INFLUENCE OF COGNITIVE LOAD ON ACADEMIC PERFORMANCE IN MATHEMATICS AMONG GRADE NINE STUDENTS IN PUBLIC JUNIOR SECONDARY SCHOOLS IN KAJIADO-WEST SUB-COUNTY, KAJIADO COUNTY, KENYA

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A Research Thesis Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Master of Education, School of Humanities and Social Sciences of Africa Nazarene University

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DECLARATION

This research project is my original work and has not been submitted to any other university for academic purposes.

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DEDICATION

I dedicate this research project to my dear family, whose constant love, patience, and encouragement have been my greatest source of strength. Their physical support together with their spiritual backing enabled me to overcome my obstacles successfully. The team support reveals their trust in my work abilities and their complete devotion to help me achieve academic success.

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ABSTRACT

Mathematics as a backbone of Science, Technology, Engineering, and Mathematics (STEM) develop students' abilities to innovate, make well-informed choices, and solve problems which lead to personal achievements, societal advancement, and economic growth. However, poor academic performance in Mathematics starting from the announced KJSEA 2025 has emerged as a major issue in the country. The current study focused on examining the influence of cognitive load on learner academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west Sub- County, Kajiado County, Kenya. The study was guided by cognitive load theory and scaffolding theory. The study used convergent parallel mixed research design. The study targeted 1830 Grade Nine students and 74 Mathematics subject teachers from 35 public junior secondary schools in the Kajiado-West sub-county, Kajiado county, Kenya. Yamane's (1967) formula was used to determine students' sample size while proportionate stratified random sampling formula to determine school sample size per category. Both stratified and simple random sampling were used to sample the participants. The study used questionnaires and interview to collect data. Construct validity was supported by content validity through Exploratory Factor Analysis (EFA) and University supervisors assessed the study instruments to establish face validity. Cronbach alpha coefficient was used to assess the instruments' internal consistency. Descriptive statistics which include means, standard deviations, and frequency distributions were used to summarize data while Pearson Coefficient correlation and multiple linear regression analysis used for inferential statistics. The research findings established a significant positive relationship between cognitive load dimensions and academic performance in Mathematics. Intrinsic cognitive load ($r = .805$, $p < .001$), extraneous cognitive load ($r = .724$, $p < .001$), and germane cognitive load ($r = .813$, $p < .001$) significantly influenced academic performance. The regression analysis demonstrated that cognitive load accounted for 68.1% of performance variations ($R^2 = .681$) with germane cognitive load showing the highest prediction power ($\beta = .397$), followed by intrinsic cognitive load ($\beta = .270$), and finally extraneous cognitive load ($\beta = .173$). The study results demonstrate that students will achieve better results when they manage to direct their mental resources in an efficient manner during their learning process. Students who actively participated in concept understanding and integration activities showed the highest improvement in their performance levels. The research shows that learning task complexity impacts results but inefficient teaching methods produce minimal effects through unneeded mental effort. Teachers need to develop their lesson plans properly because students will succeed better when they learn in meaningful ways which teachers create for them. The study recommends that education policies that will help improve Mathematics performance in junior secondary schools in Kajiado-West sub-county besides improving country wide performance. Similarly, Mathematics teachers should apply student-focused methods which break down difficult topics while they connect fresh information to existing knowledge and maintain student involvement. The study further recommends that school administrators create ongoing teacher training programs on cognitive load management and effective Mathematics teaching methods. The schools need to establish proper educational material supply and create learning spaces which support student success.

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DEFINITION OF TERMS

Academic Performance: Describes the level of achievement attained in Mathematics by the grade nine students in public junior secondary school in Kajiado West Sub-County.

Cognitive Load: Refers to the amount of mental effort that grade nine students in public junior secondary schools in Kajiado West Sub-County need to process, solve tasks, and understand content in Mathematics.

Extraneous Cognitive Load: Refers to the mental effort imposed by the manner in which learning materials and teaching approaches are designed as well as delivered rather than by the actual learning content.

Germane Cognitive Load: Describes the mental effort which learners in public junior secondary schools in Kajiado West Sub-County dedicate to acquire essential knowledge through information organization, schema development, and problem-solving application of their learning.

Intrinsic Cognitive Load: Refers to mental effort required by grade nine students in public junior secondary schools in Kajiado West Sub-County to grasp the natural complexity which exists in Mathematics content.

ABBREVIATIONS/ACRONYMS

CBC: Competency-Based Curriculum

CL: Cognitive Load

KJSEA: Kenya Junior School Education Assessment

MOE: Ministry of Education

NACOSTI: National Commission of Science, Technology and Innovation

SPSS: Statistical Package for the Social Sciences

STEM: Science, Technology, Engineering, and Mathematics

VR: Virtual Reality

CHAPTER ONE
INTRODUCTION

1.1 Introduction

This chapter presents the background of the study, the statement of the problem, the research objectives and hypotheses, the significance of the study, the scope of the study, the limitations of the study, theoretical model, and the conceptual framework.

1.2 Background of the Study

Mathematics stands as a fundamental academic discipline which supports scientific thinking and drives technological progress while teaching students essential problem-solving abilities that lead to social and economic growth (Onoshakpokaiye & Avwiri, 2025; Zhu et al., 2024). Globally, continued concerns have been raised about students' low performance in Mathematics particularly in lower secondary schools where academic material becomes more challenging to understand and cognitively demanding. According to Palengka and Juniati (2022), in Mathematics, students must handle mathematical symbols, formulas, procedures as well as logical connections simultaneously which creates a demanding situation for their working memory capacity. Nonetheless, research in educational psychology shows that when the mental demands of mathematical tasks exceed learners' cognitive capacity, understanding deteriorates and performance declines (Mason et al., 2022; Wakhata et al., 2023). International research shows that students' math achievement depends on their intrinsic, extraneous, and germane cognitive load levels which affect their ability to solve problems and understand concepts (Wang et al., 2022).

Notably, in Africa, performance in Mathematics remains a challenge as most students must learn in overcrowded classrooms with insufficient teaching materials while teachers focus on delivering content which causes students to experience cognitive overload (Vakili et al., 2024; Luneta, 2022). Graham (2023) in a study proves that teaching methods which create unnecessary mental work through confusing explanations and disorganized assignments result in poor mathematical results but methods which promote organized learning produce better results. The research (Adeleke et al., 2025; Roorda et al., 2024; Graham, 2023) reveals that cognitive load analysis should receive proper attention for understanding how students in African classrooms achieve success in Mathematics.

Mathematics in Kenya has consistently shown weaker national assessment results than other subjects which makes teachers and government officials majorly from the Ministry of Education (MOE) worried about the situation. For example, from the 2025 Kenya Junior School Education Assessment (KJSEA) performance, Mathematics was identified as the lowest performed subjects across the country (Kihaki, 2025). Public junior secondary schools at Grade Nine level teach students advanced mathematical concepts which need them to develop advanced thinking abilities for complex problem resolution. Noteworthy, research studies done in Kenya have focused on curriculum implementation, teacher factors, and school resources with limited attention by scholars put on how students think about learning (Gray-Lobe et al., 2022; Muchira et al., 2023; Waiti, 2023).

Students' performance in Mathematics is further influenced by other more contextual factors in public junior secondary schools in Kenya. Wilfred et al. (2023) assert that the delivery of curriculum and student engagement suffers because schools face resource shortages which include failure to provide enough teaching materials, failure to build sufficient facilities, and failure to maintain small class sizes. According to Bremner et al. (2022), the educational process depends on teachers who must demonstrate subject mastery, teaching skills, and student-centered learning approach implementation. As such, teachers who lack sufficient professional development opportunities will encounter obstacles which prevent them from delivering their best possible instruction. Additionally, learning readiness of students depends on their individual characteristics which include their previous knowledge base, language proficiency, financial background, and their family backing at home (Ndijuye, 2023). These factors therefore influence how students process mathematical concepts which affects their understanding of Mathematics and their ability to solve problems and their general performance in the subject.

Noteworthy, the connection between cognitive load and academic performance stems from Cognitive Load Theory which states that learning achieves its best results when instructional demands align with the students' cognitive capacity (Zou et al., 2025). According to Evans et al. (2024), the learning process becomes obstructed by too much extraneous load as it blocks student understanding, yet well-managed intrinsic load and enhanced germane load promotes their deeper learning. Research study by (Gkintoni et al., 2025) demonstrate that high cognitive overload leads

to lower problem-solving precision but students who receive appropriate mental workloads show better ability to remember information and apply it in different situations. Ngu and Phan (2024) denote that in Mathematics, effective instructional design through worked examples, simple explanations reduce unnecessary cognitive burden which enhances students' better conceptual grasp and improved academic performance. However, there still remains limited knowledge on how cognitive load represents an accurate prediction tool for determining how well students will perform in Mathematics. The current research therefore sought to study cognitive load of academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

1.2.1 Academic Performance

Academic performance is a central measure of students' success as well as the effectiveness of instructional practices, specifically in cognitively demanding learning areas such as Mathematics (Maia et al., 2023). A cross several countries in the world, Mathematics performance remains as the primary assessment tool to measure student achievement and evaluate how well teachers can teach this subject (Wang et al., 2023). Research demonstrates that student achievement in Mathematics depends on both educational content, instructional techniques and the mental operations required to complete learning assignments (Wild & Neef, 2023). As such, according to Vale and Barbosa (2023), students who receive organized learning materials which follow their mental development stage tend to achieve better results in solving problems, understanding concepts, and learning Mathematics in general.

Equally, the current state of performance in math education in Africa faces problems because of overcrowded classrooms which contain many students and teachers do not have enough resources thus they follow a teaching style which focuses on students memorizing information instead of understanding concepts (Luneta, 2022). In this regard, Adeleke et al. (2025) assert that students face higher mental work because of these learning conditions which result in their low performance in school. Thus, instead students can only achieve better mathematical results through problem-solving and conceptual understanding when instructors provide organized instruction which matches their mental processing abilities (Roorda et al., 2024).

1.2.2 Cognitive Load

Research studies (Evendi et al., 2022) about cognitive styles and awareness demonstrate that mental processes directly affect how students perform in Mathematics. Surbakti et al. (2024) describes cognitive load (CL) as the mental power required by the students to process, understand and apply learning materials while they study. According to Cognitive Load Theory, cognitive load comprises three cognitive load, extraneous cognitive load, and germane cognitive load (Skulmowski & Xu, 2022). Learning requires students to handle their mental resources properly when they study difficult subjects like Mathematics. Almarzouki, (2024) that when the cognitive demands of a task exceed a learner's working memory capacity, understanding is impaired, retention decreases, and academic performance is negatively impacted. Research has found that students who face high mental demands during their studies experience difficulties with solving problems, understanding concepts, and using their knowledge which leads to poor performance in mathematical subjects that need abstract thinking (Wakhata et al., 2023). Likewise, students who control their mental workload properly will dedicate their attention to essential content learning which leads them to build better comprehension and achieve higher academic success (Wang et al., 2022). Therefore, teaching resources together with educational methods need to focus on student mental capabilities as this approach will decrease unnecessary thinking while improving learning results which leads to better student performance in Mathematics.

1.2.2.1 Intrinsic Cognitive Load

Intrinsic cognitive load reflects the natural complexity of educational materials (Chen et al., 2023). In other words, intrinsic load is the mental effort generated to handle the complex nature of learning resources and the degree to which students must process all connected information elements at the same time during their learning process. According to Chen et al. (2023) grounded in the Cognitive Load Theory, the level of intrinsic cognitive load depends on how complex the task is and what the student already knows and their mental abilities. Students must learn to combine different mathematical ideas with formulas and procedural methods which creates additional requirements for their working memory capacity. Topics such as algebra in Grade Nine demand students to use advanced thinking abilities which might prove difficult for some students who lack essential basic knowledge. The brain therefore receives too much information which

stops students from understanding things, solving problems, and remembering mathematical concepts which leads to poor school results (Barbieri & Rodrigues, 2025). In Kajiado-West Sub-County, the way teachers teach junior secondary schools along with student readiness and classroom settings will shape how students experience their natural mental processing requirements.

1.2.2.2 Extraneous Cognitive Load

Extraneous cognitive load which arises from poorly designed teaching methods (Skulmowski & Xu, 2022). In other words, the unnecessary mental effort imposed on students because of ineffective instructional design besides unrelated information that blocks their path to understanding. Within the framework of Cognitive Load Theory advanced by John Sweller (1988), extraneous cognitive load decreases the amount of working memory space available for essential learning activities. Students in Mathematics face learning difficulties that arises from excessive instructional explanations, complex diagrams, split attention between multiple sources of information, and unclear problem-solving procedures which could hinder their conceptual understanding. Research (Wang et al., 2022) shows that improperly designed mathematics instruction creates higher extraneous cognitive load which leads students to lose focus while their problem-solving abilities and academic performance in algebra and related mathematical tasks suffer. Similarly, research (Safira & Natadiwijaya, 2025) emphasizes on reducing unnecessary mental work through step-by-step help, example-based learning, and basic teaching methods which lead to better student learning of mathematics and longer memory retention.

1.2.2.3 Germane Cognitive Load

Germane cognitive load on the other hand is described as the mental energy devoted to meaningful learning and helps students build knowledge structures which they can remember for the long term in mathematics education (Krieglstein et al., 2023). The educational value of germane cognitive load in Mathematics learning becomes vital because it enables students to develop their conceptual understanding while building their reasoning abilities and problem-solving skills. The educational approach from Cognitive Load Theory shows that students will succeed better in school when teachers help them learn through active thinking instead of simple memorization. Research (Lee & Ayres, 2024; Ngu & Phan, 2024) shows that teachers who use

scaffolding, worked examples, metacognitive guidance, and collaborative learning activities help students develop their germane cognitive load as these methods help them build their knowledge structures and learn to perform tasks automatically. According to Aydin and Özgeldi (2024) students who work with mathematical reasoning and self-directed learning methods will achieve better academic performance and maintain their math knowledge. Germane cognitive load is thus important in explaining how effective instructional strategies and learner engagement influence academic performance in Mathematics.

1.3 Statement of the Problem

Despite the critical role of Mathematics in students' academic progression as well as future career goals, evidence shows that junior secondary students in Kenya fail to achieve proper proficiency in this subject (Sichangi, 2024). The 2025 Kenya Junior Secondary Education Assessment (KJSEA) results show that only 32.44% of students across the country achieved a meeting or exceeding expectation score thus one of the weakest subjects compared to other learning areas (Muriuki, 2025). This trend denotes underlying challenges in how learners engage with mathematical content, which is vital for access to science, technology, engineering, and further academic pathways.

