children's science education, thereby maximizing parental support and involvement. Additionally, administrators should encourage teachers to implement creative teaching strategies and provide them with the necessary resources and professional development to support their success.

To Teachers

Teachers should incorporate hands-on activities and real-world examples into their science lessons to make learning more engaging for students. They should also

encourage group work and collaboration among students to promote the sharing of ideas and perspectives. Ultimately, by creating a safe environment where students feel comfortable expressing their creativity and making mistakes, teachers can foster innovative thinking in their science classes.

To Students

Students should take an active role in their own science education by exploring topics that interest them and asking questions in class. They can benefit from working collaboratively with classmates on projects and experiments, as this can enhance their creativity and innovation skills. Additionally, students should seek out resources, such as online materials or community events, to improve their understanding of science beyond the classroom.

5.4.2 Recommendation for Further Studies

i. Future research could explore how various technological tools, such as virtual labs and interactive simulations, influence student engagement, creativity, and innovation in science subjects.

ii. Studies could focus on the impact of targeted professional development programs for science teachers. Researching how different training formats (e.g., workshops, peer mentoring, online courses) affect teaching practices and student outcomes

iii. Further studies could investigate how different types of parental involvement (e.g., support, communication, participation in school activities) affect students' interest and performance in science subjects.

iv. Research could examine how a strong foundation in science education influences students' career paths and their likelihood of pursuing Science, Technology, Engineering, and Mathematics (STEM) fields.

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APPENDICES

Appendix I: A Questionnaire Guide to Students

Dear respondents

I am **Ng'andilo Boniventure Nathanely**, a student at the Open University of Tanzania, Faculty of Education, pursuing a Master of Education in Curriculum Design and Development (MEDCDD) of the Open University of Tanzania. I am researching "the contribution of science subjects towards the development of creativity and innovation among the young generation in public secondary schools in Kwimba district.

I humbly ask that you actively participate in this study so that it can be completed effectively. If you are not comfortable with the study, you can accept or reject it. The information you provide will be kept private, used purely for research purposes, and not shared with anyone who is not a participant in this project.

SECTION A: DEMOGRAPHIC INFORMATION

Which class are you studying?

i. Form three ( )

ii. Form four ( )

Which age category do you belong to?

i. 13 – 15 years ( )

ii. Above 15 years ( )

SECTION B: The driving forces for students that influence them to take science subjects

Read each item carefully and think of the driving forces that influenced you to take science subjects**.** Indicate your response to each item by ticking one of the five alternatives to the right of each item.

Key: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA).

S/N	STATEMENTS	SA	A	U	D	SD
1	The parents are the ones who influenced you to choose science subjects at your current level of schooling.					
2	You decided to take science subjects to become a scientist yourself.					
3	Your friend is the one who influenced you to take the science subject.					
4	Your class teacher is the one who influenced you to take science subjects.					
5	The school that you're studying at has set a system for you to take science subjects.					
6	You decided to take science subjects because they have a wide range of applications in the job market.					

SECTION C. Science subjects promote creativity and innovation in students who interact with that curriculum

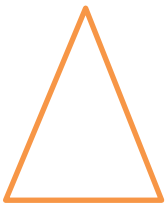
Read each item carefully and think about how science subjects have helped you to become creative and innovative**.** Indicate your response to each item by ticking one of the five alternatives to the right of each item.

Key: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA).

S/N	STATEMENTS	SA	A	U	D	SD
1	Science subjects have helped you to increase your level of creativity.					
2	Through science subjects, you have developed new objects or tools.					
3	Science subjects have not contributed to increasing your level of creativity.					
4	Through science subjects, you have successfully addressed some problems that you have recently encountered.					

D. The level of creativity and innovation of students taking the science subject

At the following table, use the original figure from A to make your own new, freely created figure or picture at part B

S/N	Part A. original figure	Part B. A newly created figure or picture from Figure A
1	. 	
2		
3		

4	. 	

Section E. Challenges and ways to overcome challenges of secondary schools' science teaching in promoting creativity and innovation

Please read each item carefully and consider the Challenges and ways to overcome them in promoting creativity and innovation in secondary school science teaching**.** Indicate your response to each item by ticking one of the five alternatives to the right of each item.