Persistent underperformance in mathematics among the Grade Nine students in public junior secondary schools located in Kajiado-West Sub-County of Kajiado County remains a major educational issue. Despite curriculum reforms and expanded access to instructional resources, many learners continue to exhibit low proficiency in mathematical reasoning and problem-solving (Wekesa & Kitainge, 2020). Students face challenges with understanding material and building significant mental structures and remembering information when their mental abilities become overwhelmed by their learning requirements. In other words, they face challenges with information overload as their working memory reaches its maximum capacity which prevents them from processing information effectively and learning new concepts. As such, the learners lose their capacity to link fresh information with their existing knowledge base which creates obstacles for their schoolwork success. In this regard, they may struggle to process complex mathematical information effectively, resulting in poor academic outcomes. However, empirical evidence linking cognitive load to mathematics performance among Grade Nine students in this context

remains limited. The current study was thus to confirm or disapprove this hypothesis through research the influence of cognitive load on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

1.4 Purpose of the Study

The purpose of this study was to examine cognitive load and academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

1.5 Objectives of the Study

The following specific objectives guided the study:

i. To assess the influence of intrinsic cognitive load on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.
ii. To examine the influence of extraneous cognitive load on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.
iii. To establish the influence of germane cognitive load on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.
iv. To develop a prediction equation for academic performance in Mathematics from cognitive load among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

1.6 Research Hypotheses

This study sought to answer the following hypotheses:

H_{O1}: Intrinsic cognitive load has no significant influence on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

H_{O2}: Extraneous cognitive load has no significant influence on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

H_{O3}: Germane cognitive load has no significant influence on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

H_{O4}: Cognitive load does not significantly predict academic performance in Mathematics from cognitive load among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya

1.7 Significance of the Study

The study findings may be valuable to students since they provide information to help them adopt the best learning strategies in terms of cognitive load that can be used to improve Mathematics achievement. Furthermore, the findings may benefit teachers by assisting them in developing appropriate instructional designs that will help also improve Mathematics achievement.

Similarly, the study provides empirical evidence on how cognitive load affects academic performance in Mathematics among junior secondary learners. In this regard, the study will enrich scholarly understanding of learner-centred cognitive factors within Kenya's CBC and provide a foundation for further research on instructional design, learning efficiency, and Mathematics education in similar educational contexts.

The research findings offer policy makers concrete proof which enables them to make informed decisions about how to execute school curricula and teaching methods. The research demonstrates how cognitive load affects Mathematics performance which should direct educational authorities to establish policies on content sequencing, teacher training, and learner-centred approaches that will boost student Mathematics results in public junior secondary schools.

1.8 Scope of the Study

The research investigated how cognitive load affects their Mathematics results at Grade Nine level in public junior secondary schools in Kajiado-West Sub-County of Kajiado County

Kenya. The research collected quantitative data about student's cognitive experiences in learning Mathematics and their corresponding academic results in the term when the study was carried out. The research focused on junior secondary students under the Competency-Based Curriculum at particular public schools within the sub-county. The study thus provides insights on how students face learning obstacles and how teachers can improve their teaching methods.

1.9 Delimitations of the Study

Delimitation of the study refers to the defined boundaries under which a study narrows to a particular investigation area (Coker, 2022). The study scope receives definition through this process which determines all variables, population groups, geographic locations, time periods, and research methods that will be included in the study according to the researcher's goals and available resources. In this case, the research study delimited its focus on the analysis of grade nine students only in public junior secondary schools in Kajiado-West Sub-County in Kajiado County in Kenya. The research further focused on studying cognitive load as a predictor of mathematical achievement among students who attend public junior secondary schools. The researcher collected data from the grade nine students based on their Mathematics education experiences and their actual academic performance reflected in their Mathematics test results within the research period which is after their first term. Finally, the research took place at public junior secondary schools which operate under the Competency-Based Curriculum system throughout the Kajiado-West Sub-County region.

1.10 Limitations of the Study

Data was collected through the utilization of questionnaires and interview schedules, which could elicit subjective responses. However, the researcher clarified the objective of the study in order to enhance the reliability of the responses. The study was also carried out in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.; hence, the results could be extrapolated to other public junior secondary schools in Kenya with caution, considering their distinct settings and characteristics. the study utilized a convergent parallel mixed-method research design, which might not establish a causal relationship between the studied variables.

1.11 Assumptions of the Study

The study assumed that the fundamental principles of Cognitive Load Theory explain how students process mathematical information and that variations in each type of cognitive load; intrinsic, extraneous, and germane cognitive load influence their understanding, schema construction, and retention of mathematical concepts, which in turn affect academic performance.

The study further assumed that the study's selected design together with the statistical procedures would appropriately capture and explain the linear correlation that exists between cognitive load and academic performance in Mathematics learning area.

The research also assumed that its measurement tools for cognitive load and mathematics achievement produce consistent results which properly assess the intended research variables.

Similarly, the study was conducted under the assumption that the participants would accurately report their experiences of cognitive load about learning in Mathematics learning area and that the selected sample adequately represents students in public junior secondary schools.

Finally, the research assumed that public junior secondary schools in Kajiado West Sub-County operate under normal teaching conditions which determine how students handle mental work in learning mathematics.

1.12 Theoretical Framework

This study is anchored in two complementary frameworks: cognitive load theory and scaffolding theory.

1.12.1 Cognitive Load Theory (CLT)

John Sweller the proponent of Cognitive Load Theory (CLT) developed the theory in the late 1980s before its expansion by scholars like Fred Paas and Tamara van Gog (Duran et al., 2022). According to Oakley et al. (2025), the theory states that working memory has a fixed capacity but long-term memory allows people to save an unlimited number of schemas. In this regard, learning achieves its highest effectiveness when educational activities match the mental abilities which students possess. Students who need to process more information than their

working memory can handle, will experience reduced understanding and memory retention which leads to lower academic achievements (Almarzouki, 2024).

Cognitive Load Theory (CLT) functions as a primary educational framework which teachers use to teach Mathematics as students need to understand abstract ideas while they manage symbols, formulas, and complex operational sequences. According to Driscoll and Burner (2024), people need to deal with various mental demands which appear at the same time to achieve their understanding goals and maintain memory recall and solve problems. Research studies demonstrate that students achieve better academic results in their Mathematics as well as in other STEM subjects when their learning activities match their cognitive processing abilities (Berkowitz et al., 2022). However, critics of CLT argue that the theory's main focus is on teaching methods but fails to analyze how students learn through their personal characteristics which include motivation, emotional responses, and social background which together also affects learning outcomes (Duran et al., 2022). Moreover, measuring cognitive load faces multiple practical difficulties as most studies rely on participants to report their mental effort which produces subjective answers that depend on personal perception of mathematical work.

Nonetheless, despite the criticisms about CLT, the theory remains essential for this research. The theory offers a framework to study how students' mental effort during Mathematics lessons affects their academic results. The theory therefore helped to explain current variations in the performance among the Grade Nine students in public junior secondary schools of Kajiado-West Sub-County positioning cognitive load as a critical load determinant of success in Mathematics.

1.12.2 Scaffolding Theory

Scaffolding Theory was developed by Jerome Bruner's work in the 1970s while building upon Lev Vygotsky's ZPD framework (Taber, 2025). According to Sarmiento-Campos et al. (2022), the theory explains that students will achieve better results when teachers and classmates who know more guide their learning process through organized help which is then withdraw gradually when students master the tasks. The process of scaffolding requires educators to give students individualized support through prompts, demonstration, and evaluation which enables

them to reach their present knowledge level toward their target learning objectives (Puntambekar, 2022).

Teachers who use scaffolding methods in Mathematics education help students break down complicated subjects and problem-solving activities into small parts which helps them understand better and reduces their mental burden. Research indicates that proper scaffolding methods help students stay focused while they achieve better learning results and achieve higher Mathematics grades (Acosta-Gonzaga et al., 2022).

However, critics of the theory argue that scaffolding depends on teacher actions and its success depends on how well teachers perform and what students already know and how they learn in their learning space. In this regard, the process of scaffolding which exceeds its limits prevents students from developing their own ideas but insufficient scaffolding fails to deliver needed assistance (Sugiati et al., 2025).

Noteworthy, the theory serves as a valuable tool for this research as it will enable the researcher to study the connection between teaching assistance and students' cognitive capacity. In this case, the teaching methods which Kajiado-West Sub-County public junior secondary schools for their Mathematics classes determine how students approach their mental tasks which eventually shapes their academic success. The research study applies Cognitive Load Theory to show how students must handle information processing which determines their mathematical knowledge and their ability to perform in Mathematics. The theory provides basic support for teaching yet its current version fails to deliver adequate information on instructional support. The Scaffolding Theory complements this by emphasizing guided support that helps learners handle their mental processing requirements while they gain knowledge step-by-step and become better at solving problems. The approach develops problem-solving skills, thereby addressing gaps related teaching methods and student support. Thus, the application of scaffolding principles together with cognitive load theory explained why different Grade Nine students achieved various levels of success in their Mathematics studies.

1.13 Conceptual Framework

This section establishes the context of academic performance in Mathematics as influenced by cognitive load among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya. Intrinsic, extraneous, and germane cognitive load form the independent variable while academic performance in Mathematics forms the dependent variable as presented in Figure 1.1.

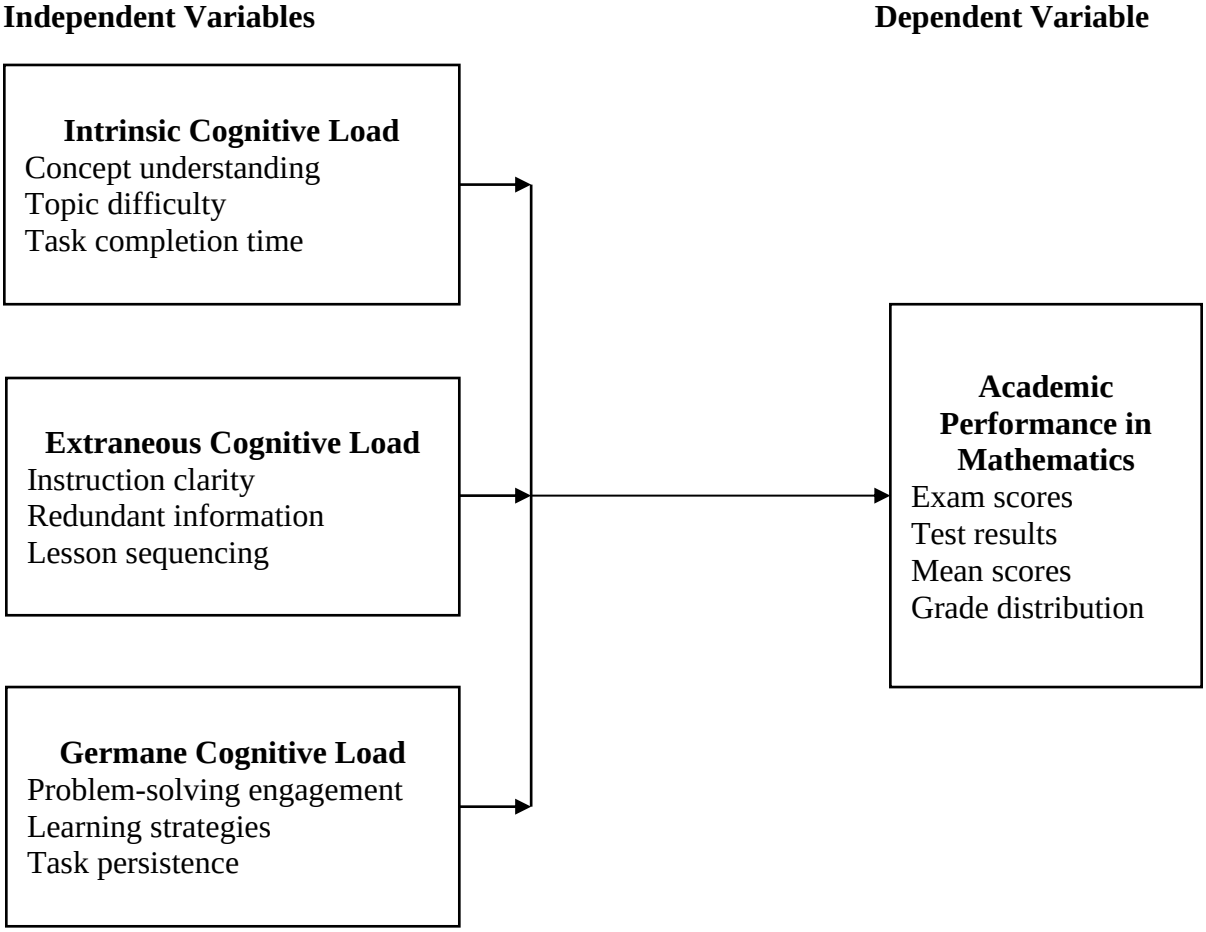


Figure 1. 1: Conceptual Framework

Source: Researcher, (2026)

The conceptual framework demonstrated how cognitive load affects student learning outcomes in Mathematics for Grade Nine pupils who attend public junior secondary schools in Kajiado-West Sub-County of Kajiado County Kenya. The research framework established three

independent variables which included intrinsic cognitive load, extraneous cognitive load, and germane cognitive load while academic performance in Mathematics served as the dependent variable. The mental work needed to understand the original complexity of mathematical ideas and operations defines intrinsic cognitive load. Extraneous cognitive load arose from ineffective instructional methods, poorly designed learning materials, and unnecessary information that distracted learners from the learning process. Students need to dedicate their mental power which constitutes germane cognitive load to grasp concepts while building knowledge frameworks and they must combine newly acquired information with their current understanding. The framework suggested that cognitive load dimensions would affect students' mathematical learning abilities which would impact their academic results. The study focused on how different levels of intrinsic, extraneous, and germane cognitive load affected student performance in Mathematics for Grade Nine students.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature on cognitive load of academic performance in mathematics among Grade Nine students from a global, regional, and local viewpoint. It also summarizes related literature and identifies research gaps.

2.2 Empirical Review of Literature

Previous studies both globally, regional, and local have been done on cognitive load as a predictor of academic performance in mathematics among Grade Nine students presenting different findings and conclusions. This section is presented in the following structure; intrinsic cognitive load and academic performance Mathematics, extraneous cognitive load and academic performance in Mathematics, and germane cognitive load and academic performance in Mathematics among grade nine students in public junior secondary schools, and finally prediction equation for academic performance in Mathematics from cognitive load among grade nine students in public junior secondary schools.

2.2.1 Intrinsic Cognitive Load and Academic Performance in Mathematics Among Grade Nine Students in Public Junior Secondary Schools

The mental work which students need to learn complexity learning content represents the core concept of intrinsic cognitive load (Chen et al., 2023). In Mathematics, this intrinsic cognitive load is shaped by the number of interacting elements within concepts, students' prior knowledge, and the way mathematical problems follow logical patterns. The mathematical content becomes difficult for students because its intrinsic complexity surpasses the learners' ability to remember information which leads to negative impacts on the learning process and academic achievements (Schoenfeld, 2022). Students who possess sufficient basic knowledge can handle intrinsic load better which leads them to achieve better academic results (Evans et al., 2024). Students' mathematical understanding develops through the ability to learn, use, and move mathematical concepts in math's lessons. Examining intrinsic cognitive load in relation to academic performance is thus critical for understanding how content complexity influences learning outcomes among Grade Nine students.

Early studies across the world have been done on this subject presenting varied findings and conclusions. For example, Al-Sarry et al. (2022) studied “Cognitive load of university students and its relationship to their academic achievement” in Iraq. The primary goal of this research focused on discovering the relationship between student learning cognitive load and their complete academic performance. The researchers used a descriptive correlational design to gather data from a group of undergraduate students. The research collected data through a fixed cognitive load questionnaire which measured student perceptions of mental effort during their learning activities. The study used statistical analysis which included correlation and regression methods to determine how cognitive load affected student academic performance. The study discovered that university students who experienced more mental effort during their work achieved lower academic results. However, the research (Al-Sarry et al., 2022) demonstrates that cognitive load affects student academic results yet it only studied students from one country who attended higher education institutions without measuring intrinsic cognitive load as a separate academic success prediction factor, hence a research gap.

Further, Baiduri et al. (2024) studied “The Impact of Cognitive Load on Learning Achievement and Semester Level in Mathematics Education Students” in Indonesia. The main objective was to determine whether cognitive load influences students’ academic performance and their academic level in mathematics education programs. The research used a quantitative survey method to collect data from 158 university students who studied mathematics education at three private universities in Indonesia. The research team used questionnaires to collect data about cognitive load elements and student grades which they turned into academic achievement scores. The research team used descriptive statistics, correlation analysis, and one-way ANOVA to study variable relationships and student performance differences between different semester levels. The research found varying average values between different cognitive load types but the data showed no connection between cognitive load measurements and students' success in mathematics learning. However, the research by Baiduri et al. (2024) focused on Indonesian higher education students but they did not study how intrinsic cognitive load affects mathematics achievement for students who attend lower secondary school, thus a research gap.

Spijkerman et al. (2024) studied "A cognitive load theory perspective of the undergraduate anesthesia curricula in South Africa." The study aimed to identify how students learn and develop their abilities through their curriculum-based experiences which lead to their academic growth. The research study applied a constructivist cross-sectional qualitative approach to analyze data from 1,336 students through thematic analysis of their experiences. The study showed that students encountered high intrinsic load because of their complicated assignments but their learning suffered because of bad instructional design which created additional external cognitive load. The process of learning became more effective as students used their motivation and metacognitive abilities to handle Germane load. However, the study (Spijkerman et al., 2024) focused on medical education but it did not establish any numerical connection between intrinsic cognitive load and academic achievement. Thus, a research gap that the current study aims to fill.

Finally, Wara et al. (2018) studied "Relationship between cognitive engagement and academic achievement among Kenyan secondary school students." The study focused on Nyamira County to study how students in secondary schools engage mentally with their schoolwork which affects their academic success. The study collected data through mixed methods which combined different research approaches in a design that collected data simultaneously from 312 students who completed questionnaires and participated in interviews. The research findings showed that students who actively engaged cognitively in their studies achieved higher academic results through statistical correlation and regression analysis ($r = .376$, $p < .01$). The research study (Wara et al., 2018) concentrated on general student engagement instead of examining particular mental processes which include intrinsic cognitive load and also did not focus on any specific academic discipline, hence a research gap. The current research addresses this missing element by studying how intrinsic cognitive load predicts mathematical success of Grade Nine students who attend public junior secondary schools in Kajiado West-sub-county.

2.2.2 Extraneous Cognitive Load and Academic Performance in Mathematics Among Grade Nine Students in Public Junior Secondary Schools

The instructional design elements which fail to support learning like vague explanations, duplicated content, and unordered educational resources create the extraneous cognitive load (Surbakti et al., 2024). Students must manage their mental abilities to solve problems as they need

to focus on essential problem-solving methods. The instructional materials should create a learning environment which blocks students from handling unneeded information while they grasp core mathematical concepts (Gnawali, 2025). The way teachers present content during instruction affects student Mathematics academic success alongside their natural learning abilities. Therefore, understanding the influence of extraneous cognitive load on academic performance is crucial for identifying teaching methods that block or support student success in Grade Nine Mathematics learning.

Similarly, early studies across the world have been done on this subject presenting varied findings and conclusions. For example, Warsono et al. (2024) conducted a study "The mathematics-based learning method and its impact on student performance in the Introductory Accounting course: cognitive load theory" in Indonesia. The main objective was to determine whether integrating mathematical reasoning into accounting instruction could enhance academic performance by managing learners' cognitive load. The research used a quasi-experimental approach to study 230 students who attended the faculty of economics and business for their undergraduate education. The researchers used student academic results to run regression analysis. The study employed gender, major, and academic background as control variables during its analysis. The research demonstrated that students achieved better results through the mathematics-based learning approach when compared to conventional teaching methods. The control variables failed to achieve statistical significance during the research process. However, the research took place in an accounting department at a university but it failed to study how extraneous cognitive load variables function as prediction factors.

Moreover, Geberkidan et al. (2025) studied "The effect of blended learning on mathematics cognitive demand and cognitive load in learning calculus of several variables at universities in Tigray, Ethiopia." The research main objective was to examine the effects of blended learning environments on student cognitive load and their performance with difficult mathematical problems. The research study used a quasi-experimental design to study university students who took calculus courses during their undergraduate studies. The study gathered data through achievement tests, cognitive load questionnaires, and task-based assessments which assessed both mental effort requirements and students' self-perceived mental workload. Inferential statistical

methods were employed to analyze quantitative data to compare results from blended education programs with conventional teaching methods. The research showed that blended learning methods effectively lowered students' unnecessary mental effort while they could focus on essential learning processes and they became more interested in challenging mathematical work. However, the research (Geberkidan et al., 2025) took place in higher education institutions where researchers studied teaching methods instead of studying how extraneous cognitive load affects student performance.

Similarly, Ochukut et al. (2025) studied "Measuring Cognitive Load and Motivation in E-Learning: The Case of Two Kenyan Universities." The primary goal of this project was to evaluate student cognitive load and motivation levels at the university while analyzing how these elements affect their participation in online learning and academic success. The research used a descriptive cross-sectional survey method to study undergraduate students who took their courses through online learning platforms. The research team collected data through online self-report questionnaires which contained established cognitive load measurement scales and motivation assessment tools. The statistical analysis of quantitative data included both descriptive statistical methods and inferential statistical techniques. The research showed that students developed negative learning results from poor engagement with extraneous cognitive load although motivation levels helped them handle the mental tasks required for e-learning. The research demonstrated that proper instructional design helps students by removing extra mental work which does not contribute to their learning process. However, the study (Ochukut et al., 2025) focused its investigation on university settings which used e-learning platforms but failed to establish a connection between extraneous cognitive load as predictor of student academic achievements.

2.2.3 Germane Cognitive Load and Academic Performance in Mathematics Among Grade Nine Students in Public Junior Secondary Schools

Students must learn to build and organize schemas which they need to master long-term learning as Germane cognitive load requires them to perform mental work. The educational theory of germane load produces beneficial effects since it helps students develop mathematical understanding and skills (Sulisworo et al., 2024). According to Seepiwsiw and Seehamongkon (2023), the process of reasoning, reflection, and problem-solving activities help students develop

deep mathematical understanding which leads to better academic results. The academic performance of students in Mathematics depends on their ability to understand and use the mathematical concepts which they have learned. Therefore, examining germane cognitive load is essential for understanding how productive cognitive engagement supports performance among Grade Nine students, particularly in contexts where instructional practices vary in their ability to promote meaningful learning.

Different scholars have studied the relationship between germane cognitive load and academic performance in Mathematics across the world presenting different findings and conclusions. For example, Ahmed (2024) studied “Cognitive load and academic performance in online learning: Evidence from undergraduate students” in Pakistan. The goal was to study how cognitive load experienced learning environment affects student academic performance. The research used a correlational design to collect data from an online survey which students took while studying remotely for their undergraduate courses. The research used a standardized cognitive load questionnaire to evaluate student understanding of three cognitive load types and their academic results based on their grade point averages (GPAs). The research findings showed that students who used more germane cognitive load achieved better learning results but excessive extraneous load harmed their academic success. However, the study (Ahmed, 2024) focused on Pakistan's higher education system and online learning environment but it did not study mathematics education for students who attend junior secondary school, thus a research gap.

Moreover,Liu et al. (2022) studied “Effects of immersive virtual reality classrooms on students' academic achievement, motivation and cognitive load in science lessons” in China. The study aimed to find out if virtual reality (VR) learning environments would improve student learning results through their ability to handle multiple cognitive processing needs. The researchers conducted a quasi-experimental study which assigned science students to either experience VR education or follow standard classroom learning through random selection. The study collected data through academic achievement tests which students took before and after the study and through motivation assessment tools and cognitive load measurement instruments which evaluated intrinsic, extraneous, and germane load types. The research results showed that students who studied with VR technology achieved better academic results while maintaining higher motivation

levels and they experienced greater germane cognitive load with reduced extraneous cognitive load compared to students who studied in traditional classrooms. However, the research study (Liu et al., 2022) focused on science education with technology but it failed to investigate how germane cognitive load affects student success in basic subjects such as Mathematics outside of virtual reality learning environments.

Mohammed et al. (2025) studied "Perceived Determinants of Academic Achievement in Integrated Science among Senior High School Students in Ghana." The study aimed to establish which elements from schools, teachers, and students would affect performance. The research used a descriptive survey design to collect data from 294 students and 18 teachers who completed validated questionnaires which researchers analyzed through descriptive statistical methods. The research results showed that poor learning environments, inadequate instructional resources, low teacher competence, and limited learner support negatively affected achievement. However, the study (Mohammed et al., 2025) focused on overall elements which affect student performance rather than cognitive processes, thus, a research gap that the current study intends to fill.

Finally, Owidi and Lyanda (2025) studied "Technological and classical pedagogical agents in action: How design influences learning in Kenyan Higher Education." The research sought to determine which teaching methods would best generate effective germane cognitive load which leads to improved academic results among 200 students in higher education. The research employed a mixed-methods approach which involved participants taking pre- and post-tests while they also participated in focus group discussions. The research showed that classical teaching agents achieved better results as they controlled germane cognitive load which helped students learn effectively resulting in better test results and improved understanding of concepts than technological agents did. Students found classical designs to be more engaging which helped them understand the material better. The research demonstrates that instructional design stands as an essential factor which enables students to manage their mental work demands for better educational results. However, the research (Owidi & Lyanda, 2025) focused on university education but it did not address how students in junior secondary schools manage their mental resources which affects their mathematics results thus creating a research gap that this study will investigate in Kenyan schools.

2.2.4 Prediction Equation for Academic Performance in Mathematics from Cognitive Load Among Grade Nine Students in Public Junior Secondary Schools

Understanding academic performance in Mathematics requires a comprehensive examination of the cognitive factors that shape how learners process, organize, and apply information during learning. The working memory system contains three types of cognitive loads which researchers like Sweller et al. (2011) identified through their research on Cognitive Load Theory. The math content complexity together with student background knowledge determine intrinsic cognitive load but poor teaching methods create extraneous cognitive load and students need to invest mental effort to develop essential knowledge which produces germane cognitive load. The learning components create a system which produces academic results through their combined effect on learning speed and knowledge depth acquisition.

Although earlier studies have analyzed the separate impacts of intrinsic, extraneous, and germane cognitive load on student learning and performance, only a few studies have created a unified model which predicts these effects for students in their first years of secondary education. Developing a prediction equation that incorporates all dimensions of cognitive load allows for a more holistic understanding of how cognitive demands interact to influence Mathematics achievement. This approach therefore recognizes that academic performance is not the result of isolated cognitive factors, but rather the combined effect of how learning content is structured, presented, and cognitively processed.

2.3 Summary of Literature Reviewed and Research Gaps

The reviewed literature indicates that cognitive load is a key determinant of students' academic performance in Mathematics and related disciplines. Research shows that intrinsic cognitive load which is shaped by both student's existing mathematical knowledge and ability to understand complex mathematical concepts influences their ability to understand as well as apply content effectively (Chen et al., 2023; Schoenfeld, 2022; Evans et al., 2024). Further, research shows that extraneous cognitive load resulting from instructional materials lacking proper design together with bad presentation techniques produces negative effects on their academic progress or leads to weak academic performance (Surbakti et al., 2024; Gnawali, 2025; Warsono et al., 2024). Conversely, germane cognitive load, which supports schema construction through reasoning and

problem-solving, is consistently associated with improved learning and academic achievement (Sulisworo et al., 2024; Ahmed, 2024; Liu et al., 2022). The research studies thus demonstrate that students need to reach an equilibrium between all three cognitive load elements to improve their Mathematics performance.

Nonetheless, despite growing evidence on the role of cognitive load in learning, notable gaps persist in the existing literature. Methodologically, the research studies used descriptive survey designs to measure generic and individual cognitive load (Al-Sarry et al., 2022) while others used quasi-experimental designs to test teaching methods and technology-based solutions (Warsono et al., 2024; Geberkidan et al., 2025; Liu et al., 2022). Similarly, contextually, majority of the studies included students from higher education institutions which exist in Iraq, Indonesia, Pakistan, China, and Ethiopia (Baiduri et al., 2024; Ahmed, 2024; Geberkidan et al., 2025) so the findings do not apply to students who attend junior secondary schools. Additionally, the research field included studies which concentrate on teaching accounting, science, and technology education but they do not focus on Mathematics as a subject (Warsono et al., 2024; Liu et al., 2022). To fill the research gaps, the current study examined cognitive load as predictor of academic performance in Mathematics among Grade Nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya. The study thus used convergent parallel mixed research design to provide a comprehensive understanding of the study and regression analysis to investigate how cognitive load elements predict performance outcomes and create predictive models.

CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The chapter discusses the study design, study site, target population, study sample, data collection which includes instrument used, collection procedures, and analysis, and finally ethical issues.

3.2 Research Design

The study used convergent parallel mixed research design where a study gathers quantitative and qualitative data at the same time and separate analyses of each data set before combining the results to achieve a full understanding of the research subject (Creswell & Clark, 2017). The design method receives preference above other designs as it enables researchers to gather data quickly while they can directly match and verify the results which leads to better research validity. The method shows its best results when researchers need to merge multiple data sources into a single analysis to study complicated educational systems. In the current study, the design allowed statistical links between intrinsic, extraneous, and germane cognitive load and academic performance to be complemented with contextual insights from students and teachers, resulting in a more robust and holistic interpretation of the findings.

3.3 Research Site

The research took place within Kajiado-West Sub-County which serves as a rural semi-arid region where people mainly raise livestock. Kajiado-West Sub-County exists as a rural area within Kajiado County which hosts multiple Maasai communities under a dry semi-arid climate. The sub-county contains counted number of public junior secondary schools which follow the national curriculum. The researcher chose Kajiado-West sub-county because this area presents an exceptional learning environment, easy accessibility while delivering relevant data to the study population thus offering representative data on cognitive load and performance.