Key: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA)

S/N	**STATEMENTS**	**SA**	**A**	**U**	**D**	**SD**
1	Lack of science teachers at your school is the main problem that you're facing in learning science subjects.					
2	A lack of science laboratories at your school is an obstacle that hinders students from doing science practical work.					
3	Among the challenges you are facing in studying science subjects is the scarcity of science textbooks.					
4	Science subjects add nothing to your creativity and innovation.					
5	Many science topics are challenging to understand					

Appendix II: A Questionnaire for Science Subjects Teachers

Dear respondents

I am **Ng'andilo Boniventure Nathanely**, a student at the Open University of Tanzania, Faculty of Education, pursuing a Master of Education in Curriculum Design and Development (MEDCDD) of the Open University of Tanzania. I am researching "the contribution of science subjects towards the development of creativity and innovation among the young generation in public secondary schools in Kwimba district.

I humbly ask that you actively participate in this study so that it can be completed effectively. If you are not comfortable with the study, you can accept or reject it. The information you provide will be kept private, used purely for research purposes, and not shared with anyone who is not a participant in this project.

A: Demographic Information

Please put a tick (√) next to the alternative of your choice.

1. How old are you?
   i. Below 29 years ( )
   ii. 30–40 years ( )
   iii. 41–50 years ( )
   iv. Above 51 years ( )
2. What is your gender?
   i. Male ( )
   ii. Female ( )
3. What is your highest level of education?
   i. Diploma in education ( )
   ii. Bachelor's Degree in Education ( )
   iii. Master's degree in education ( )

iv. Other please (specify)……..

4. How long have you been teaching in this school?

i. Below 5 years ( )

ii. Between 6 and 10 years ( )

iii. Between 11and 15 years ( )

iv. Between 16 and 20 years ( )

v. Above 21 years ( )

B. The driving forces for students that influence them to take science subjects

Read each item carefully and think of the driving forces that influenced you to take science subjects**.** Indicate your response to each item by ticking one of the five alternatives to the right of each item.

Key: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA).

S/N	STATEMENTS	SA	A	U	D	SD
1	The parents are the ones who influence students to choose science subjects at your school.					
2	Students themselves are the ones who decide to take science subjects at your school.					
3	The friends are the ones who influence students to take science subjects.					
4	The class teachers are the ones who influence students to take science subjects.					
5	The school where you teach has established a system for students to take science subjects.					
6	The students choose to take science subjects because these subjects have a wide range of applications in the job market.					

B. Science subjects promote creativity and innovation in students to interact with that curriculum

Read each item carefully and think about how science subjects have helped students to become creative and innovative**.** Indicate your response to each item by ticking one of the five alternatives to the right of each item.

Key: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA).

S/N	STATEMENTS	SA	A	U	D	SD
1	Science subjects have helped students to increase their level of creativity and innovation.					
2	Through science subjects, students have developed new inventions for various objects and tools.					
3	Science subjects have made little to no impact on increasing students' level of creativity and innovation.					
4	Through science subjects, students have successfully addressed some problems they have recently encountered.					

C. Challenges and ways to overcome challenges of secondary schools' science teaching in promoting creativity and innovation

Please read each item carefully and consider the Challenges and ways to overcome them in promoting creativity and innovation in secondary school science teaching**.** Indicate your response to each item by ticking one of the five alternatives to the right of each item.

Key: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA).

S/N	STATEMENTS	SA	A	U	D	SD
1	A lack of science teachers at your school is the primary issue that students encounter when learning science subjects.					
2	The lack of science laboratories at the school is an obstacle that hinders students from participating in science and practical activities.					
3	Among the challenges that students face in studying science subjects is the scarcity of science textbooks.					
4	Science subjects' topics do not contribute to students' creativity and innovation.					
5	Many science topics are complex for students to understand.					

Provide Ways to Overcome Challenges of Secondary Schools' Science Teaching in Promoting Creativity and Innovation in Selected Schools

……

……

……

……

……

……

Appendix III: An Interview Guide for Head of Schools

Dear respondents

I am **Ng'andilo Boniventure Nathanely**, a student at the Open University of Tanzania, Faculty of Education, pursuing a Master of Education in Curriculum Design and Development (MEDCDD) at the Open University of Tanzania. I am researching "the contribution of science subjects towards the development of creativity and innovation among the young generation in public secondary schools in Kwimba district.

I humbly ask that you actively participate in this study so that it can be completed effectively. If you are not comfortable with the study, you can accept or reject it. The information you provide will be kept private, used purely for research purposes, and not shared with anyone who is not a participant in this project.

1. What have been the main influences for many students to decide to study science subjects at your school?
2. How do science subjects help to promote creativity and innovation in your students?
3. What are the challenges of secondary schools' science teaching in promoting creativity and innovation in students?
4. What should be done to overcome the challenges of secondary school science teaching in promoting creativity and innovation to students?
5. Are there any students at your school who have shown extraordinary creativity and innovation?