3.4 Target Population

The target population included Grade Nine students enrolled in public junior secondary schools in Kajiado-West sub-county, Kajiado County, Kenya. This population is of interest since

it is a critical transition stage in junior secondary school where increased curriculum complexity and cognitive demands in Mathematics influence students' cognitive load and academic trajectory. According to Ryan et al. (2021), students experience increased cognitive demand in mathematics in their transition to junior secondary which leads to a short-term drop in their academic performance. The study thus focused on accessible population of 1830 Grade Nine students from which 983 are boys while 847 are girls and 74 Mathematics subject teachers from 35 public junior secondary schools in the Kajiado-West sub-county, distributed as 1 Girls boarding school, 2 mixed boarding schools, and 32 mixed day schools. Mathematics teachers participated in the study as they are responsible for creating instructional designs and delivering courses in the classroom.

3.5 Study Sample

3.5.1 Sample Size

The study used Yamane's (1967) formula to determine the sample size. The parameters of the formula are as described as follows;

$$\mathbf{n} = \frac{N}{1+N(e)^2}$$

From the formula, **n** = the sample size required

N = Target Population

e = error of margin or the precision level (for this study the researcher used 5%)

Thus, desired sample size for Grade Nine students was calculated as follows;

$$\text{n} = \frac{1830}{1+1830(0.05)^2} = 328 \text{ students}$$

To adjust the sample size for return rate, the estimated return rate is 90% as for cross-sectional studies. Therefore, in order for the final count of usable responses to meet the requirement, the initial sample size was divided by the estimated return rate as follows;

$$\frac{335}{0.9} = \mathbf{364} \text{ students}$$

To determine the sample size for Mathematics teachers, the study used the same Yamane's (1967) formula to obtain a sample size of 74 teachers.

To get the sample size of each category of schools from the target population, proportionate stratified random sampling formula was utilized. In order to use this formula, the sample size of all the strata must be established, where the study also used Yamane's (1967) formula. The proportionate stratified random sampling formula is described as follows;

$$nh = \frac{Nh}{N} n$$

Where; ***nh*** =Sample size obtained from proportionate stratified random sampling formula

Nh =Total Stratum Population

N = Total Population

n = Sample size calculated using the Yamane's (1967) formula

Thus, for instance, to calculate the sample size of public boys boarding secondary school for this research, the sample size for all the strata was calculated first and then used to calculate the sample size of this stratum. The procedure was as follows;

$$\text{n} = \frac{35}{1+35(0.05)^2} = 32$$

Next, working with proportionate stratified random sampling formula;

Sample size of Girls boarding schools **(**nh) $= \frac{1}{35} 32$=1 Schools

Table 3. 1: Target Population and Sample Size

School Category	Target Population				Sample size			
	Schools	Students		Mathematics Teachers	Students			Mathematics Teachers
		Boys	Girls		Schools	Boys	Girls	
Girls' Boarding	1	-	35	2	1	-	7	1
Mixed Boarding	2	30	27	2	2	6	5	1
Mixed Day	32	953	785	70	29	190	156	67
Sub-total		**983**	**847**	**74**		**196**	**168**	**69**
Total	**35**	**1830**		**74**	**32**		**364**	**69**

Source: **County Education Office, 2026**

3.5.2 Sampling Procedures

Grade Nine students and Mathematics teachers were purposefully selected by using maximum variation sampling. The sub-counties under study have boys', girls', day and boarding, and day junior secondary schools. School from each category was selected using stratified sampling followed by simple random sampling to pick a school for study. Students and teachers from each school were also selected using simple random sampling. Simple random sampling technique is appropriate since it gives every participant an equal chance to participate in the study, increasing data generalization.

3.6 Data Collection

3.6.1 Data Collection Instruments

To collect data from the Grade Nine students, questionnaires that include cognitive load scale by Leppink et al. (2013) used interview guide for Mathematics teachers.

3.6.1.1 Questionnaires for Students

The student questionnaire consisted of 31 items of both open-ended (4 item) and closed-ended (27 items) questions for easy coding analysis and interpretation of data. The questionnaire was divided into three sections labeled alphabetically. The first section A, sourced participants

demographic information. Section B contained items on academic performance. Further, section C consisted of items on intrinsic cognitive load, section D on extraneous cognitive load, and finally, section E on germane cognitive load. The cognitive load items followed the cognitive load scale developed by Leppink et al. (2013) which was used to assess the cognitive load experiences by the students. The scale exhibits a reliability coefficient of .78. The scale consists of 10 items, and participants are supposed to respond on a five-point Likert scale. The scale ranges from 1 (strongly disagree) to 5 (strongly agree). The interpretation therefore was based score where 1.00 – 1.80 described as very low, 1.81 – 2.60 low, 2.61 – 3.40 moderate, 3.41 – 4.20 high, while 4.21 – 5.00 as very high (Leppink et al., 2013).

3.6.1.2 Interview Guide for Mathematics Teachers

The researcher prepared both interview questions and a procedure to guarantee that this research remained applicable. A direct and honest discussion with the interviewees helped bring out important sensitive information from the teachers through a planned interview. Therefore, the researcher was able to ask questions that were more specific. The interview guide contained three sections (A - C). Section A solicited background information, section B on general academic performance in Mathematics subject from the respective schools. Finally, section C was designed to gather data about cognitive load factors on academic performance in Mathematics in public junior secondary schools in Kajiado-West sub-county, Kajiado County, Kenya.

3.6.2 Pilot Testing of Research Instruments

To determine whether the instruments function correctly a pilot study took place with 30 Grade Nine students and two Mathematics teachers all from public junior secondary schools located in Kajiado-North sub-county of Kajiado county Kenya. The main study excluded the pilot study school because its students as well as the Mathematics teachers would already know the research questions which would reduce the trustworthiness of the collected data. The research process needed the pilot study as its first stage because this stage verified whether the main study would succeed in delivering trustworthy results with proper study design and maintain its feasibility.

3.6.3 Instrument Validity

The research used construct validity as its main method to prove that cognitive load and academic performance have proper operational definitions which follow Cognitive Load Theory principles. Construct validity was supported by content validity through Exploratory Factor Analysis (EFA). Further, the University supervisors assessed the study instruments to establish face validity during the review process. The researcher replaced vague questions not to create problems for achieving better research tool validity. The current comments became more useful when researchers performed a complete review about how cognitive load evaluation methods operate.

3.6.4 Instrument Reliability

The Cronbach alpha coefficient was used to assess the instruments' internal consistency dependability. A reliability test serves to confirm that data collection processes produce identical results which become trustworthy. The method works to verify that researchers can obtain identical measurement results when they perform their research instruments multiple times. According to Malkewitz et al. (2023), if a study shows a reliability coefficient value of 0.7 or above then this proves the questionnaires maintain reliability.

3.6.5 Data Collection Procedures

The researcher first obtained a research approval letter from the Department of Education through School of Post Graduate studies which was used to apply for a research permit from the National Commission of Science, Technology and Innovation (NACOSTI) as well as to be used in the field. The researcher further obtained permission from the Sub-County Education Officer to carry out the study in the sample schools.

At the field, the research conducted interviews to obtain qualitative information while questionnaires served to gather quantitative data. The research completed data collection work through survey methods which deliver quick results (Borgobello & Pierella, 2019). The researcher used research assistants to administer questionnaires for learners. The researcher obtained parent consent through the schools before students could join the project. Interviews were conducted for

teachers who specialize in teaching mathematics. Finally, voice recorder data was tagged and stored for examination.

3.7 Data Analysis

Data cleaning was done to identify and separate completed questionnaires that meet the criteria before data analysis. Data was encoded by variables under inquiry. The process of data entry required users to input unprocessed information into the SPSS 27.0 codebook system. The data analysis process used descriptive statistics which included means, standard deviations, and frequency distributions while Pearson Coefficient Correlation and multiple linear regression analysis for inferential statistics at a 5% significance threshold. Qualitative data from the interview guide underwent transcription which the researcher then organized before starting the coding process to find common patterns in the data. The codes were categorized and developed into thematic structures. Thematic analysis was used to analyze these themes to understand how participants experience cognitive load during their mathematics learning process, what meanings they associate with it, what perspectives they hold about a systematic, and meaningful understanding of the data. The multiple linear regression equation is follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$$

From the equation;

Y = Academic performance in Mathematics

$\boldsymbol{\beta_0}$**=** Y intercept which is the constant

$\boldsymbol{\beta_1}$, $\boldsymbol{\beta_2}$, $\boldsymbol{and}$ $\boldsymbol{\beta_3}$ coefficients of intrinsic, extraneous, and germane cognitive load

$\boldsymbol{X_1}$**=** Intrinsic cognitive load and

$\boldsymbol{X_2}$ =Extraneous cognitive load

$\boldsymbol{X_3}$ = Germane cognitive load

$\boldsymbol{\varepsilon}$= error term

3.7.1 Underlying Assumptions of the Multiple Linear Regression Model

The analysis through multiple linear regression depends on various essential assumptions which verify both the accuracy and trustworthiness of the research findings. The basic assumption of linearity requires that the dependent variable demonstrates a direct linear connection with each

independent variable. The requirement for independent errors means that residual values must stay unconnected to each other. The assumption of homoscedasticity requires that residuals show equal spread throughout all predictor variable ranges (James et al., 2023). The normal distribution of residuals requires that error terms follow a distribution which closely resembles a normal distribution. The model requires independent variables to exist without strong relationships between them for proper operation. The analysis depends on having no extreme data points because these values would create inaccurate estimation results. Thus, according to James et al. (2023), when all assumptions are fulfilled, multiple linear regression produces unbiased, efficient estimates which can be easily used for reference.

3.8 Legal and Ethical Considerations

The researcher secured authorization through Africa Nazarene University School of Post Graduate studies and the National Council of Science Technology and Innovation (NACOSTI) based in Nairobi before proceeding with the research. The researcher conducted the research through this system which fulfills the operational requirements. In the field, the researcher followed beneficence as the guiding principle for fieldwork because it requires the researcher to protect participants from any form of harm or exploitation and establish a proper balance between research risks and benefits. In this regard, the researcher protected all participants who joined the study throughout every stage of the research process. Lastly, the researcher prevented any plagiarized content through proper referencing while also verifying that all presented information remains accurate.

CHAPTER FOUR
DATA ANALYSIS AND FINDINGS

4.1 Introduction

This section presents the study's findings from the field data analysis. The section is organized as; response rate, demographic analysis of the respondents, analysis per the study's specific objectives: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load, all on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

4.2 Response Rate

The response rate describes the proportion of distributed questionnaires or targeted participants who successfully provide usable responses (Wu et al., 2022). According to Khan (2024), the research results become more representative, reliable, and valid when a study achieves high response rates through minimizing non-response bias thus improving the generalizability of the findings. In this study, out of the 364 Grade nine students that were sampled and therefore issued with questionnaires, 81.04% (295) successfully provided the usable responses. In this regard, 18.96% (69) of the Grade nine students did not submit back their questionnaires mainly because of failure to complete them and some lack of parental consent. Similarly, out of the 69 sampled teachers 37 (53.62%) were successfully interviewed while 32 (46.38%) were not available because of some involvement in administrative duties and others absent from school during the data collection period which was in the school opening weeks. According to Brick and Tourangeau (2017), a response rate above 50% is acceptable for social science studies. Thus, a response rate of 81.04% for Grade nine students and 53.62% for Mathematics teachers were sufficient for generalizability of the findings to study population.

4.3 Demographic Characteristics of the Study Respondents

Demographic characteristics were essential in this study as they provided important background information about the Grade Nine students which helped to explain variations in cognitive load and academic performance in Mathematics. The study sought to understand students' gender, type of school, and age to compare them effectively leading to a better

understanding of patterns and trends, in order to produce more valid and generalizable research results. Table 4.1 presents the student demographic analysis.

Table 4. 1: Student Demographic Data Results

Category		Frequency (n=295)	Percent (%)
Gender	Male	161	54.6
	Female	134	45.4
Type_of_School	Girls School	7	2.4
	Mixed Boarding School	11	3.7
	Mixed Day School	277	93.9
Age_Bracket	Below 13 Years	2	0.7
	14 -15 Years	256	86.8
	Above 16 Years	37	12.5

Source: Field, 2026

From Table 4.1, on student gender, the research findings showed that out of the 295 Grade Nine students who took part in the survey, 161 (54.6%) were males while 134 (45.4%) were females. The relatively balanced gender distribution suggests that both male and female students were well represented in the survey which reduced gender-based biases and made its results applicable to wider the population. The sampled schools showed a slight predominance of male students which could reflect the enrollment patterns. As cognitive load and academic performance could the genders because of study methods, learning experiences, classroom participation. Therefore, the inclusion of both genders offered a comprehensive basis for examining how cognitive load influences Mathematics performance among the Grade Nine learners.

Further, on the type of school, the results that 277 (93.9%) of respondents attended mixed day schools followed by 11 (3.7%) students who attended mixed boarding schools and 7 (2.4%) students who attended girls' school. The results suggest dominance of mixed day Sub-County which reflect the educational landscape. School type may influence cognitive load and academic performance through factors like instructional support, access to learning materials, study time, and learning environment. Thus, understanding of the school type was important in interpreting variations in Grade Nine students' cognitive load and mathematics achievement.

Finally, student age bracket, 256 (86.8%) of the respondents were between 14 to 15 years old, followed by 37 (12.5%) aged 16 years and above while 2 (0.7%) students below 13 years old. The distribution shows that most participants matched the expected age range which the Competency-Based Curriculum established for Grade Nine students. The sample became more uniform as students between 14 to 15 years old formed the main group which reduced age-related differences that could influence cognitive processing and academic performance. As cognitive development as well as problem-solving abilities evolve with age, the age profile of the Grade Nine students provided an important context for understanding differences in cognitive load and mathematics achievement among them.

4.4 Preliminary and Diagnostics Tests

The researcher conducted diagnostic tests and preliminary assessments before starting the main analysis to determine if the data met the requirements for statistical analysis. Construct validity was evaluated to determine whether the measurement instruments successfully captured the intended constructs. The researcher further conducted tests on regression assumptions which included normality, linearity, homoscedasticity, and multicollinearity absence to verify regression result accuracy, reliability, and validity of final conclusions.

4.4.1 Reliability Test Results

Table 4. 2: Summary of Reliability Statistics

Variables	No. of Items	Cronbach's Alpha	Conclusion
Academic Performance	4	.802	Good Reliability
Intrinsic Cognitive Load	4	.847	Good Reliability
Extraneous Cognitive Load	4	.884	Good Reliability
Germane Cognitive Load	4	.816	Good Reliability
Overall Instrument Reliability	16	.888	Good Reliability

Based on Table 4.2, reliability test statistics, all the research items under the main study variables obtained Cronbach's Alpha values above 0.70 indicating a high internal consistency (Malkewitz et al., 2023). As such, the overall reliability coefficient of $\alpha = .888$ demonstrated that the study questionnaire provided good reliability to be used in the collection of data. Thus, the items on the questionnaire collected the intended data on for examining cognitive load on academic

performance in Mathematics among Grade nine students in public junior secondary schools in Kajiado-West Sub-County, Kajiado County, Kenya.

4.4.2 Construct Validity Analysis

The researcher conducted a construct validity analysis to verify that the study instruments effectively measured the specified constructs which included intrinsic cognitive load, extraneous cognitive load, and germane cognitive load. The researcher applied Exploratory Factor Analysis (EFA) to examine the underlying factor structure besides assessing the items loading on their respective construct. The analysis process validated that the measurement scales maintained both theoretical and statistical integrity which resulted in better research findings and conclusions with greater validity, accuracy, and credibility. The findings were as follows;

Table 4. 3: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.800
Bartlett's Test of Sphericity	Approx. Chi-Square	2071.071
	df	120
	Sig.	0.000

From Table 4.3, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy reached 0.800 which exceeded the recommended threshold of 0.60 shows that the data set met the requirements for factor analysis thus showing proper sample adequacy (Shrestha, 2021). Likewise, Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 2071.071$, $df = 120$, $p < .001$). The research findings demonstrated sufficient intercorrelations among variables which made factor analysis suitable for this study.

Table 4. 4: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.579	28.617	28.617	4.579	28.617	28.617	4.528	28.302	28.302
2	2.059	12.866	41.483	2.059	12.866	41.483	1.795	11.216	39.518
3	1.500	9.374	50.857	1.500	9.374	50.857	1.702	10.640	50.158
4	1.245	7.784	58.641	1.245	7.784	58.641	1.357	8.483	58.641

Extraction Method: Principal Component Analysis.

Total Variance Explained Table 4.4, the analysis of Exploratory Factor Analysis showed that 4 factors with eigenvalues > 1.0 were extracted from the dataset accounting for 58.641% of the total variance exceeding the 50% threshold (Sürücü et al., 2022). The results demonstrate that the extracted factors successfully identified the fundamental elements of research constructs which proves the measurement instrument contains a valid factor structure and maintains its construct validity.

Table 4. 5: Rotated Component Matrix

	Component			
	1	**2**	**3**	**4**
I find it difficult to focus and perform well in Mathematics subjects due to high cognitive load during lessons.	0.947			
The teaching methods in Mathematics subjects are clear and easy to follow.	0.931			
I often feel mentally exhausted after Mathematics classes, which affects my ability to perform well in exams	0.902			
The quality of instruction I receive in Mathematics subjects significantly improves my academic performance	0.854			
The topics covered in Mathematics are difficult		0.791		
I need to put in a lot of mental work to understand the concepts which this subject requires.		0.748		
The tasks in Mathematics require handling multiple elements which need to be processed at the same time.		0.647		
I feel overwhelmed when solving difficult Mathematics problems.		0.636		
The way the information is presented make learning more difficult than necessary.			0.633	
The instructions and explanations during Mathematics lesson are very ineffective or confusing			0.516	
I need to focus my mental energy on matters which does not contribute to my content understanding			0.507	
The teacher moves too fast for me to follow.			0.758	
I to actively engage with the Mathematics material through active thinking				0.669
I need to dedicate time for understanding the basic principles which support the Mathematics material.				0.655
The Mathematics lessons enable me to connect fresh information with the knowledge which I had already learned				0.808
I actively work to improve my understanding of the subject matter.				

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Table 4.5 for the Rotated Component Matrix showed factor loadings which extended from 0.507 to 0.947 while stayed above the recommended minimum threshold of 0.50 (Widaman & Helm, 2023). All retained items showed strong factor relationships which successfully represented their original constructs. The absence of weak loadings suggests good construct validity thus confirming the suitability of the measurement items for inclusion in subsequent statistical analyses and interpretation of the study findings.

4.4.3 Assumptions of Regression Analysis

The researcher performed diagnostic evaluations before inferential analysis to verify if data fulfilled the essential assumptions for regression analysis to function properly. conducted tests for normality, multicollinearity, linearity, and homoscedasticity to confirm the statistical results and the conclusions maintained reliability, accuracy, and validity.

4.4.3.1 Normality Test

The researcher performed a normality assessment to verify if the collected data followed a standard normal distribution which is a key assumption for parametric statistical analyses. The study examined the distribution of variables using skewness and kurtosis measures. Establishing normality thus helped ensure the validity, reliability, and accuracy of subsequent correlation and regression analyses. Demir (2022) asserts that skewness and kurtosis values which fall between -2 and +2 for normality assessment indicate a data distribution that follows a normal pattern which meets parametric analysis requirements.

Table 4. 6: Normality Test Statistics

	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Academic_Performance	0.187	0.142	-0.631	0.283
Cognitive_Load	-0.275	0.142	-0.851	0.283

From Table 4.6, the normality test results showed that Academic Performance recorded a skewness value of 0.187 and kurtosis of -0.631, while Cognitive Load had a skewness value of -0.275 and kurtosis of -0.851. The research data showed that all variables demonstrated acceptable normal distribution as the skewness and kurtosis values fell within the acceptable range of ±2. Thus, the normality assumption satisfied implying that the data met all necessary criteria which allowed for parametric analysis including correlation and regression methods.

4.4.3.2 Multicollinearity Test

A multicollinearity test was conducted to determine how strongly the independent variables showed high interrelatedness before conducting the regression analysis. The test was evaluated using Tolerance and Variance Inflation Factor (VIF) statistical measures.

Table 4. 7: Collinearity Statistics

	Collinearity Statistics	
Model	**Tolerance**	**VIF**
Intrinsic Cognitive Load	0.374	2.6738
Extraneous Cognitive Load	0.298	3.3557
Germane Cognitive Load	0.316	3.1646

a. Dependent Variable: Academic_Performance

From the study's findings Table 4.7, all independent variables showed VIF values < 10 while their tolerance values exceeded 0.10. According to Kalnins and Praitis Hill (2025), to satisfy the assumption of no multicollinearity, Tolerance values should exceed 0.10, while VIF values should be below 10. Thus, from the results, the multicollinearity assumption was satisfied, implying the absence of problematic correlations among the independent variables.

4.4.3.3 Linearity Test

The researcher conducted a linearity analysis to establish if the independent variables established a direct relationship with the dependent variable using a scatterplot.

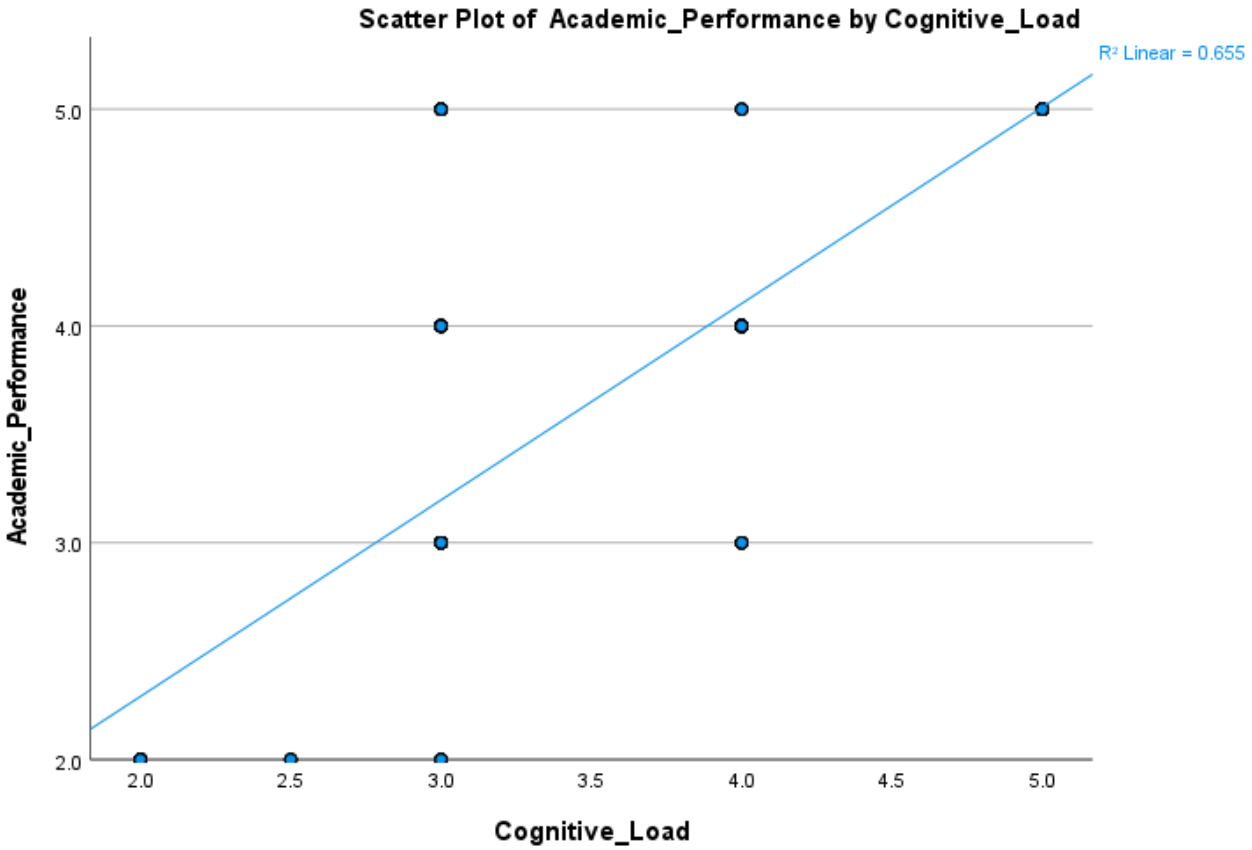


Figure 4. 1: Scatter Plot for Academic Performance by Cognitive Load

The scatter plot Figure 4.1 demonstrated that the data points spread along a straight line which showed a direct connection between the independent variable and the dependent variable. The data did not show any signs of major curves or regular patterns which would indicate non-linear behavior (Roustaei, 2024). The data thus met the linearity requirement which proved its suitability for regression analysis and allowed for proper modeling of study variable relationships through multiple linear regression.

4.4.3.4 Homoscedasticity Test

The researcher performed a homoscedasticity test to check if residual variances remained consistent throughout all levels of the independent variables. The assumption of homoscedasticity stands as a fundamental part of linear regression as varying error variances will produce incorrect parameter value estimates. The researcher used residual scatter plot to evaluate the assumption.

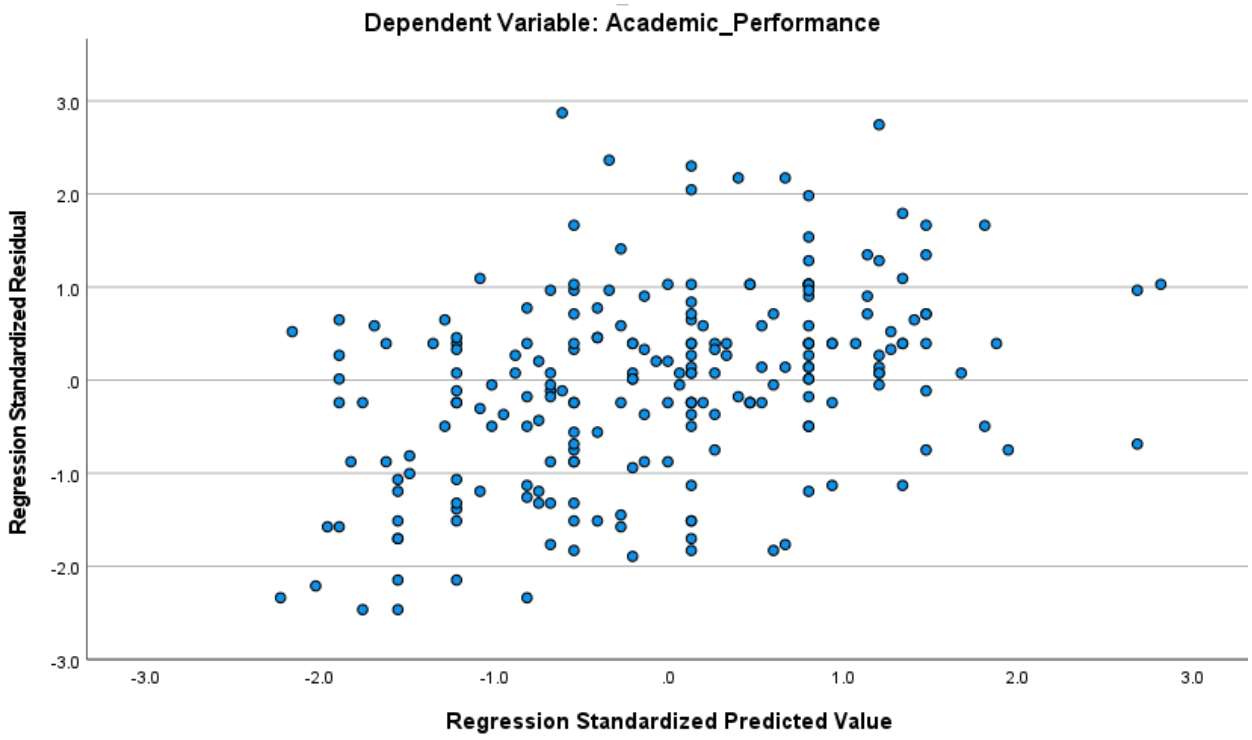


Figure 4. 2: Scatter Plot for Residual vs Predicted Values

The residual scatter plot Figure 4.2 showed random distribution of data points around the zero line without any visible pattern or organized grouping. The residual variance shows no significant changes thus remained relatively constant across all predicted values. The homoscedasticity assumption was therefore satisfied, suggesting that the study regression model produced unbiased and reliable estimates (Kumar, 2023; Yang et al., 2019).

4.4 Presentation of Research Analysis and Findings

Both the quantitative data from the questionnaires issued to Grade Nine students and qualitative data from the mathematics teachers' interview, all sampled from the public junior secondary schools in Kajiado West Sub-County, were analyzed and the findings organized as per the study specific objectives.

4.4.1 Intrinsic Cognitive Load on Academic Performance in Mathematics

The first research objective was to assess the influence of intrinsic cognitive load on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya. Grade Nine students in sampled

public junior secondary schools in Kajiado West were issued with questionnaire containing queries and four items on a 5-point Likert scale on intrinsic cognitive load sub scale. Mathematics teachers were also interviewed on this subject to provide more insights. The findings were as presented.