   No …….. YES…….

1. If YES, how many are they?

Appendix IV: An Interview Guide to School Quality Assurers

Dear respondents

I am **Ng'andilo Boniventure Nathanely**, a student at the Open University of Tanzania, Faculty of Education, pursuing a Master of Education in Curriculum Design and Development (MEDCDD) at the Open University of Tanzania. I am researching "the contribution of science subjects towards the development of creativity and innovation among the young generation in public secondary schools at Kwimba district.

I humbly ask that you actively participate in this study so that it can be completed effectively. If you are not comfortable with the study, you can accept or reject it. The information you provide will be kept private, used purely for research purposes, and not shared with anyone who is not a participant in this project.

1. Do science subjects help to promote creativity and innovation in students?

   Yes…… No…….

   If yes, explain how ……

2. Do science subjects' contents give room for students to develop their creativity and innovation?

   Yes …….. No…….

   If yes, explain how……

Appendix V: An Observation Checklist of the Research

Title of the research: The contribution of science subjects towards the development of creativity and innovation among the young generation in public secondary schools in Kwimba district

General objective of the research: To investigate the contribution of science subjects towards the development of creativity and innovation among the young generation in public secondary schools in Kwimba District.

Name of the researcher: Boniventure Ng'andilo

Reg No: PG 202803151

Course: Master of Education in Curriculum Development and Design

Course code: MEDCDD

School observed ……..

Date of observation …….

S/NA	Criterion	Yes	No	Observation
1	Students show high performance in science subjects.			
2	There is room for science subjects to develop creativity and innovation in students.			
3	The school has sufficient learning materials for its science subjects.			
4	The school has laboratories that have complete science equipment.			
5	The students are showing some active creativity and innovation.			

THE UNITED REPUBLIC OF

MINISTRY OF EDUCATION, SCIENCE A

THE OPEN UNIVERSITY OF TA

Ref. NoPG201803151OUT/ **1st August, 2024**

District Executive Director (DED),

Kwimba District Council,

P.O Box 20950,

MWANZA.

Dear Regional Administrative Secretary,

RE: RESEARCH CLEARANCE FOR MR. BONIVE NTURE NG PG201803151

2. The Open University of Tanzania was esta
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however replac
Charter of 2005, which Januarybecme operational2007.Inlineonw the Open Uni
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3. To facilitate and to simplify resea Chancellor of the Open University of Tanzania th
Government of Tanzania and Tanzania Commi both its staff and students who are do
background, the purpose of MrthisBoniventureer.I isNg'anto

Reg.No: PG201803151),pursuingMaster of Education in Curri Development
We(MEDCDD)here.by grant this clearance

KWIMBA DISTRICT COUNCIL

All correspondences should be addressed to the District Executive Director P.O Box 88 Ngudu.

TEL. 028-2983121
FAX. 028-2983119

P.O Box. 88,
NGUDU/KWIMBA

Ref. No DB.320/389/01

Date: 23/08/2024

Deputy Vice Chancellor (Academic)
The Open University of Tanzania,
P.O. Box23409,
DAR ES SALAAM.

RE: PERMISSION FOR RESEARCH CLEARANCE FOR MR. BONIVENTURE NGA'NDILO, REG NO PG201803151

Refer to the heading above with your letter dated 1st August,2024 with reference number Ref. No. OUT/PG.201803151

This is to inform you that we allow Mr **Boniventure Nga'ndilo Reg No PG201803151** pursuing Master of Education in Curriculum Design and Development (**MEDCDD**). To conduct a Research title "**THE CONTRIBUTION OF SCIENCE SUBJECT TOWARDS DEVELOPMENT OF CREATIVITY AND INNOVATION AMONG YOUNG GENERATION IN PUBLIC SECONDARY SCHOOL AT KWIMBA DISTRICT**" is granted with effect for three month 2nd August to 30th October. The Research station will be at Mwamashimba Secondary School , Mhande Secondary School, Sumve High School, Nyamilama Secondary School, Kikubiji Secondary School and School Quality Assuarance Office.

However the Council will be no any financial obligation during research exercise. You are required to adhere to the code of ethics and conduct for the Public service.
All the best.

Angela. S. Mulisa
For: DISTRICT EXECUTIVE DIRECTOR,
KWIMBA DISTRICT COUNCIL.

Cop. DISTRICT EXECUTIVE DIRECTOR
KWIMBA DISTRICT COUNCIL

CC: 1. Headmistress,
Mwamashimba S/School

2. Headmistress,
Sumve High School
3. Headmaster,
Nyamilama S/School