4.4.1.1 Descriptive Statistics of Intrinsic Cognitive Load

Table 4. 8: Grade Nine Student Responses on Intrinsic Cognitive Load

Statement	SD	D	N	A	SA	Mean	Std. Dev.
	F (%)	F (%)	F (%)	F (%)	F (%)		
The topics covered in Mathematics are difficult	0 (0.0%)	27 (9.2%)	130 (44.1%)	110 (37.3%)	28 (9.4%)	3.5	1.0027
I need to put in a lot of mental work to understand the concepts which this subject requires.	0 (0.0%)	0 (0.0%)	49 (16.6%)	169 (57.3%)	77 (26.1%)	4.1	0.9709
The tasks in Mathematics require handling multiple elements which need to be processed at the same time.	0 (0.0%)	0 (0.0%)	120 (40.7%)	158 (53.6%)	17 (5.7%)	3.7	0.9012
I feel overwhelmed when solving difficult Mathematics problems.	7 (2.4%)	32 (10.8%)	144 (48.8%)	67 (22.7%)	45 (15.3%)	3.4	1.2141
Overall Mean and Standard Deviation						**3.7**	**1.0222**

Source: Field, 2026

Table 4.8 on the first statement “The topics covered in Mathematics are difficult,” 27 (9.2%) of the Grade Nine students disagreed with it while 130 (44.1%) remained neutral, 110 (37.3%) agreed, and 28 (9.4%) strongly agreed. On this statement, students who remained neutral formed the largest group at 130 (44.1%) implying that they were uncertain about the level of difficulty of Mathematics topics or perceived the difficulty to vary across topics. The researcher found that students faced difficulties when learning Mathematics subjects which involved abstract thinking and required students to perform various steps. The statement average score of 3.5 thus implies that the majority of the students agreed that Mathematics topics are difficult, while a standard deviation of 1.0027 showed moderate differences in their individual responses. These findings therefore imply that the complexity of Mathematics topics contributes to intrinsic cognitive load, which may influence the academic performance of the Grade Nine students.

Similarly, the research findings show that 49 (16.6%) of the students under survey remained neutral with the statement "I need to put in a lot of mental work to understand the concepts which this subject requires" while 169 (57.3%) agreed, and 77 (26.1%) showed strong agreement. The highest percentage was recorded among those who agreed 169 (57.3%), suggesting that most learners perceived Mathematics as requiring substantial mental effort to understand. The researcher found that students needed to spend long periods studying mathematical concepts and procedures before they reached full understanding. The statement achieved the highest average score of 4.1 implying strong agreement that learning Mathematics requires significant mental effort, while a standard deviation of 0.9709 indicating consistency in responses.

Moreover, on the statement "The tasks in Mathematics require handling multiple elements which need to be processed at the same time," the results show that 120 (40.7%) of the students stayed neutral about it while 158 (53.6%) showed agreement and 17 (5.7%) expressed strong agreement. The finding showed that the majority of the students 158 (53.6%) agreed with the statement which indicates students view Mathematics assignments as requiring them to handle multiple connected elements at the same time. The researcher found that students faced obstacles when they needed to bring together mathematical formulas with academic knowledge and calculation methods during their problem-solving process. The average score of 3.7 thus shows that most students agreed with the statement, while the low standard deviation of 0.9012 suggests substantial consensus among themselves. The result therefore shows that mathematical problems with complex structures create higher mental processing requirements which produce negative effects on student school performance.

Finally, the findings show that 7 (2.4%) of the Grade Nine students strongly disagreed with the statement "I feel overwhelmed when solving difficult Mathematics problems", 32 (10.8%) disagreed, 144 (48.8%) were neutral, 67 (22.7%) agreed, and 45 (15.3%) strongly agreed. In this regard, students who remained neutral about their mathematical difficulties made up the largest group with 144 (48.8%) which shows how students experience tough math problems in different ways. The researcher observed that some learners became anxious or frustrated when solving difficult tasks, whereas others remained confident and persistent. The average score of 3.4 indicates moderate agreement that difficult Mathematics problems can be overwhelming while the

standard deviation of 1.2141 implies substantial variation in responses. The findings thus imply that Grade Nine learners differ in their ability to manage intrinsic cognitive load when confronted with complex mathematical problems.

4.4.1.2 Qualitative Findings on Intrinsic Cognitive Load

The researcher further sought to understand the views of the public junior secondary school Mathematics teachers on intrinsic cognitive load. The responses were grouped into related themes and respondent coded as per the themes. The researcher sought first to understand the strategies Mathematics teachers used to simplify complex Mathematics concepts without losing meaning and secondly how they supported students who struggle with understanding difficult topics.

From the first question, one of the common themes was that the process of breaking complicated information into smaller parts makes it easier for the students to understand as the steps cognitive burden (18 Respondents). This implies that students achieve better understanding of information through the process of breaking down complex subjects into simple parts as this approach reduces their mental effort when learning difficult Mathematics concepts. For example, one of the Mathematics teacher from a Girls school indicted that;

> *I usually break down challenging subjects into multiple parts which I teach as separate topics before I continue with the following material.*

Another Mathematics teacher from a mixed boarding school stated that;

> *I demonstrate abstract concepts to students through basic examples which connect to their regular experiences so they understand the material better.*

On the second question, a common theme was that individualized support promotes understanding of difficult concepts (15 Respondents). The finding shows that students who receive specific educational support together with extra help and customized assistance will achieve better results in mastering difficult mathematical subjects. For instance, one of the Mathematics teacher from a mixed day school stated that;

> *I offer students who struggle with Mathematics subjects' extra explanations together with remedial instruction.*

Another Mathematics teacher from a mixed day school stated that;

> *I encourage students who have learning difficulties to ask questions as well as consult their peers to allow receive support from different people.*

The result thus indicates that simplifying complex concepts and providing individualized support for the learners could help them manage intrinsic cognitive load, thereby improving comprehension and enhancing Mathematics performance.

4.4.1.3 Hypothesis Testing

The following study hypothesis was advanced from this objective;

H_{O1}: Intrinsic cognitive load has no significant influence on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya. Pearson Coefficient Correlation was used to test the strength and direction of the relationship between intrinsic cognitive load and academic performance.

Table 4. 9: Correlations

		Academic_Performance	Intrinsic_Cognitive_Load
Academic_Performance	Pearson Correlation	1	.805**
	Sig. (2-tailed)		.000
	N	295	295
Intrinsic_Cognitive_Load	Pearson Correlation		1
	Sig. (2-tailed)		
	N		295

**. Correlation is significant at the 0.01 level (2-tailed).

The research results Table 4.9 established a strong positive and statistically significant relationship between academic performance in Mathematics and intrinsic cognitive load (r = .805 p < .000). The finding demonstrates that students who understand mathematical complexity will achieve better academic results. Similarly, as the p-value was < 0.05, the influence was statistically significant. As such, intrinsic cognitive load was found to significantly influence academic performance in Mathematics among the Grade Nine learners. Therefore, the study rejects the **H_{O1}**.

4.4.2 Extraneous Cognitive Load and Academic Performance in Mathematics

The second research objective was to examine the influence of extraneous cognitive load and academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya. Similarly, Grade Nine students in public junior secondary schools in Kajiado West sub county were issued with a questionnaire containing queries and four items on a 5-point Likert scale on extraneous cognitive load sub scale.

Mathematics teachers were also interviewed on this subject to provide more insights. The findings were as presented.

4.4.2.1 Descriptive Statistics of Extraneous Cognitive Load

Table 4. 10: Grade Nine Student Responses on Extraneous Cognitive Load

Statement	SD	D	N	A	SA	Mean	Std. Dev.
	F (%)	F (%)	F (%)	F (%)	F (%)		
The way the information is presented make learning more difficult than necessary.	0 (0.0%)	28 (9.5%)	89 (30.2%)	123 (41.7%)	55 (18.6%)	3.4	1.1560
The instructions and explanations during Mathematics lesson are very ineffective or confusing	27 (9.2%)	74 (25.1%)	146 (49.5%)	30 (10.1%)	18 (6.1%)	2.9	1.3191
I need to focus my mental energy on matters which does not contribute to my content understanding	21 (7.1%)	133 (45.1%)	141 (47.8%)	0 (0.0%)	0 (0.0%)	2.4	1.4322
The teacher moves too fast for me to follow.	37 (12.5%)	62 (21.0%)	154 (52.2%)	30 (10.1%)	12 (4.2%)	2.4	1.4322
Overall Mean and Standard Deviation						**2.8**	**1.3349**

Source: Field, 2026

Table 4.10 the results shows that 28 (9.5%) disagreed with the statement "The way the information is presented make learning more difficult than necessary," while 89 (30.2%) remained neutral, 123 (41.7%) agreed, and 55 students (18.6%) strongly agreed with it. From this finding, the highest percentage 123 (41.7%) of the students agreed with this statement which shows that many students believe information delivery methods create additional learning obstacles. The researcher found that some students faced difficulties in understanding concepts when explanations, examples, or instructional materials lacked clarity. The average score of 3.4 shows moderate agreement that teaching methods create learning challenges while a standard deviation value of 1.1560 suggests moderate variation in students' perceptions.

Similarly, the findings on the statement "The instructions and explanations during Mathematics lesson are very ineffective or confusing" show that 27 (9.2%) of the students strongly

disagreed with it, 74 (25.1%) disagreed, 146 (49.5%) were neutral, 30 (10.1%) agreed, and 18 (6.1%) strongly agreed with it. The research shows 146 (49.5%) of the students chose neutral which indicates that they did not show strong feelings about confusing instructional explanations. The researcher found that most Mathematics teachers delivered their lessons through understandable explanations yet some students faced difficulties when following their instructions. The statement recorded a mean score of 2.9 most students showed neutral reactions to explanation effectiveness while a standard deviation of 1.3191 implied considerable variation in opinions.

Moreover, the research data shows that 21 (7.1%) strongly disagreed, 133 (45.1%) disagreed, 141 (47.8%) were neutral, while none agreed or strongly agreed with the statement "I need to focus my mental energy on matters which does not contribute to my content understanding." From this finding, students who remained neutral about the statement made up the largest group 141 (47.8%). This suggests that most learners did not perceive themselves as expending substantial mental effort on irrelevant matters during Mathematics lessons. The research found that students kept their attention on their learning tasks and the educational material which their teachers presented. The statement average score of 2.4 indicates disagreement that irrelevant activities consumed cognitive resources, while the high standard deviation of 1.4322 suggests diverse perceptions among respondents.

Finally, on the statement "The teacher moves too fast for me to follow," the research data shows that 37 (12.5%) strongly disagreed with it, 62 (21.0%) disagreed, 154 (52.2%) were neutral, 30 (10.1%) agreed, and 12 (4.2%) strongly agreed with it. From the finding, students who stayed neutral about their lesson pace formed the largest group 154 (52.2%). The researcher found that teachers modified their teaching methods to match student comprehension levels but some students still encountered difficulties when trying to follow the lessons. The statement mean score value of 2.4 indicates that lesson pace was generally not considered problematic while a standard deviation value of 1.4322 suggests that students showed different levels of concern about this issue.

4.4.2.2 Qualitative Findings on Extraneous Cognitive Load

Mathematics teachers were further interviewed on extraneous cognitive load to get more details and insights not captured in the questionnaire. The researcher first sought their opinion on

which aspects of teaching could unintentionally make Mathematics harder for students and secondly, how they managed the pace of instruction to accommodate different learners.

One of the common themes on the first question was that poor instructional delivery increases unnecessary cognitive load (13 Respondents). The theme shows how teaching methods which lack clarity, provide too much content, disorganized materials, and ineffective instructional approaches create extra mental work for students which blocks the ability to learn and understand. For example, one of the Mathematics teacher from a mixed day school indicated that;

> *Mathematics teaching becomes confusing for students when teachers use complex words and provide excessive instructions all at once*.

Similarly, another teacher from a mixed boarding school stated that;

> *Teachers who move through their lessons too fast without proper explanations create learning obstacles for their students who must understand all concepts.*

Likewise, on the second question, another recurring theme was that flexible pacing supports diverse learning needs among the students (12 Respondents). The theme demonstrates that by adjusting the instructional pace according to the abilities of the students, help reduce mental overload while enabling them to understand material properly. For example, one of the teachers from a mixed day school indicted that;

> *I conduct student understanding assessments before beginning new material because I want to verify that most students maintain equal progress levels.*

Another teacher from a mixed day stated that;

> *I take extra time to help students who struggle with the material by giving them more practice before I continue with the rest of the lesson.*

The research finding showed that teachers who deliver lessons effectively through adaptable delivery methods successfully minimized the amount of mental effort students needed to comprehend the material. Mathematics teachers therefore recognized that by reducing extraneous cognitive load supports better understanding and engagement in Mathematics.

4.4.2.3 Hypothesis Testing

The following study hypothesis was advanced from this objective;

H_{O2}: Extraneous cognitive load has no significant influence on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-

county, Kajiado county, Kenya. Pearson Coefficient Correlation was also used to test the strength and direction of the relationship between extraneous cognitive load and academic performance.

Table 4. 11: Correlations

		Academic_Performance	Extraneous_Cognitive_Load
Academic_Performance	Pearson Correlation	1	.724**
	Sig. (2-tailed)		.000
	N	295	295
Extraneous_Cognitive_Load	Pearson Correlation		1
	Sig. (2-tailed)		
	N		295

**. Correlation is significant at the 0.01 level (2-tailed).

The analysis results Table 4.11 showed a strong positive statistical correlation between extraneous cognitive load and Mathematics academic performance (r = .724, p = .000). The research established that instructional factors establish strong connections with student academic performance. The significance value of < 0.05 threshold, confirmed that the influence was statistically significant. The research results demonstrate that aspects of instructional delivery together with classroom settings create essential conditions which significantly influence student performance in Mathematics. Extraneous cognitive load was therefore found to significantly influence academic performance among Grade Nine students. Thus, the study rejected **H_{O2}.**

4.4.3 Germane Cognitive Load and Academic Performance in Mathematics

The third research objective was to establish the influence of germane cognitive load and academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya. The researcher issued a questionnaire to Grade Nine students in public junior secondary schools in Kajiado West sub county containing queries and four items on a 5-point Likert scale on germane cognitive load sub scale. Further, Mathematics teachers were interviewed on this subject to offer their opinion about it. The findings were as presented.

4.4.3.1 Descriptive Statistics of Germane Cognitive Load

Table 4. 12: Grade Nine Student Responses on Germane Cognitive Load

Statement	SD	D	N	A	SA	Mean	Std. Dev.
	F (%)	F (%)	F (%)	F (%)	F (%)		
I to actively engage with the Mathematics material through active thinking	0 (0.0%)	0 (0.0%)	89 (30.2%)	157 (53.2%)	49 (16.6%)	3.9	0.9641
I need to dedicate time for understanding the basic principles which support the Mathematics material.	0 (0.0%)	0 (0.0%)	45 (15.3%)	165 (55.9%)	85 (28.8%)	4.1	0.6729
The Mathematics lessons enable me to connect fresh information with the knowledge which I had already learned	0 (0.0%)	0 (0.0%)	83 (28.1%)	174 (59.0%)	38 (12.9%)	3.8	1.0021
I actively work to improve my understanding of the subject matter.	0 (0.0%)	0 (0.0%)	34 (11.5%)	189 (64.1%)	72 (24.4%)	4.1	0.6194
Overall Mean and Standard Deviation						**4.0**	**0.8146**

Source: Field, 2026

The results from Table 4.10 on the statement "I to actively engage with the Mathematics material through active thinking," 89 (30.2%) stayed neutral, while 157 (53.2%) agreed, and 49 (16.6%) strongly agreed with it. The largest group of students 157 (53.2%) agreed that they deliberately invested mental effort in understanding and processing mathematical concepts. The researcher found that students participated in classroom discussions, problem-solving activities, and analytical thinking tasks. The statement average rating of 3.9 indicates that students agree that they learn through active participation in learning activities, while a standard deviation 0.9641 of suggests that consistency in responses.

Moreover, the research data shows from the sampled students, 45 (15.3%) kept neutral positions on the statement "I need to dedicate time for understanding the basic principles which support the Mathematics material" while 165 (55.9%) agreed with it and 85 (28.8%) strongly agreed with it. From the finding, the majority of students showed 165 (55.9%) agreed to dedicate

their time on understanding the basic mathematical concepts. The researcher found that students who achieved good results put in additional effort to study Mathematics concepts and develop their basic skills. The average score of 4.1 thus indicates strong agreement with the statement, while the standard deviation of 0.6729 reflects substantial consensus among respondents.

In addition, on the statement "The Mathematics lessons enable me to connect fresh information with the knowledge which I had already learned," 83 (28.1%) students remained neutral about it while 174 (59.0%) agreed and 38 (12.9%) strongly agreed with it. The research indicates that most students 174 (59.0%) demonstrated their ability to understand new mathematical ideas by combining them with their existing knowledge. The researcher found that students made repeated connections between their previous studies and their current problem-solving work which proved their ability to build important mental relationships. The average score of 3.8 shows most students agree their lessons help them connect different types of knowledge while a standard deviation score of 1.0021 suggests that the respondents' opinions show moderate variability.

Finally, the study results show that 34 (11.5%) of the students chose to stay neutral all with the statement "I actively work to improve my understanding of the subject matter" while 189 (64.1%) agreed and 72 (24.4%) showed strong agreement with it. The highest percentage was recorded among students who agreed 189 (64.1%) with the statement. The finding suggests that most students decided to spend their time learning better Mathematics skills based on their actions. The researcher found that students dedicated their time to revising material while they worked on practice problems, discussed with their peers, and studied alone. The mean value of 4.1 indicates strong agreement with the statement, while a standard deviation of 0.6194 reflects a high degree of consensus among respondents.

4.4.3.2 Qualitative Findings on Germane Cognitive Load

Finally, Mathematics teachers from the sampled public junior secondary schools were asked to give their opinions on germane cognitive load. The researcher first sought to understand how the teachers' helped students connect new topics with prior knowledge and secondly, how

peer discussions or group work contributed to students' understanding. Responses were also grouped into themes and findings were as follows;

One of the recurring themes from the respondents was that linking prior knowledge to new learning enhances conceptual understanding (10 Respondents). The theme demonstrates that students should connect new knowledge with their existing knowledge base as this process helps them build a mental framework which leads to effective learning and better understanding of Mathematical concepts. For instance, one of the teachers from a mixed day school stated that;

> *I start every new subject by going over relevant past material which helps students understand how different concepts link together.*

Another Mathematics teacher from a mixed boarding school noted that;

> *I support students to remember their existing knowledge which they can apply to find answers for fresh Mathematics challenges.*

Another common theme on the second question was that collaborative learning strengthens knowledge construction (14 Respondents). The theme shows that students who work together will actively participate in learning activities through mutual discussions which help them share different viewpoints and correct mistaken beliefs about Mathematics concepts which leads to improved comprehension of the subject matter. For instance, one of the Mathematics teacher from a girls school indicated that;

> *Students learn better when they participate in group discussions which let them explain concepts to classmates who gain understanding through listening activities.*

Another teacher from a mixed day school noted that;

> *Students who work together share individual problem-solving methods which enables them to grasp the subject matter at a more profound level.*

The results thus demonstrate that students achieve better learning by connecting existing knowledge to fresh information while working together with peers which enhances their cognitive processing abilities and leads to better performance in Mathematics.

4.4.3.3 Hypothesis Testing

The following study hypothesis was advanced from this objective;

H_{O3}: Germane cognitive load has no significant influence on academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-

county, Kajiado county, Kenya. The study used Pearson Coefficient Correlation to further test the strength and direction of the relationship between germane cognitive load and academic performance.

Table 4. 13: Correlations

		Academic_Performance	Germane_Cognitive_Load
Academic_Performance	Pearson Correlation	1	.813**
	Sig. (2-tailed)		.000
	N	295	295
Germane_Cognitive_Load	Pearson Correlation		1
	Sig. (2-tailed)		
	N		295

**. Correlation is significant at the 0.01 level (2-tailed).

The research findings in Table 4.13 established a strong positive connection between germane cognitive load and academic performance in Mathematics (r=.813 p < 0.000). The research showed the highest correlation between the three cognitive load dimensions under study. The finding suggests that students who actively participate in meaningful learning activities which involve linking what they know with new information tend to achieve better academic results. The statistical test showed a p-value < 0.05 which means the influence was statistically significant. Therefore, germane cognitive load significantly influenced academic performance in Mathematics. The study thus rejected **H_{O3}**.

4.4.4 Prediction Equation for Academic Performance in Mathematics

The fourth research objective was to develop a prediction equation for academic performance in Mathematics from cognitive load among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya. The researcher sought to understand whether cognitive load predicted academic performance in Mathematics.

4.4.4.3 Hypothesis Testing

The following study hypothesis was advanced from this objective;

H_{O4}: Cognitive load does not significantly predict academic performance in Mathematics from cognitive load among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

Regression analysis was thus done to establish how changes in cognitive load variables intrinsic cognitive load, extraneous cognitive load, and germane cognitive load would influence academic performance in Mathematics among Grade Nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

Table 4. 14: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.825[a]	.681	.677	.49332

a. Predictors: (Constant), Intrinsic_Cognitive_Load, Extraneous_Cognitive_Load, Germane_Cognitive_Load,

The model summary results Table 4.14 showed that the different cognitive load dimensions which combined together predicted academic performance (R = .825). The research demonstrated that 68.1% of academic performance changes could be explained through intrinsic, extraneous, and germane cognitive load variables (R^2 = .681). The findings therefore suggest that cognitive load dimensions collectively provide substantial explanatory power in predicting learners' academic performance in Mathematics.

Table 4. 15: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	150.905	3	50.302	206.691	.000[b]
	Residual	70.820	291	.243		
	Total	221.725	294			

a. Dependent Variable: Academic_Performance
b. Predictors: (Constant), Intrinsic_Cognitive_Load, Extraneous_Cognitive_Load, Germane_Cognitive_Load,

The ANOVA results Table 4.15 demonstrated that the regression model regression model was statistically significant, $F(3,291) = 206.691$, $p < .000$). As the p value was <0.0, the regression model adequately predicts academic performance in Mathematics. The research results suggest that the combined dimensions of cognitive load significantly explain variations in the academic performance of students. Thus, cognitive load significantly predicts academic performance in Mathematics among Grade Nine students in public junior secondary schools. The study therefore rejects **H_{O4}** and concludes that all the dimensions of cognitive load (intrinsic cognitive load,

extraneous cognitive load, and germane cognitive load) jointly and significantly predict academic performance in Mathematics among Grade Nine students in public junior secondary schools in Kajiado-West Sub-County, Kajiado County, Kenya.

Table 4. 16: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.660	.115		5.735	.000
	Intrinsic_Cognitive_Load	.240	.113	.270	2.128	.034
	Extraneous_Cognitive_Load	.152	.151	.173	1.007	.001
	Germane_Cognitive_Load	.362	.109	.397	3.332	.000

a. Dependent Variable: Academic_Performance

The regression coefficients results Table 4.16 demonstrated that germane cognitive load (β = .397, p = .000) served as the most powerful academic performance predictor followed by intrinsic cognitive load (β = .270, p = .034). and finally extraneous cognitive load (β = .173, p = .001). The research revealed that all three dimensions made important contributions to the prediction model. The regression equation as follows;

$$Academic\ Performance\ in\ Mathematics(Y) = .660 + .240 Intrinsic\ Cognitive\ Load + .152 Extraneous\ Cognitive\ Load + .362 Germane\ Cognitive\ Load$$

The equation indicates that a one-unit increase in intrinsic cognitive load would result in increase of 0.240 units in academic performance, holding other variables constant. Likewise, an increase by a one-unit germane cognitive load and extraneous would also result in increase of .362 and .152 units in academic performance, respectively, holding other variables constant. Thus, the research findings demonstrated that cognitive load directly affects academic performance which led to the rejection of the null hypothesis (**H_{O4}**).

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the discussions per study objectives from the findings, the conclusions, and the recommendations.

5.2 Discussions

5.2.1 Intrinsic Cognitive Load on Academic Performance in Mathematics

The study results established a strong positive and statistically significant relationship between intrinsic cognitive load and academic performance in Mathematics among Grade Nine students in Kajiado West Sub-County, Kenya. From the analysis, the overall mean for intrinsic cognitive load was 3.7 (SD = 1.0222) on a 5-point scale (Table 4.8) which indicated a strong agreement that mathematical content complexity imposes mental effort. Moreover, the correlation analysis results Table 4.3 demonstrated a strong correlation between intrinsic cognitive load and academic performance (r = .805 p < .000). Similarly, with p < 0.05 implied the relationship was statistically significant, which led to the rejection of the null hypothesis (H_{01}). The findings therefore suggest that students' ability to manage the inherent complexity of Mathematics concepts significantly influences their academic performance.

The current findings strongly align with the theoretical proposition by Chen et al. (2023) that intrinsic cognitive load, shaped by element interactivity and prior knowledge, directly impacts learning outcomes. The strong positive relationship between the two variables (r = .805) supports the findings by Evans et al. (2024) who denotes that student who managed their intrinsic load performed better in their studies. However, the present study contradicts Baiduri et al. (2024) who identified no relationship between cognitive load and mathematical performance in Indonesian university students, the present research shows a strong relationship between these factors in public junior secondary schools. Similarly, while the research by Al-Sarry et al. (2022) demonstrated negative impact of mental effort on educational outcomes, the study failed to separate intrinsic load as a separate predictor variable. The present research fills the gaps by examination intrinsic cognitive load as a predictor of academic performance in Mathematics among Grade Nine students and specifically quantifying the predictive power (β = .270 p = .034). The current study presents a

statistically robust model for public junior secondary schools in Kenya which Spijkerman et al. (2024) did not develop for their medical education. Finally, whereas Wara et al. (2018) analyzed general cognitive engagement, the present study focuses on intrinsic load on academic performance in Mathematics which fills the contextual gap identified in the literature review for Kajiado-West Sub-County.

5.2.2 Extraneous Cognitive Load and Academic Performance in Mathematics

The study results established a strong positive and statistically significant relationship between extraneous cognitive load and academic performance in Mathematics. The correlation analysis results in Table 4.11 shows a statistical relationship between variables ($r = .724$) and $p < .05$ indicates strong significance. The statistical analysis shows that instructional elements strongly affect student academic success and the p-value demonstrates the relationship was statistically significant at the 0.05 level. As such, the null hypothesis (H_{02}) was rejected. The findings thus suggest that lesson organization, instructional delivery, classroom communication, and learning environments significantly influence students' academic performance in Mathematics.

The present research supports the findings by Surbakti et al. (2024) and Gnawali (2025) which demonstrated that poorly designed instruction created unnecessary mental load that hindered academic performance. The study further aligns with Warsono et al. (2024) whose established that mathematics-based learning techniques improved learners' performance by managing the cognitive load. The study builds upon prior research which Warsono et al. conducted on university accounting by exploring its effects on junior secondary school mathematics education. Unlike the study by Geberkidan et al. (2025) who focused on how blended learning affected student cognitive demand but did not create a performance prediction model based on extraneous load, the current study creates a prediction equation from its data ($\beta = .173$, $p < .001$). Further, while Ochukut et al. (2025) studied extraneous load in Kenyan university e-learning settings, their study failed to establish it as a predictor of academic performance. The current study therefore fills this gap by demonstrating that extraneous cognitive load significantly predicts mathematics performance in public junior secondary schools.

5.2.3 Germane Cognitive Load and Academic Performance in Mathematics

The findings of the study established that germane cognitive load had the strongest relationship with academic performance in Mathematics among the three cognitive load dimensions investigated. Table 4.13 presenting the correlation analysis results showed that germane cognitive had a strong positive relationship with academic performance in Mathematics (r = .813, p < .000). As the significance value was below the 0.05 level, the relationship was statistically significant. The study thus rejected the null hypothesis (H_{03}). The research therefore showed that students who actively participated in meaningful learning activities and actively build their understanding achieved better results in Mathematics.

The current research results support the findings of Sulisworo et al. (2024) and Seepiwsiw & Seehamongkon (2023) who argued that students who build schemas through reflective thinking achieve higher academic performance. Further from the current study, students from Grade Nine in Kajiado-West dedicate mental resources to learning process based on the average score of 4.0 (SD = 0.8146) which reflects their active mental participation in understanding material. The finding aligns with a study by Ahmed (2024) in Pakistani online higher education who demonstrated that students who engaged in higher germane load achieved better learning outcomes. However, while Liu et al. (2022) demonstrated that virtual reality environments boosted germane load during science learning, their research failed to establish a general average and did not study germane load as an independent variable in standard mathematics classrooms. The current research study fills this research gap by providing this evidence (β = .397, p = .000; overall mean = 4.0). Similarly, while Mohammed et al. (2025) studied the factors which influence student success in Ghanaian science education, they ignored cognitive processes entirely the mental processes which students use. The current study thus filled the gap by demonstrating that germane cognitive load significantly predicts mathematics performance in public junior secondary schools in Kajiado West Sub-County, Kenya.

5.2.4 Prediction Equation for Academic Performance in Mathematics

The study established that cognitive load dimensions significantly predict academic performance in Mathematics. The results from Table 4.14 demonstrated that the three cognitive load types explained 68.1% of academic performance variations (R^2=.681). The statistical analysis

results from Table 4.15 showed that the regression model was statistically significant $F(3,291) = 206.691$ $p < .000$). The findings from Table 4.16 further established that germane cognitive load ($\beta = .397$, $p < .000$) emerged as the most powerful predictor followed by intrinsic cognitive load ($\beta = .270$, $p = .034$) and extraneous cognitive load ($\beta = .173$, $p < .001$). Thus, the study rejected the H_{04} and concluded that cognitive load does significantly predict academic performance in Mathematics among grade nine students in public junior secondary schools in Kajiado-west sub-county, Kajiado county, Kenya.

The current study findings align with Sweller et al. (2011) who established Cognitive Load Theory which explains that working memory performance stems from the combination of intrinsic, extraneous, and germane loads. The present study model which explains 68.1% of academic performance variation ($R^2 = .681$) links previous separate studies which studied individual factors with their corresponding average values. For example, while Al-Sarry et al. (2022) and Baiduri et al. (2024) studied connections between these variables they did not create a unified predictive model for public junior secondary school mathematics. The current research fills this gap by developing the first complete mathematical prediction system which forecasts Grade Nine Mathematics performance for students in Kenya. The study presents a complete statistically validated model which produces prediction results ($R = .825$ $R^2 = .681$) different from Warsono et al. (2024) and Geberkidan et al. (2025) who studied teaching methods separately without developing a combined prediction model. The research shows that germane load produces the highest impact ($\beta = .397$) which demonstrates the vital role of schema construction, consistent with the high overall mean of 4.0 obtained from the descriptive analysis. The present research therefore addresses the methodological and contextual gap the literature review by developing a forecasting tool for public junior secondary schools in Kajiado-West Sub-County, Kenya, demonstrating that all three cognitive load dimensions jointly and significantly predict mathematics academic performance.

5.3 Summary of Main Findings

The study established that intrinsic cognitive load had a strong and statistically significant influence on academic performance in Mathematics among Grade Nine students. The study results showed that students found Mathematics to be a challenging subject which them to work hard

mentally for both concept comprehension and problem solving. Students who successfully handled the intricate parts of their mathematical assignments achieved better academic results. The correlation analysis showed a strong positive relationship between intrinsic cognitive load and academic performance implying that students who grasped complex Mathematics content through their natural mental abilities achieved better academic results.

Further, the study found that extraneous cognitive load significantly influenced academic performance in Mathematics among Grade Nine students. The research demonstrated through quantitative and qualitative data that proper teaching methods decrease unnecessary mental effort which leads to better student learning outcomes. The correlation results demonstrated a significant positive relationship between extraneous cognitive load and academic performance, implying that instructional practices play a critical role in shaping students' Mathematics achievement.

Moreover, the research results demonstrated that germane cognitive load produced the highest impact on student academic achievement when compared to the other two cognitive load factors which were studied. Students reported active participation in important educational activities through which they connected fresh information to their existing knowledge while working to enhance their understanding of Mathematics concepts. Teachers also emphasized the importance of collaborative learning and connecting previous knowledge to new learning. Students who engage deeply with germane cognitive load factors achieve better academic results because their meaningful mental work leads to improved Mathematics comprehension.

Finally, the research demonstrated intrinsic cognitive load, extraneous cognitive load, and germane cognitive load jointly and significantly predicted academic performance in Mathematics. The regression analysis demonstrated that students' academic performance showed major variations which the three cognitive load dimensions explained fully. The research identified germane cognitive load as the most powerful predictor which other factors followed at varying levels of influence. The research results show that cognitive load creates a major influence on Mathematics success while the study developed a dependable system which predicts student academic success.

5.4 Conclusions

The study concludes that intrinsic cognitive load significantly influences academic performance in Mathematics among Grade Nine students. Students who successfully handle inherent complexity of mathematical concepts and assignments re likely to achieve better academic results. The learning materials needs proper adjustment to achieve successful educational results which lead to enhanced student achievement.

Similarly, the study concludes that extraneous cognitive load significantly affects academic performance in Mathematics. Instructional practices that minimize unnecessary cognitive demands and help students learn better and reach their academic targets. Teachers need to provide students with proper teaching methods because this approach will help them achieve better results in Mathematics.

Further, the study concludes that germane cognitive load is a significant and the strongest contributor to academic performance in Mathematics. Students achieve better academic results when they participate in learning activities which encourage knowledge integration as well as active engagement enables to understand well. Therefore, promoting germane cognitive processes is crucial for successful Mathematics learning.

Finally, the study concludes that cognitive load significantly predicts academic performance in Mathematics among Grade Nine students. The three types of cognitive load which include intrinsic, extraneous, and germane together account for major student success rates yet germane cognitive load shows the most powerful effect. The primary goal of Mathematics performance enhancement programs needs to create environments which support useful cognitive processing while decreasing any superfluous mental efforts.

5.5 Recommendations

5.5.1 Recommendations for Practice

The study recommends that Mathematics teachers should apply student-focused methods which break down difficult topics while they connect fresh information to existing knowledge and maintain student involvement. The educational techniques enable students to handle mental workload while they build better understanding of concepts which leads to improved school

results. The educational system needs to focus on teamwork activities which will support and improve Mathematics learning.

The study also recommends that school administrators create ongoing teacher training programs on cognitive load management and effective Mathematics teaching methods. The schools need to establish proper educational material supply and create learning spaces which support student success. The established measures will strengthen teaching quality while they decrease student learning difficulties which will lead to improved student results in Mathematics.

5.5.2 Recommendations for Policy

The study recommends that the Ministry of Education and the Kenya Institute of Curriculum Development to integrate Cognitive Load Theory principles into curriculum implementation and teacher development programs. The educational system needs policies which support organized lesson presentation, step-by-step learning approaches, and student participation methods to improve Math teaching results, student involvement, and their academic success.

5.6 Areas of Further Research

Future research studies need to explore the moderating role of learner characteristics like self-efficacy, motivation on the relationship between cognitive load and student performance in Mathematics. The study would reveal how individual learner characteristics affect the success of cognitive load management methods and academic performance among junior secondary school students.

Also, future studies should conduct a comparative study on cognitive load and academic performance across other different subjects to help establish whether the influence of cognitive varies across the subjects.

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APPENDICES

Appendix I: Consent Form

Dear respondent,

The researcher is a student undertaking a Master of Education at Africa Nazarene University. The study topic is: **Influence of Cognitive Load on Academic Performance in Mathematics among Grade Nine Students in Public Junior Secondary Schools in Kajiado-West Sub-County, Kajiado County, Kenya.** For the sake of completing the study, I request for your support on responding to the questionnaire, please spare some time to complete the set of questions. I will protect your personal data by following strict privacy rules which will keep your information confidential.

The research questionnaire will remain without your name while the researcher maintains exclusive access to your personal information. Your participation remains completely voluntary so you can decide to stop participating at any time before the study begins or during its active phase. The researcher or the research assistant will not offer financial rewards or provide any facilities to support this participation. If you want to participate in this research, please sign the form in the provided space.

Participant: [To be signed by parent/guardian]

| --- | --- | --- |
| Participant's Code | Signature | Date |

Researcher:

| --- | --- | --- |
| Name of Researcher | Signature | Date |

Appendix II: Student Questionnaire

Instructions

i. Do not write your name or contact information on the questionnaire.

ii. Answer all of the questions by following the guidelines provided.

Consent: Please acknowledge below if you are willing to participate in the study.

Signature……

Date……

Signature…….

Questionnaire on an assessment on **Influence of Cognitive Load on Academic Performance in Mathematics among Grade Nine Students in Public Junior Secondary Schools in Kajiado-West Sub-County, Kajiado County, Kenya.**

Questionnaire Number: _____ Date: / / 2026

Please check the box [ ] for the relevant response in the questions below or fill in the blanks.

SECTION A: DEMOGRAPHIC DATA OF STUDENTS

1. Gender: Female [ ] Male [ ]

2. Type of your school; Girls school [ ] Mixed boarding school [ ] Mixed day school [ ]

3. Age; Below 13 yrs [ ] 14-15 yrs [ ] Above 16 yrs [ ]

SECTION B: ACADEMIC PERFORMANCE

4. State your end of term one marks: Mathematics Marks…… ……...

5. Have you noticed an improvement in your Mathematics subject performance over the last academic term?

   Yes [ ] No [ ]

6. Indicate your agreement or disagreement level with the following statements on academic performance in Mathematics. (Please tick appropriately) Note: 1= Strongly disagree 2= Disagree 3=Neutral 4=Agree 5= Strongly agree

Statement	1	2	3	4	5
I find it difficult to focus and perform well in Mathematics subjects due to high cognitive load during lessons.					
The teaching methods in Mathematics subjects are clear and easy to follow.					
I often feel mentally exhausted after Mathematics classes, which affects my ability to perform well in exams					
The quality of instruction I receive in Mathematics subjects significantly improves my academic performance					

7. How would you rate your overall performance in Mathematics?

   Excellent [ ] Good [ ] Average [ ] Below average [ ] Poor [ ]

SECTION C: INTRINSIC COGNITIVE LOAD

8. How often do you find Mathematics problems difficult to understand?

   Always [ ] Often [ ] Sometimes [ ] Rarely [ ] Never [ ]

9. Do you struggle to follow multiple steps in a Mathematics problem?

   Yes [ ] No [ ]

10. Intrinsic cognitive load is supposed to influence students' academic performance in Mathematics. Using a scale of: Strongly disagree = 1[ ], Disagree = 2[ ], Uncertain = 3[ ], Agree = 4[ ] and strongly agree = 5[ ] indicate your agreement or disagreement level with the following statements. Use tick [√] as appropriate

Statement	1	2	3	4	5
The topics covered in Mathematics are difficult					
I need to put in a lot of mental work to understand the concepts which this subject requires.					
The tasks in Mathematics require handling multiple elements which need to be processed at the same time.					
I feel overwhelmed when solving difficult Mathematics problems.					

11. How does the difficulty level of Mathematics content affect your performance?

……

……

SECTION D: EXTRANEOUS COGNITIVE LOAD

12. How clear are your teacher's explanations during Mathematics lessons?

    Very clear [ ] Clear [ ] Neutral [ ] Unclear [ ] Very unclear [ ]

13. Do you get distracted by how the lesson is delivered?

    Yes [ ] No [ ] Not Sure [ ]

14. Extraneous cognitive load is supposed to influence students' academic performance in Mathematics. Using a scale of: Strongly disagree = 1[ ], Disagree = 2[ ], Uncertain = 3[ ], Agree = 4[ ] and strongly agree = 5[ ] indicate your agreement or disagreement level with the following statements. Use tick [√] as appropriate.

Statement	**1**	**2**	**3**	**4**	**5**
The way the information is presented make learning more difficult than necessary.					
The instructions and explanations during Mathematics lesson are very ineffective or confusing					
I need to focus my mental energy on matters which does not contribute to my content understanding					
The teacher moves too fast for me to follow.					

15. What teaching methods help you understand Mathematics best?

    ……

    ……

    ……

SECTION E: GERMANE COGNITIVE LOAD

16. How often do you practice Mathematics outside class time?

    Daily [ ] Several times a week [ ] Once a week [ ] Rarely [ ] Never [ ]

17. Do you attempt extra Mathematics questions beyond classwork?

    Yes [ ] No [ ]

18. Germane cognitive load is supposed to influence students' academic performance in Mathematics. Using a scale of: Strongly disagree = 1[ ], Disagree = 2[ ], Uncertain = 3[ ],

Agree = 4[ ] and strongly agree = 5[ ] indicate your agreement or disagreement level with the following statements. Use tick [√] as appropriate.

Statement	**1**	**2**	**3**	**4**	**5**
I to actively engage with the Mathematics material through active thinking					
I need to dedicate time for understanding the basic principles which support the Mathematics material.					
The Mathematics lessons enable me to connect fresh information with the knowledge which I had already learned					
I actively work to improve my understanding of the subject matter.					

19. What strategies do you use to solve difficult Mathematics problems?

……

……

……..

Thank You!!!

Appendix III: Mathematics Teachers Interview Guide

Section A: Background

i. Can you give an overview of the general performance of Grade Nine students in Mathematics in your school?

ii. What, in your view, constitute the prevailing conditions that influence the students' performance in the Mathematics?

Section B: Academic Performance

iii. In your experiences, how would you say cognitive load affect the overall academic performance of students in Mathematics?

iv. What instructional strategies do you believe most effectively improve academic performance in Mathematics?

Section C: Intrinsic Cognitive Load

v. What strategies do you use to simplify complex Mathematics concepts without losing meaning?

vi. How do you support students who struggle with understanding difficult topics?

Section D: Extraneous Cognitive Load

vii. In your opinion, what aspects of teaching can unintentionally make Mathematics harder for students?

viii. How do you manage the pace of instruction to accommodate different learners?

Section E: Germane Cognitive Load

ix. How do you help students connect new topics with prior knowledge?

x. How do peer discussions or group work contribute to students' understanding?

THANK YOU!!!

Appendix IV: Work Plan

Activity	Jan-Feb 2026		March-April 2026		May 2026	June 2026
1. Develop and finalize research proposal - Conduct literature review - Develop data collection tools						
2. Proposal Presentation -Adjust the defense corrections						
3. Pilot study 1 week Begin main study data collection after that (surveys) 4. Conduct detailed data analysis (qualitative & quantitative) Finalize research project						
5. Presentation of the research project 6. Binding and submission of final copies						

Appendix V: Budget

The estimated budget for this study is as follows:

Budget Item	Estimated Cost (Ksh.)
Research Proposal and Tool Development	
- Printing and stationery (questionnaires)	4,500.00
Internet and communication (Bundles, calls)	1,500.00
Subtotal	**6,000.00**
Data Collection Research Assistants allowances (3 assistants by 2 days by 1500)	9,000.00
- Transport within Kajiado-West sub county	7,000.00
- Refreshments during fieldwork	3,000.00
Subtotal	**19,000.00**
Data Entry and Analysis	
Data entry (Ms. Excel)	5,000.00
- Data analysis (SPSS) and software support	10,000.00
Subtotal	**15,000.00**
Report Writing and Printing	
Printing and binding (3 copies)	3,600.00
Subtotal	**3,600.00**
Miscellaneous/Contingency	**5,000.00**
TOTAL ESTIMATED BUDGET	**48,600.00**

Appendix VI: University Approval Letter

AFRICA NAZARENE
UNIVERSITY

P.O.Box: 53067 – 00200
Nairobi, Kenya.
Tel: 020 252 7170/1 – 5
Email: vc@anu.ac.ke
www.anu.ac.ke

7th May, 2026

Dr. David Ngigi
Ag. Director General /CEO
National Commission for Science & Technology
And Innovation (NACOSTI)
Off Waiyaki Way, Upper Kabete
P. O. Box 30623 -00100
Nairobi, KENYA

Dear Sir,

RE: RESEARCH PERMIT: Daniel Harrison Munyere (Student ID#11GMED010)

This is to confirm that Daniel Harrison Munyeri (Student ID# 11GMED010) is a bona fide Master of Education student at Africa Nazarene University (ANU), School of Humanities – Education Department. He is pursuing Master of Arts in Education, a programme that entails both coursework and thesis.

Daniel successfully completed his coursework and defended his thesis proposal entitled:

"Cognitive Load Predictor and Academic Performance in Mathematics among Grade Nine Students in Public Junior Secondary Schools in Kajiado-West Sub-County, Kajiado County, Kenya.

We kindly request that he be granted the necessary research permit to facilitate data collection and the successful completion of his thesis. Any assistance provided to him in this regard will be highly appreciated.

Faithfully,

Dr. Micky Mwamuye
Acting Dean of Post Graduate Studies & Director, Institute of Research
Africa Nazarene University

Appendix VII: NACOSTI Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **918366**

Date of Issue: **26/June/2026**

RESEARCH LICENSE



This is to Certify that Mr.. DANIEL HARRISON MUNYERE of Africa Nazarene University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kajiado on the topic: INFLUENCE OF COGNITIVE LOAD ON ACADEMIC PERFORMANCE IN MATHEMATICS AMONG GRADE NINE STUDENTS IN PUBLIC JUNIOR SECONDARY SCHOOLS IN KAJIADO-WEST SUB-COUNTY, KAJIADO COUNTY, KENYA for the period ending : 26/June/2027.

License No: **NACOSTI/P/26/4191795**

918366

Applicant Identification Number

Ag. Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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See overleaf for conditions

Appendix VIII: Map of Kajiado County Showing Kajiado-West Sub-County

